

DESCRIPTION



160160



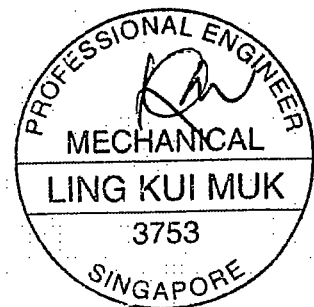
G00001

DESIGN CALCULATION

FOR

1140 TONNE S.W.L. SPREADER FRAME

**DOCUMENT NO.: 9779-C-C3-020
REVISION NO.: 0**



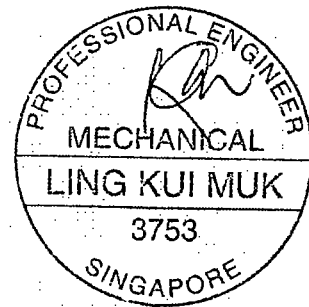
31 DEC '09

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1.0 Introduction

The purpose of this calculation report is to verify the adequacy of structural design of one existing unit of 1000 tonne S.W.L. spreader frame to load an additional of 140 tonne weight coming to a grand total of 1140 tonne. This spreader frame is designed for lifting 2 x 500 tonne spreader beam each with distribution of water bag loads in a single point lifting arrangement, with additional loads of 4x35 tonne load at each trunnion of the spreader frame during load testing of crane as illustrated in the lifting condition drawing.

2.0 Design Consideration

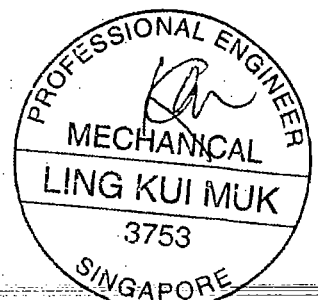
Loading conditions:

- a) This spreader frame is NOT designed and used for day-to-day transportation or handling of goods. No dynamic or impact loads is taken into account. Test loads by means of water bags are gradually filled up with water to achieve the required loading.
- b) Lifting is done by means of 4 endless round slings on 4 nos. of designated lifting trunnions.
- c) Additional 4 water bags are added to the trunnions of the spreader frame.

The designs for the structural members are based on Allowable Stress Design (ASD) in accordance with AISC.

3.0 Conclusion

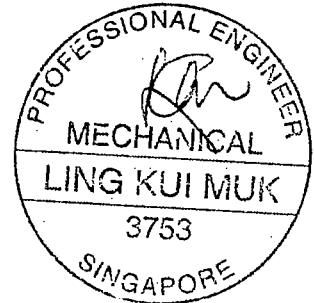
As detailed in attached reports in the Appendixes, the structural members meet the requirements of the design code base on the above design consideration.



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4.0 References:

- a) 1140 Tonne Spreader Frame Lifting Arrangement
Drawing no.: RT-RM-DWG-120 (Rev1)

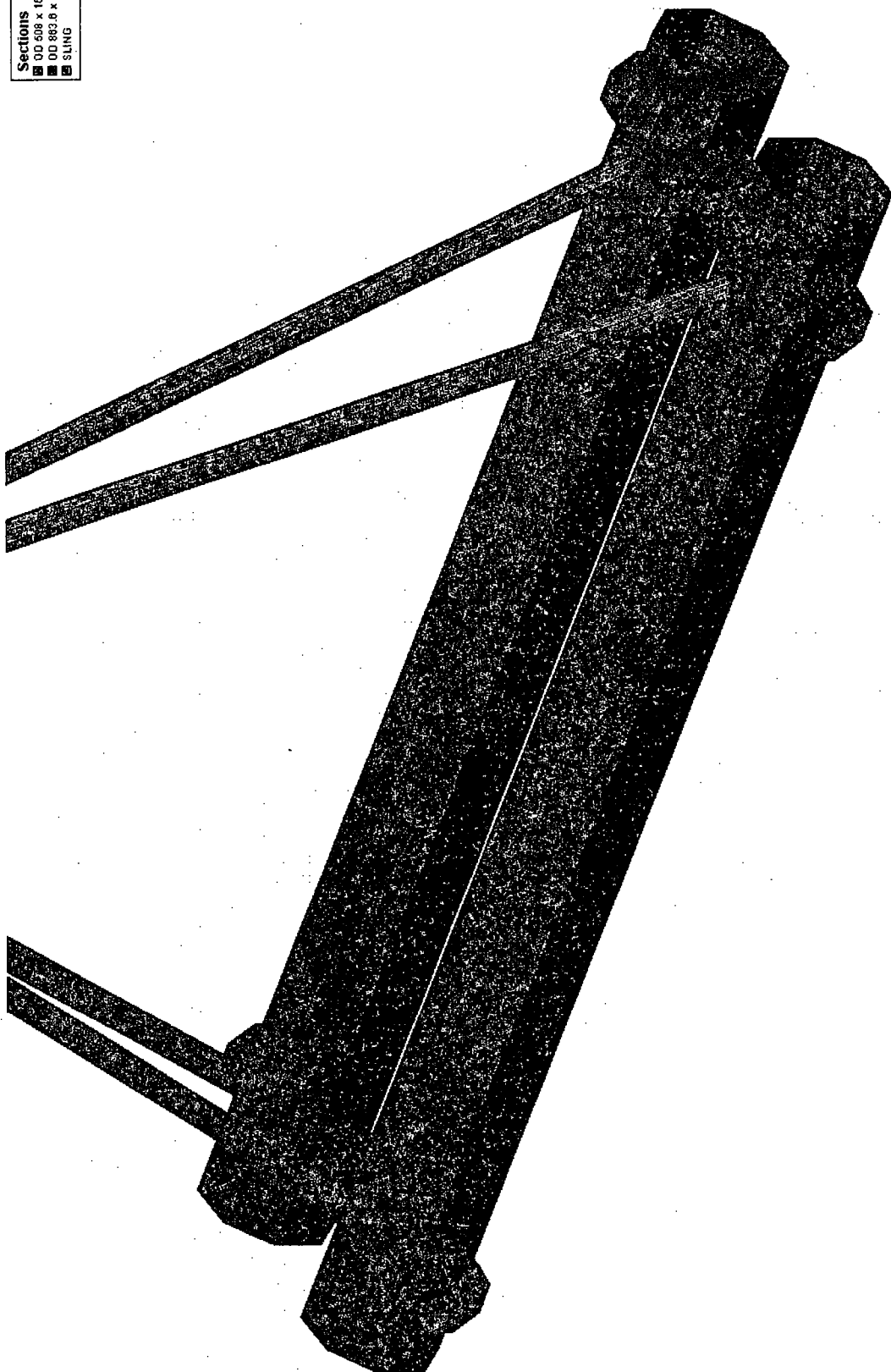


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Appendix A

MULTIFRAME Model & Graphic Plot

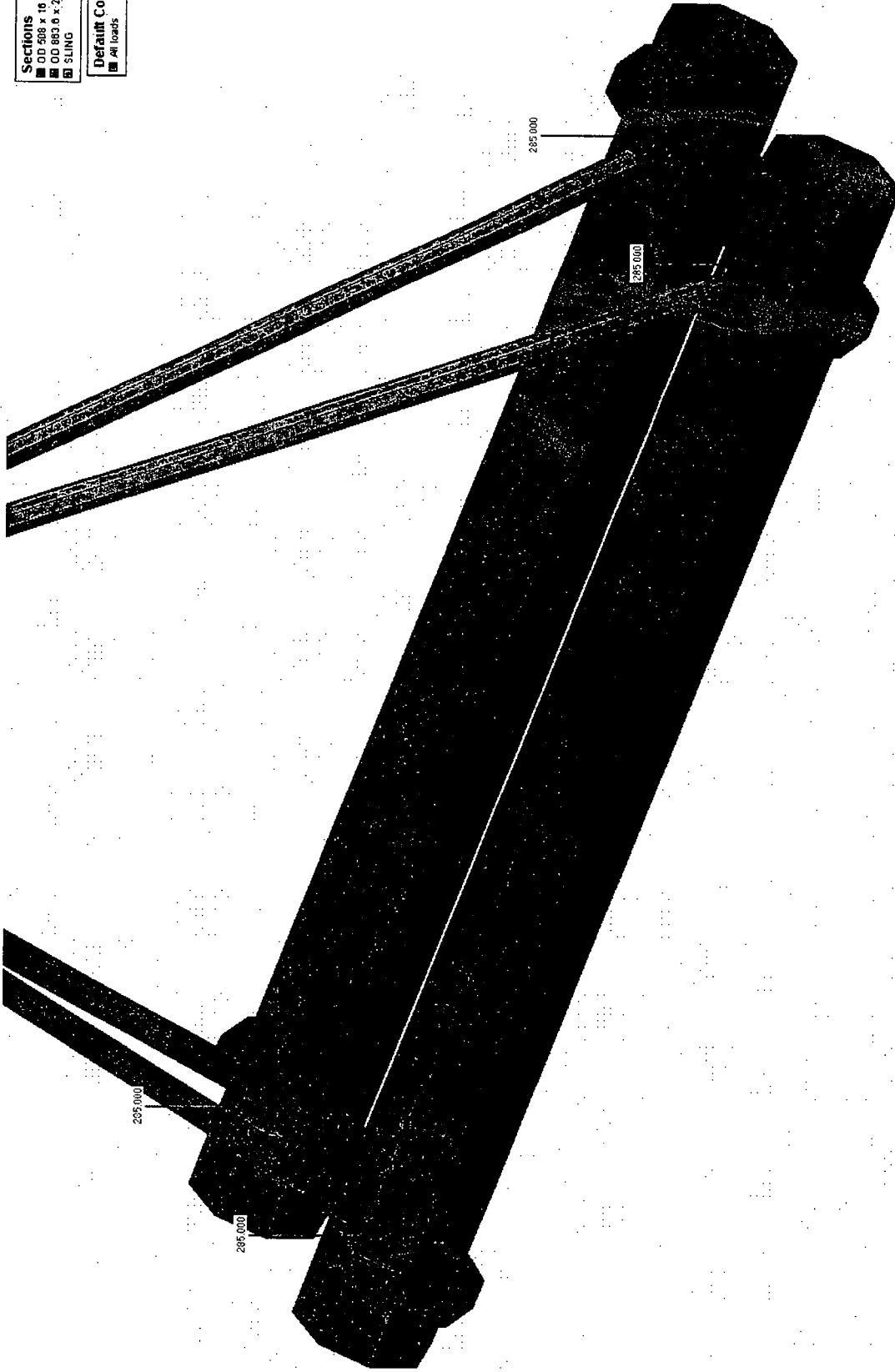
Sections	
	OD 608 x 18 WT
	OD 803.8 x 20 WT
	SLING



FRAME MODEL & MEMBER DIAGRAM

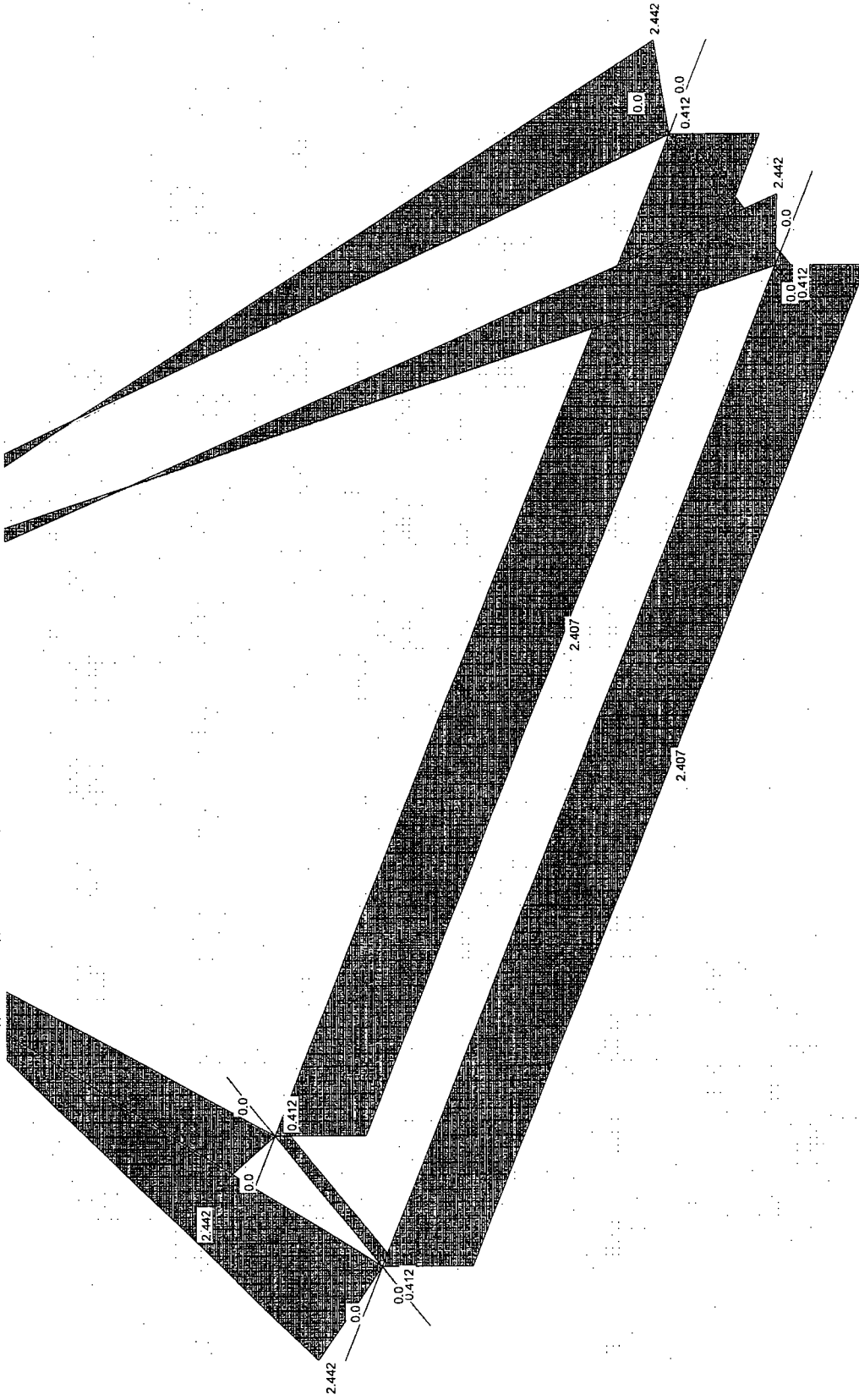
Sections
 ■ OD 508 x 10 WT
 ■ OD 683.0 x 20 WT
 ■ SLING

Default Colour
 ■ All loads



Load Case 1

LOAD DISTRIBUTION DIAGRAM



Static Case: Load Case 1: Mz (kN-m)

BENDING STRESS DIAGRAM

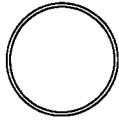
Appendix B

Steel design report to ASIC ASD

Steel Design Report

Checking design member 1

Members: 1
Group: Custom1
Section: OD 508 x 16 WT



Load Case: Load Case 1

$$F_y = 248.21 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 248.21 = 148.93 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 399.9 = 199.95 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 248.21 = 99.28 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 632.0 / 174.04, 1.0 * 632.0 / 174.04) = 3.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 3.63^2 / (2 * 126.1^2)) * 248.21 / 1.68 = 147.91 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 248.21 = 163.82 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 248.21 = 163.82 \text{ MPa}$$

Design Member 1, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 1, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 1, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.0 \leq 2.53 \text{ mm OK } 100\% \text{ under}$$

Design Member 1, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 1, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 1, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 2.53 \text{ mm OK } 100\% \text{ under}$$

Design Member 1, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 148.93 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 199.95 \text{ OK } 100\% \text{ under}$$

Design Member 1, Load Case 1, Slenderness

$$K_x * L_x / r_x = 1.0 * 632.0 / 174.04 = 3.63 \leq 200.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 632.0 / 174.04 = 3.63 \leq 200.0 \text{ OK } 98\% \text{ under}$$

Design Member 1, Load Case 1, Compression

$$f_a \leq F_a, 0.0 \leq 147.91 \text{ OK } 100\% \text{ under}$$

Design Member 1, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 199.95 + 0.0 / 163.82 + 0.0 / 163.82 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 1, Load Case 1, Bending + Compression

$$f_a / F_a = 0.0 / 147.91 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0 / 147.91 + 0.0 / 163.82 + 0.0 / 163.82 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 1, Load Case 1, Sway

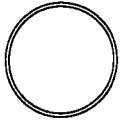
$$\Delta \leq Y/300.0, 0.47 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 2

Members: 2

Group: Custom1

Section: OD 508 x 16 WT



Load Case: Load Case 1

$$F_y = 248.21 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 \cdot F_y = 0.6 \cdot 248.21 = 148.93 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 \cdot F_u = 0.5 \cdot 399.9 = 199.95 \text{ MPa}$$

$$F_v = 0.4 \cdot F_y = 0.4 \cdot 248.21 = 99.28 \text{ MPa}$$

$$KL/r = \max(K_x \cdot I/r_x, K_y \cdot I/r_y) = \max(1.0 \cdot 1404.0/174.04, 1.0 \cdot 1404.0/174.04) = 8.07$$

$$F_a = (1 - (KL/r)^2 / (2 \cdot C_c^2)) \cdot F_y / F_S = (1 - 8.07^2 / (2 \cdot 126.1^2)) \cdot 248.21 / 1.69 = 146.52 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 \cdot F_y = 0.66 \cdot 248.21 = 163.82 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 \cdot F_y = 0.66 \cdot 248.21 = 163.82 \text{ MPa}$$

Design Member 2, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.14 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.14 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 2, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 2, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.0 \leq 5.62 \text{ mm OK } 100\% \text{ under}$$

Design Member 2, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 2, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 2, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 5.62 \text{ mm OK } 100\% \text{ under}$$

Design Member 2, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 148.93 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 199.95 \text{ OK } 100\% \text{ under}$$

Design Member 2, Load Case 1, Slenderness

$$K_x \cdot L_x / r_x = 1.0 \cdot 1404.0 / 174.04 = 8.07 \leq 200.0 \text{ OK } 96\% \text{ under}$$

$$K_y \cdot L_y / r_y = 1.0 \cdot 1404.0 / 174.04 = 8.07 \leq 200.0 \text{ OK } 96\% \text{ under}$$

Design Member 2, Load Case 1, Compression

$$f_a \leq F_a, 10.01 \leq 146.52 \text{ OK } 93\% \text{ under}$$

Design Member 2, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 199.95 + 0.14 / 163.82 + 0.0 / 163.82 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 2, Load Case 1, Bending + Compression

$$f_a / F_a = 10.01 / 146.52 = 0.07 \leq 0.15 \therefore \phi 0$$

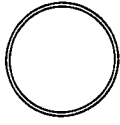
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 10.01 / 146.52 + 0.14 / 163.82 + 0.0 / 163.82 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Design Member 2, Load Case 1, Sway

$$\Delta \leq Y/300.0, 0.47 \leq 0.0/300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 3

Members: 3
Group: Custom1
Section: OD 508 x 16 WT



Load Case: Load Case 1

$$F_y = 248.21 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 248.21 = 148.93 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 399.9 = 199.95 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 248.21 = 99.28 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 632.0 / 174.04, 1.0 * 632.0 / 174.04) = 3.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 3.63^2 / (2 * 126.1^2)) * 248.21 / 1.68 = 147.91 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 248.21 = 163.82 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 248.21 = 163.82 \text{ MPa}$$

Design Member 3, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 3, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 3, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.0 \leq 2.53 \text{ mm OK } 100\% \text{ under}$$

Design Member 3, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 3, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 3, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 2.53 \text{ mm OK } 100\% \text{ under}$$

Design Member 3, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 148.93 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 199.95 \text{ OK } 100\% \text{ under}$$

Design Member 3, Load Case 1, Slenderness

$$K_x * L_x / r_x = 1.0 * 632.0 / 174.04 = 3.63 \leq 200.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 632.0 / 174.04 = 3.63 \leq 200.0 \text{ OK } 98\% \text{ under}$$

Design Member 3, Load Case 1, Compression

$$f_a \leq F_a, 0.0 \leq 147.91 \text{ OK } 100\% \text{ under}$$

Design Member 3, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 199.95 + 0.0 / 163.82 + 0.0 / 163.82 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 3, Load Case 1, Bending + Compression

$$f_a / F_a = 0.0 / 147.91 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0 / 147.91 + 0.0 / 163.82 + 0.0 / 163.82 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 3, Load Case 1, Sway

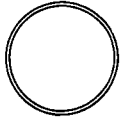
$$\Delta \leq Y/300.0, 0.47 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 4

Members: 4

Group: Custom1

Section: OD 863.6 x 20 WT



Load Case: Load Case 1

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * I/r_x, K_y * I/r_y) = \max(1.0 * 704.0 / 298.34, 1.0 * 704.0 / 298.34) = 2.36$$

$$F_a = (1 - (KL/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 2.36^2 / (2 * 105.44^2)) * 355.0 / 1.68 = 211.88 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 4, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 4, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 4, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.01 \leq 2.82 \text{ mm OK } 100\% \text{ under}$$

Design Member 4, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 4, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 4, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 2.82 \text{ mm OK } 100\% \text{ under}$$

Design Member 4, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 4, Load Case 1, Slenderness

$$K_x * L_x / r_x = 1.0 * 704.0 / 298.34 = 2.36 \leq 200.0 \text{ OK } 99\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 704.0 / 298.34 = 2.36 \leq 200.0 \text{ OK } 99\% \text{ under}$$

Design Member 4, Load Case 1, Compression

$$f_a \leq F_a, 0.0 \leq 211.88 \text{ OK } 100\% \text{ under}$$

Design Member 4, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.0 / 234.3 + 0.0 / 234.3 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 4, Load Case 1, Bending + Compression

$$f_a / F_a = 0.0 / 211.88 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 211.88 + 0.0 / 234.3 + 0.0 / 234.3 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 4, Load Case 1, Sway

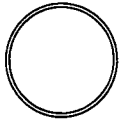
$$\Delta \leq Y/300, 0.47 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 5

Members: 5

Group: Custom1

Section: OD 863.6 x 20 WT



Load Case: Load Case 1

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 7484.0 / 298.34, 1.0 * 7484.0 / 298.34) = 25.09$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 25.09^2 / (2 * 105.44^2)) * 355.0 / 1.75 = 196.64 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 5, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.22 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.22 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 5, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 5, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.02 \leq 29.94 \text{ mm OK } 100\% \text{ under}$$

Design Member 5, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 5, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 5, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 29.94 \text{ mm OK } 100\% \text{ under}$$

Design Member 5, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 5, Load Case 1, Slenderness

$$K_x * L_x / r_x = 1.0 * 7484.0 / 298.34 = 25.09 \leq 200.0 \text{ OK } 87\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 7484.0 / 298.34 = 25.09 \leq 200.0 \text{ OK } 87\% \text{ under}$$

Design Member 5, Load Case 1, Compression

$$f_a \leq F_a, 24.88 \leq 196.64 \text{ OK } 87\% \text{ under}$$

Design Member 5, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.22 / 234.3 + 0.0 / 234.3 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 5, Load Case 1, Bending + Compression

$$f_a / F_a = 24.88 / 196.64 = 0.13 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} + \phi_{\beta_\psi} / \Phi_{\beta_\psi} = 24.88 / 196.64 + 0.22 / 234.3 + 0.0 / 234.3 = 0.13 \leq 1 \text{ OK } 87\% \text{ under}$$

Design Member 5, Load Case 1, Sway

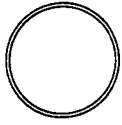
$$\Delta \leq Y/300.0, 0.47 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 6

Members: 6

Group: Custom1

Section: OD 863.6 x 20 WT



Load Case: Load Case 1

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 704.0 / 298.34, 1.0 * 704.0 / 298.34) = 2.36$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / F_S = (1 - 2.36^2 / (2 * 105.44^2)) * 355.0 / 1.68 = 211.88 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 6, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 6, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 6, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.01 \leq 2.82 \text{ mm OK } 100\% \text{ under}$$

Design Member 6, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 6, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 6, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 2.82 \text{ mm OK } 100\% \text{ under}$$

Design Member 6, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 6, Load Case 1, Slenderness

$$K_x * L_x / r_x = 1.0 * 704.0 / 298.34 = 2.36 \leq 200.0 \text{ OK } 99\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 704.0 / 298.34 = 2.36 \leq 200.0 \text{ OK } 99\% \text{ under}$$

Design Member 6, Load Case 1, Compression

$$f_a \leq F_a, 0.0 \leq 211.88 \text{ OK } 100\% \text{ under}$$

Design Member 6, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.0 / 234.3 + 0.0 / 234.3 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 6, Load Case 1, Bending + Compression

$$f_a / F_a = 0.0 / 211.88 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 211.88 + 0.0 / 234.3 + 0.0 / 234.3 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 6, Load Case 1, Sway

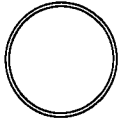
$$\Delta \leq Y/300.0, 0.47 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 7

Members: 7

Group: Custom1

Section: OD 508 x 16 WT



Load Case: Load Case 1

$$F_y = 248.21 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 248.21 = 148.93 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 399.9 = 199.95 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 248.21 = 99.28 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 632.0 / 174.04, 1.0 * 632.0 / 174.04) = 3.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 3.63^2 / (2 * 126.1^2)) * 248.21 / 1.68 = 147.91 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 248.21 = 163.82 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 248.21 = 163.82 \text{ MPa}$$

Design Member 7, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 7, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 7, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.0 \leq 2.53 \text{ mm OK } 100\% \text{ under}$$

Design Member 7, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 7, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 7, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 2.53 \text{ mm OK } 100\% \text{ under}$$

Design Member 7, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 148.93 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 199.95 \text{ OK } 100\% \text{ under}$$

Design Member 7, Load Case 1, Slenderness

$$K_x * L_x / r_x = 1.0 * 632.0 / 174.04 = 3.63 \leq 200.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 632.0 / 174.04 = 3.63 \leq 200.0 \text{ OK } 98\% \text{ under}$$

Design Member 7, Load Case 1, Compression

$$f_a \leq F_a, 0.0 \leq 147.91 \text{ OK } 100\% \text{ under}$$

Design Member 7, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 199.95 + 0.0 / 163.82 + 0.0 / 163.82 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 7, Load Case 1, Bending + Compression

$$f_a / F_a = 0.0 / 147.91 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 147.91 + 0.0 / 163.82 + 0.0 / 163.82 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 7, Load Case 1, Sway

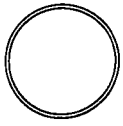
$$\Delta \leq Y/300.0, 0.47 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 8

Members: 8

Group: Custom1

Section: OD 508 x 16 WT



Load Case: Load Case 1

$$F_y = 248.21 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 248.21 = 148.93 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 399.9 = 199.95 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 248.21 = 99.28 \text{ MPa}$$

$$K_l/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1404.0 / 174.04, 1.0 * 1404.0 / 174.04) = 8.07$$

$$F_a = (1 - (K_l/r)^2 / (2 * C_c^2)) * F_y / F_S = (1 - 8.07^2 / (2 * 126.1^2)) * 248.21 / 1.69 = 146.52 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 248.21 = 163.82 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 248.21 = 163.82 \text{ MPa}$$

Design Member 8, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.14 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.14 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 8, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 8, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.0 \leq 5.62 \text{ mm OK } 100\% \text{ under}$$

Design Member 8, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 8, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 8, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 5.62 \text{ mm OK } 100\% \text{ under}$$

Design Member 8, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 148.93 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 199.95 \text{ OK } 100\% \text{ under}$$

Design Member 8, Load Case 1, Slenderness

$$K_x * L_x / r_x = 1.0 * 1404.0 / 174.04 = 8.07 \leq 200.0 \text{ OK } 96\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1404.0 / 174.04 = 8.07 \leq 200.0 \text{ OK } 96\% \text{ under}$$

Design Member 8, Load Case 1, Compression

$$f_a \leq F_a, 10.01 \leq 146.52 \text{ OK } 93\% \text{ under}$$

Design Member 8, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 199.95 + 0.14 / 163.82 + 0.0 / 163.82 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 8, Load Case 1, Bending + Compression

$$f_a / F_a = 10.01 / 146.52 = 0.07 \leq 0.15 \therefore \phi 0$$

$$\phi_a / \Phi_a + \phi_{bx} / \Phi_{bx} + \phi_{by} / \Phi_{by} = 10.01 / 146.52 + 0.14 / 163.82 + 0.0 / 163.82 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Design Member 8, Load Case 1, Sway

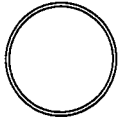
$$\Delta \leq Y/300.0, 0.47 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 9

Members: 9

Group: Custom1

Section: OD 508 x 16 WT



Load Case: Load Case 1

$$F_y = 248.21 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 248.21 = 148.93 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 399.9 = 199.95 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 248.21 = 99.28 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 632.0 / 174.04, 1.0 * 632.0 / 174.04) = 3.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 3.63^2 / (2 * 126.1^2)) * 248.21 / 1.68 = 147.91 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 248.21 = 163.82 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 248.21 = 163.82 \text{ MPa}$$

Design Member 9, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 9, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 9, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.0 \leq 2.53 \text{ mm OK } 100\% \text{ under}$$

Design Member 9, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 163.82 \text{ OK } 100\% \text{ under}$$

Design Member 9, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 99.28 \text{ OK } 100\% \text{ under}$$

Design Member 9, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 2.53 \text{ mm OK } 100\% \text{ under}$$

Design Member 9, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 148.93 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 199.95 \text{ OK } 100\% \text{ under}$$

Design Member 9, Load Case 1, Slenderness

$$K_x * L_x / r_x = 1.0 * 632.0 / 174.04 = 3.63 \leq 200.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 632.0 / 174.04 = 3.63 \leq 200.0 \text{ OK } 98\% \text{ under}$$

Design Member 9, Load Case 1, Compression

$$f_a \leq F_a, 0.0 \leq 147.91 \text{ OK } 100\% \text{ under}$$

Design Member 9, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 199.95 + 0.0 / 163.82 + 0.0 / 163.82 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 9, Load Case 1, Bending + Compression

$$f_a / F_a = 0.0 / 147.91 = 0.0 \leq 0.15 \therefore \phi 0$$

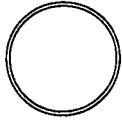
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\zeta} / \Phi_{\beta\zeta} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 147.91 + 0.0 / 163.82 + 0.0 / 163.82 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 9, Load Case 1, Sway

$$\Delta \leq Y/300.0, 0.47 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 10

Members: 10
Group: Custom1
Section: OD 863.6 x 20 WT



Load Case: Load Case 1

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * I/r_x, K_y * I/r_y) = \max(1.0 * 704.0 / 298.34, 1.0 * 704.0 / 298.34) = 2.36$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / F_S = (1 - 2.36^2 / (2 * 105.44^2)) * 355.0 / 1.68 = 211.88 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 10, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 10, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 10, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.01 \leq 2.82 \text{ mm OK } 100\% \text{ under}$$

Design Member 10, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 10, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 10, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 2.82 \text{ mm OK } 100\% \text{ under}$$

Design Member 10, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 10, Load Case 1, Slenderness

$$K_x * L_x / r_x = 1.0 * 704.0 / 298.34 = 2.36 \leq 200.0 \text{ OK } 99\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 704.0 / 298.34 = 2.36 \leq 200.0 \text{ OK } 99\% \text{ under}$$

Design Member 10, Load Case 1, Compression

$$f_a \leq F_a, 0.0 \leq 211.88 \text{ OK } 100\% \text{ under}$$

Design Member 10, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.0 / 234.3 + 0.0 / 234.3 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 10, Load Case 1, Bending + Compression

$$f_a / F_a = 0.0 / 211.88 = 0.0 \leq 0.15 \therefore \phi 0$$

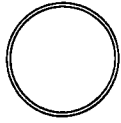
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0 / 211.88 + 0.0 / 234.3 + 0.0 / 234.3 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 10, Load Case 1, Sway

$$\Delta \leq Y/300.0, 0.47 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 11

Members: 11
Group: Custom1
Section: OD 863.6 x 20 WT



Load Case: Load Case 1

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 7484.0 / 298.34, 1.0 * 7484.0 / 298.34) = 25.09$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 25.09^2 / (2 * 105.44^2)) * 355.0 / 1.75 = 196.64 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 11, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.22 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.22 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 11, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 11, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.02 \leq 29.94 \text{ mm OK } 100\% \text{ under}$$

Design Member 11, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 11, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 11, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 29.94 \text{ mm OK } 100\% \text{ under}$$

Design Member 11, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 11, Load Case 1, Slenderness

$$K_x * L_x / r_x = 1.0 * 7484.0 / 298.34 = 25.09 \leq 200.0 \text{ OK } 87\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 7484.0 / 298.34 = 25.09 \leq 200.0 \text{ OK } 87\% \text{ under}$$

Design Member 11, Load Case 1, Compression

$$f_a \leq F_a, 24.88 \leq 196.64 \text{ OK } 87\% \text{ under}$$

Design Member 11, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.22 / 234.3 + 0.0 / 234.3 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 11, Load Case 1, Bending + Compression

$$f_a / F_a = 24.88 / 196.64 = 0.13 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 24.88 / 196.64 + 0.22 / 234.3 + 0.0 / 234.3 = 0.13 \leq 1 \text{ OK } 87\% \text{ under}$$

Design Member 11, Load Case 1, Sway

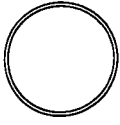
$$\Delta \leq Y/300.0, 0.47 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 12

Members: 12

Group: Custom1

Section: OD 863.6 x 20 WT



Load Case: Load Case 1

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 704.0 / 298.34, 1.0 * 704.0 / 298.34) = 2.36$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 2.36^2 / (2 * 105.44^2)) * 355.0 / 1.68 = 211.88 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 12, Load Case 1, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 12, Load Case 1, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 12, Load Case 1, Major Deflection

$$\delta \leq L/250, 0.01 \leq 2.82 \text{ mm OK } 100\% \text{ under}$$

Design Member 12, Load Case 1, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.0 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 12, Load Case 1, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 12, Load Case 1, Minor Deflection

$$\delta \leq L/250, 0.0 \leq 2.82 \text{ mm OK } 100\% \text{ under}$$

Design Member 12, Load Case 1, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 12, Load Case 1, Slenderness

$$K_x * L_x / r_x = 1.0 * 704.0 / 298.34 = 2.36 \leq 200.0 \text{ OK } 99\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 704.0 / 298.34 = 2.36 \leq 200.0 \text{ OK } 99\% \text{ under}$$

Design Member 12, Load Case 1, Compression

$$f_a \leq F_a, 0.0 \leq 211.88 \text{ OK } 100\% \text{ under}$$

Design Member 12, Load Case 1, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.0 / 234.3 + 0.0 / 234.3 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 12, Load Case 1, Bending + Compression

$$f_a / F_a = 0.0 / 211.88 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha - \phi_{\beta\zeta} / \Phi_{\beta\zeta} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 211.88 + 0.0 / 234.3 + 0.0 / 234.3 = 0.0 \leq 1 \text{ OK } 100\% \text{ under}$$

Design Member 12, Load Case 1, Sway

$$\Delta \leq Y/300.0, 0.47 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

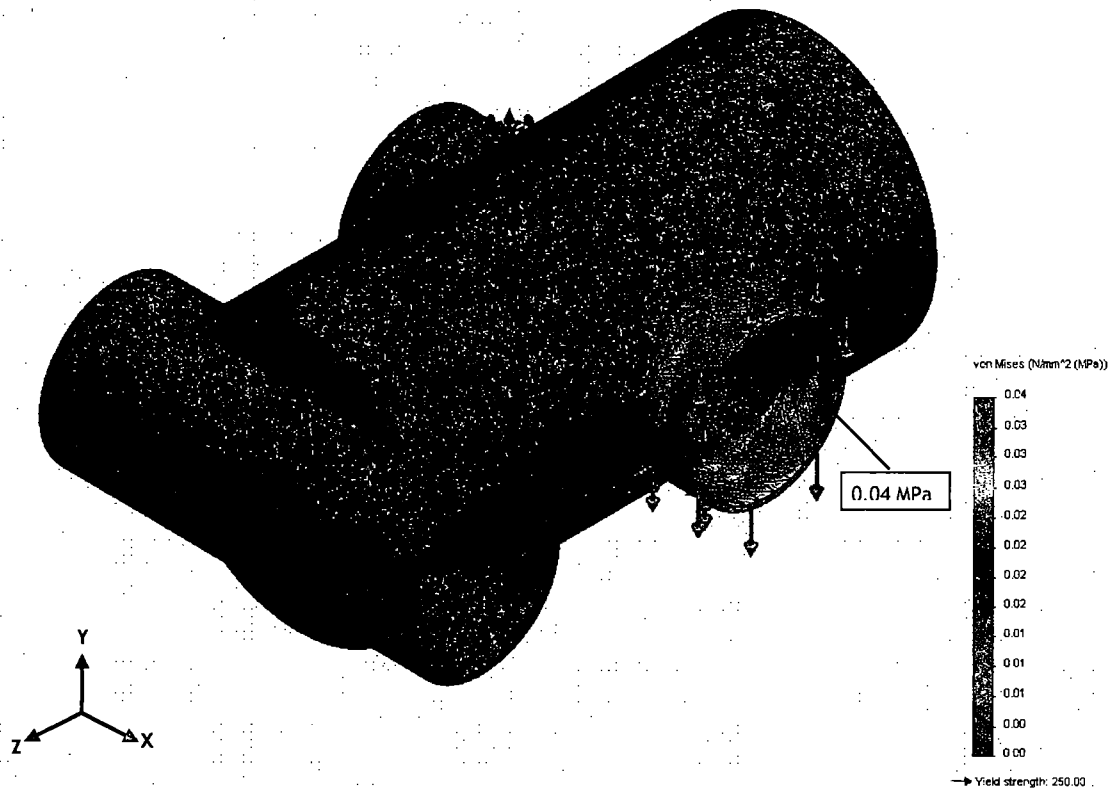
End of check

Appendix C

COSMOS Finite Element Analysis

1.0 Finite Element Analysis - Von Mises Stress plot on OD 508 x 16 WT lifting frame

Model name: OD 34 MAIN FRAME
Study name: Study 4
Plot type: Static model stress Stress1
Deformation scale: 1



A) Load & Restraint:

- Restraint on face of OD 508 circular structure within the main structure frame.
- Apply vertical load of - 35 tonnes (Y-direction) on OD 508 circular structure.

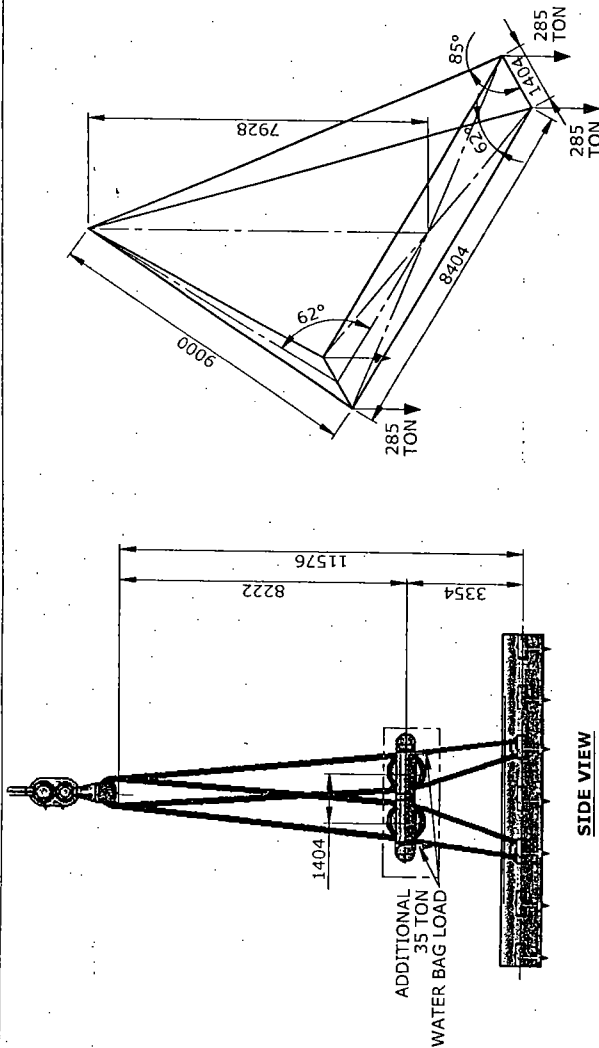
B) Material yield strength:

- OD 508 X 16 WT circular structure - allowable yield strength 255 MPa
- Weldment - min. guarantee yield strength 480 MPa

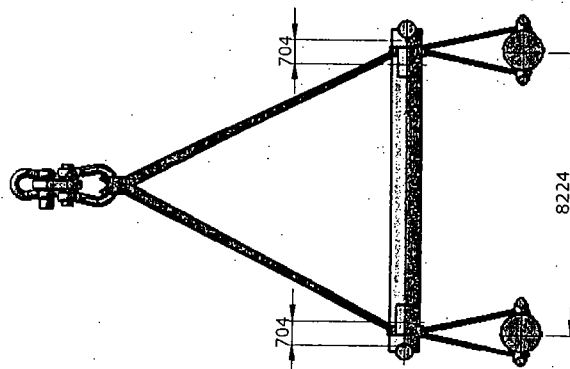
C) Conclusion:

- Maximum Von Mises equivalent stress at OD 508 circular structure is 0.04 MPa < 255 MPa.

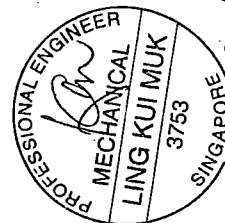
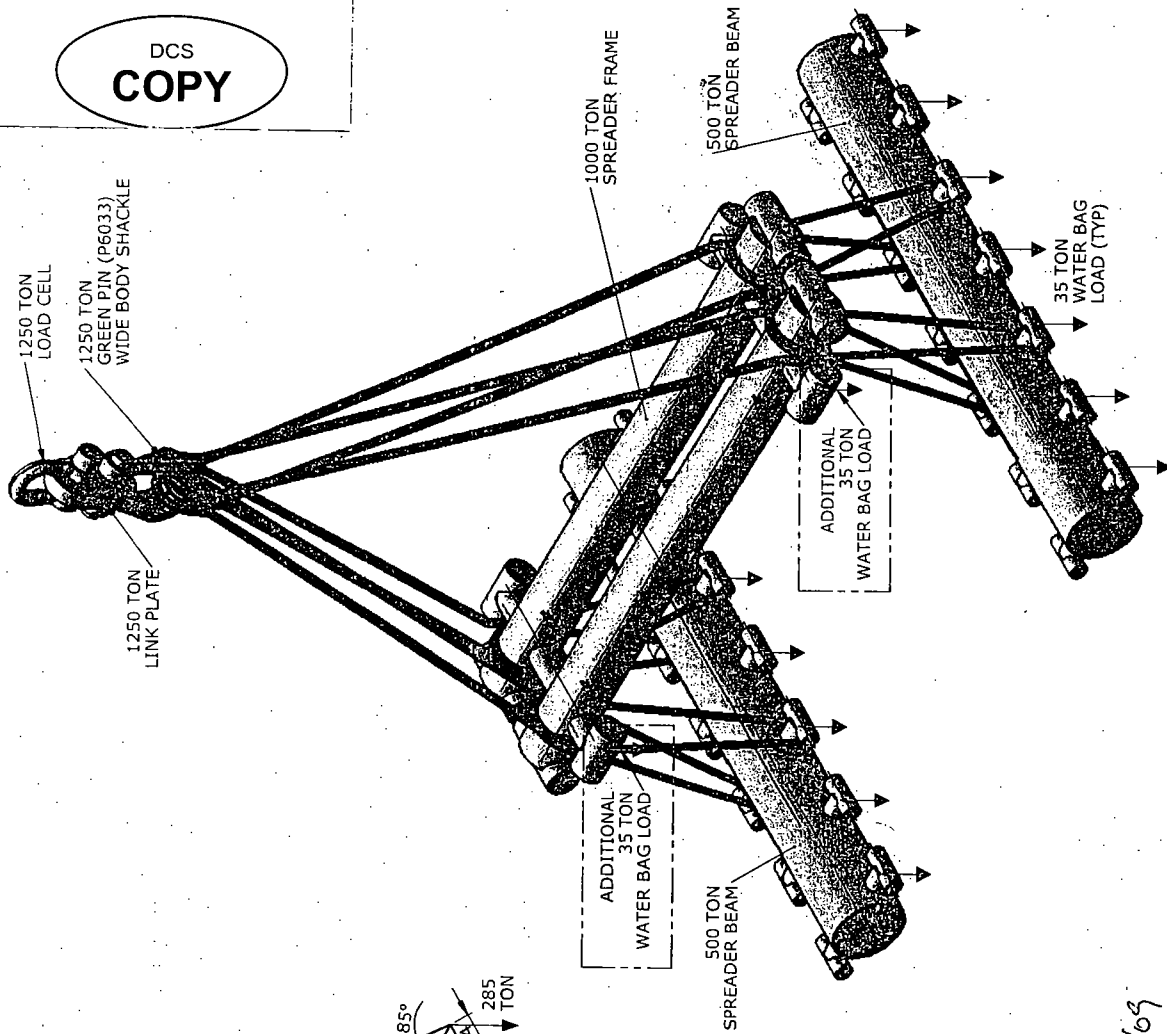
DCS
COPY



SIDE VIEW



FRONT VIEW



21 Dec '09

General Notes

1. ALL DIMENSION IN mm UNLESS OTHERWISE NOTED.
2. SPREADER BEAM WEIGHT : 8250 KG
3. LIFTING FRAME WEIGHT : 10500 KG

Title

REALTEC
exploring infinity
10 Admiralty Street, #03-88/89 North Link Building, Singapore 757695
Tel : +65 6753 8878, Fax : +65 6853 8280

**1140 TON
SPREADER FRAME
LIFTING ARRANGEMENT**

Rev.	Description	Drawn	Check	Approve	Date
1	ADDITIONAL LOAD ADDED	S.K.	S.J.W.	T.T.	15/12/09
0	ISSUE FOR CONSTRUCTION	S.K.	S.J.W.	T.T.	25/07/08
C	CHANGE IN LIFTING CONDITION	S.K.	S.J.W.	T.T.	07/07/08
B	ISSUE FOR APPROVAL	S.K.	S.J.W.	T.T.	04/07/08
A	ISSUE FOR APPROVAL	S.K.	S.J.W.	T.T.	18/06/08

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Scale 1 : 75
Size A3
Drawing No. RT-RM-DWG-120
Page 1

exploring infinity

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North Link Building Singapore 175735
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To:	RIGGING & MARINE SERVICES PTE LTD	Date:	06/01/10
Attention:	MR. LIM	Ref No.:	9779-TR-002
From:	SIDNEY KONG	Our job Ref.:	9779

The following drawing(s) / document(s) are forwarded to you for;

- | | |
|-----------------------------------|---------------------|
| 1. Construction / Fabrication () | 5. Comments () |
| 2. Approval () | 6. Submission (X) |
| 3. Reference / Information () | 7. Review () |
| 4. Printing () | |

Others: Documents are endorsed by the PE

Reply Required (Yes / No) Date: ASAP

Project:	9779 - 1140 SPREADER BEAM & 700 TONNE LIFTING FRAME
-----------------	---

No. of Copies	Drawing / Documents	Rev	Description	Remarks
1	9779-C-C3-010	0	DESIGN CALCULATION for 700 TON LIFTING FRAME	6
1	9779-C-C3-020	0	DESIGN CALCULATION for 1140 TON SPREADER FRAME	6

----- LAST ENTRY -----

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87D

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**DESIGN CALCULATION
FOR
700 TONNE S.W.L. LIFTING FRAME**

**DOCUMENT NO.: 9779-C-C3-010
REVISION NO.: 0**

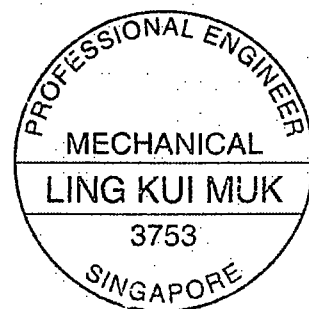
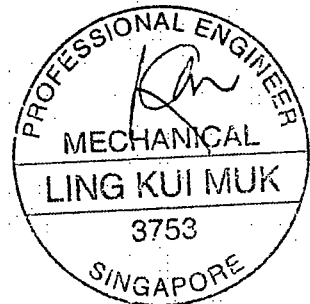


TABLE OF CONTENT

- 1.0 Introduction
- 2.0 Design Consideration
- 3.0 Conclusion
- 4.0 References

Appendix

- A MULTIFRAME Model & Graphic Plot (Equal Loading Condition)
- B MULTIFRAME Model & Graphic Plot (Unequal Loading Condition)
- C Steel Design Report to ASIC ASD (Equal Loading Condition)
- D Steel Design Report to ASIC ASD (Unequal Loading Condition)
- E Lifting Lug Design Calculation Reports



31 DEC '09

1.0 Introduction

The purpose of this calculation report is to verify the adequacy of structural design of one unit of 700 tonne S.W.L. lifting frame. This lifting frame is designed for lifting 4 x 140 tonne and 4 x 35 tonne offset at 2.7m, using lifting lugs design at a single point lifting arrangement as illustrated in the lifting condition drawing.

2.0 Design Consideration

Loading conditions:

- a) This spreader frame is NOT designed and used for day-to-day transportation or handling of goods. No dynamic or impact loads is taken into account. Test loads by means of water bags are gradually filled up with water to achieve the required loading.
- b) Lifting is done by means of lifting lugs provided. Lifting lugs are design based on appropriate size as illustrated in the lifting condition drawing

The designs for the structural members are based on Allowable Stress Design (ASD) in accordance with AISC.

3.0 Conclusion

As detailed in attached reports in the Appendixes, the structural members meet the requirements of the design code base on the above design consideration.

4.0 References:

- a) 700 Tonne Spreader Frame Lifting Arrangement
Drawing no.: 9779-D-D1-020

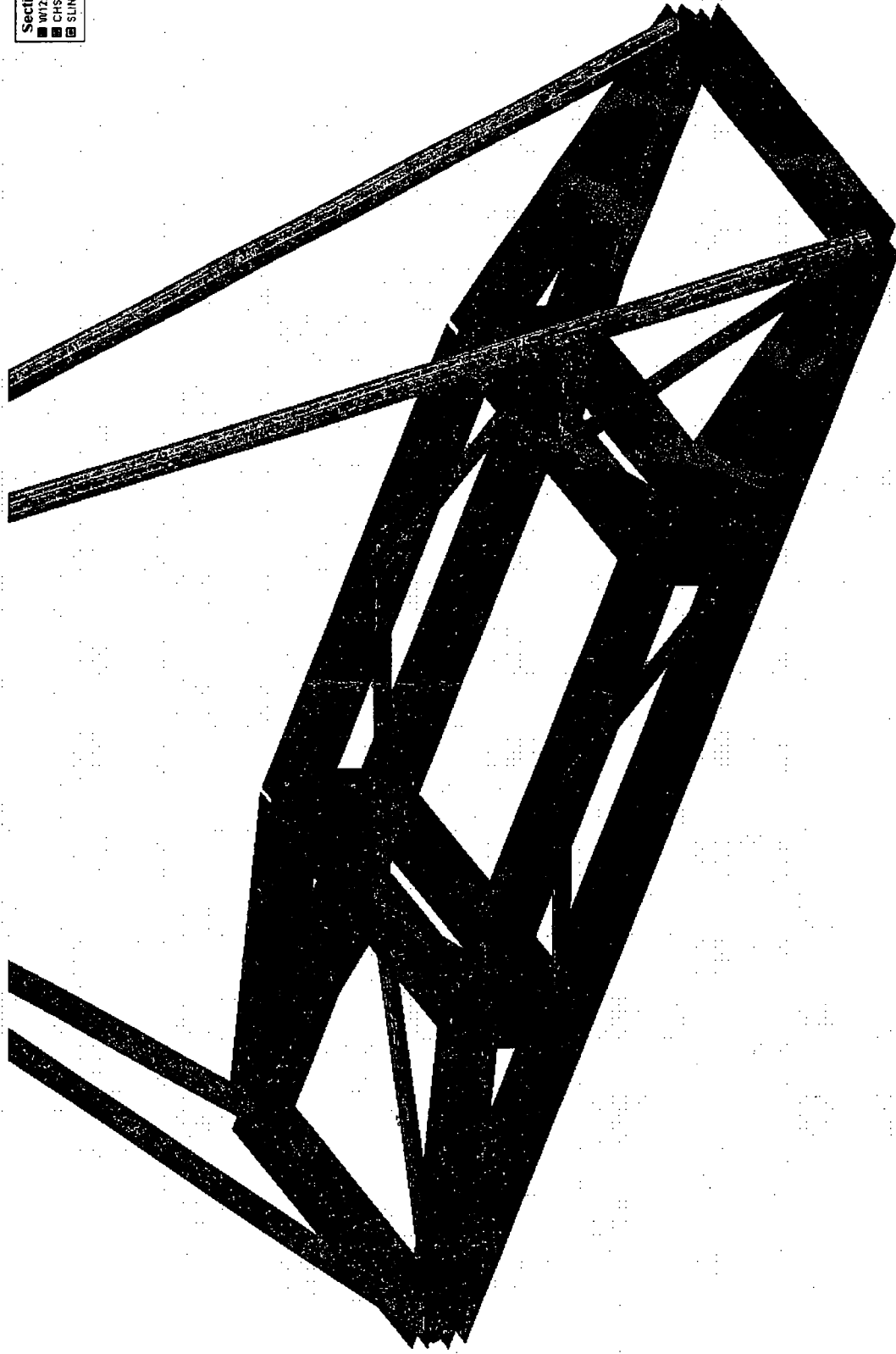


31 DEC '09

Appendix A

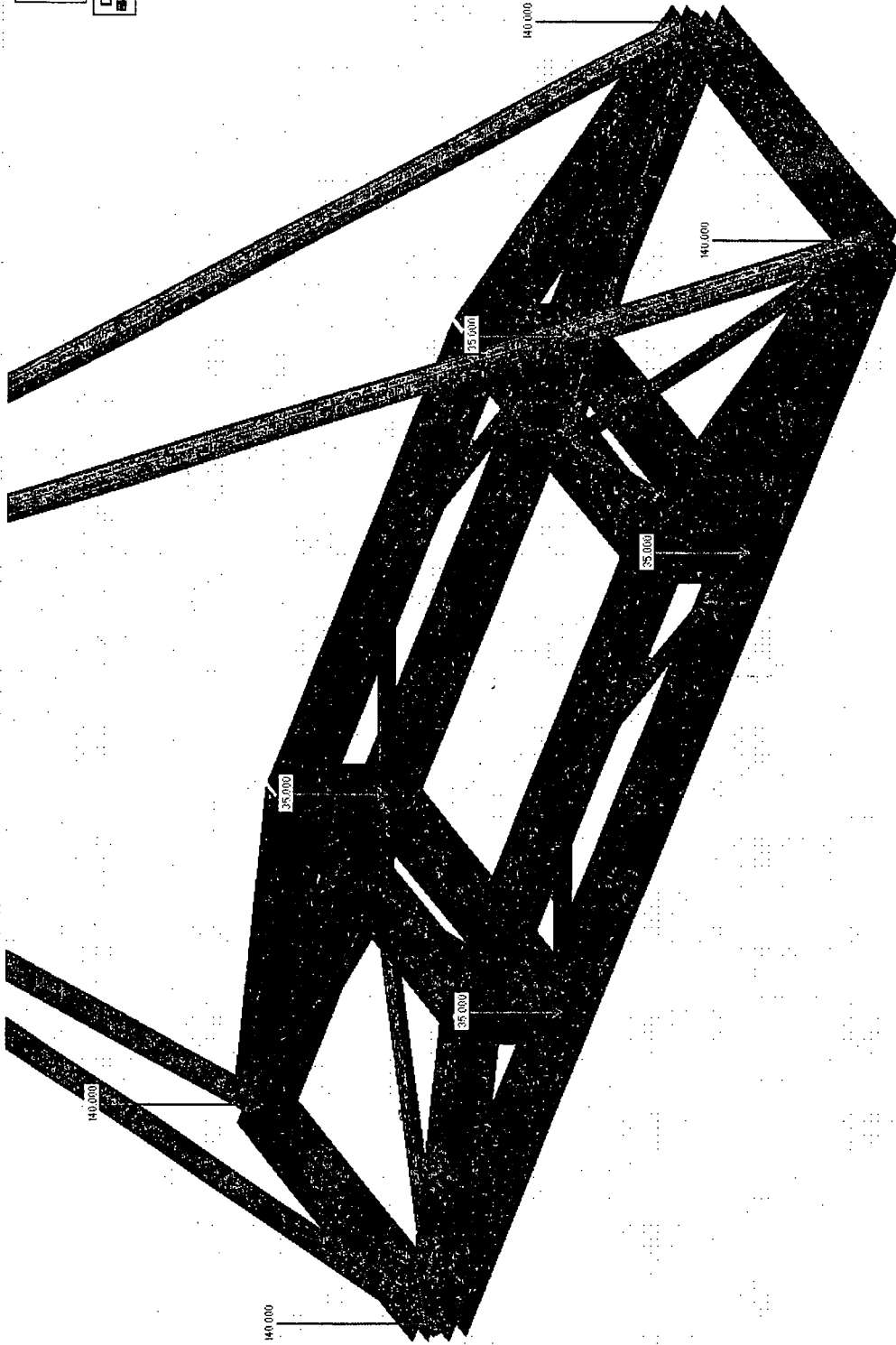
MULTIFRAME Model & Graphic Plot Equal Loading Condition

Sections	
■	W12x87
■	CHS 114.3 x 6
■	SLING



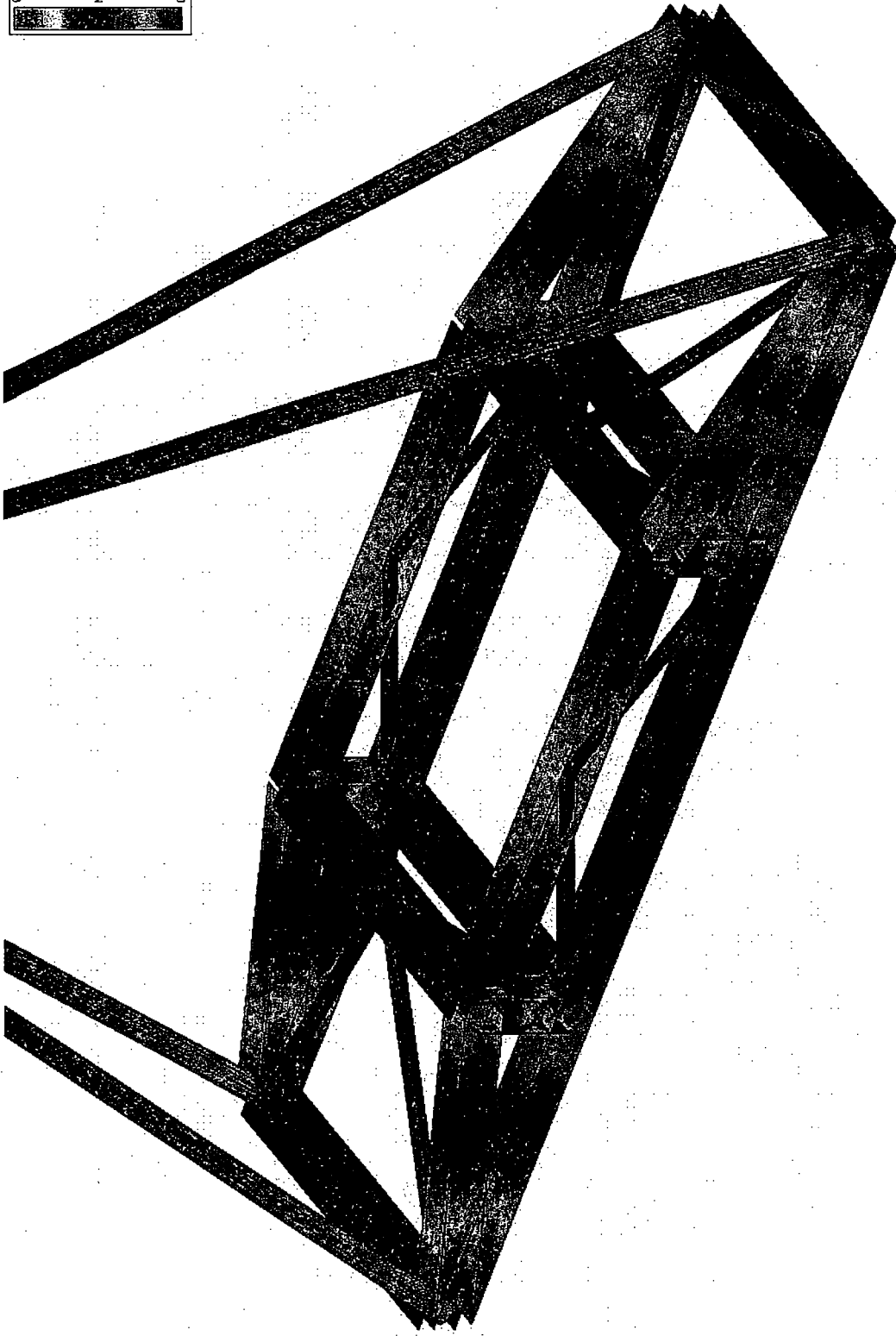
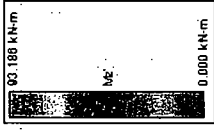
FRAME MODEL & MEMBER DIAGRAM

Sections	
	M12x87
	CHS 114.3 x 6
	SLING
Default Colour	
	All loads



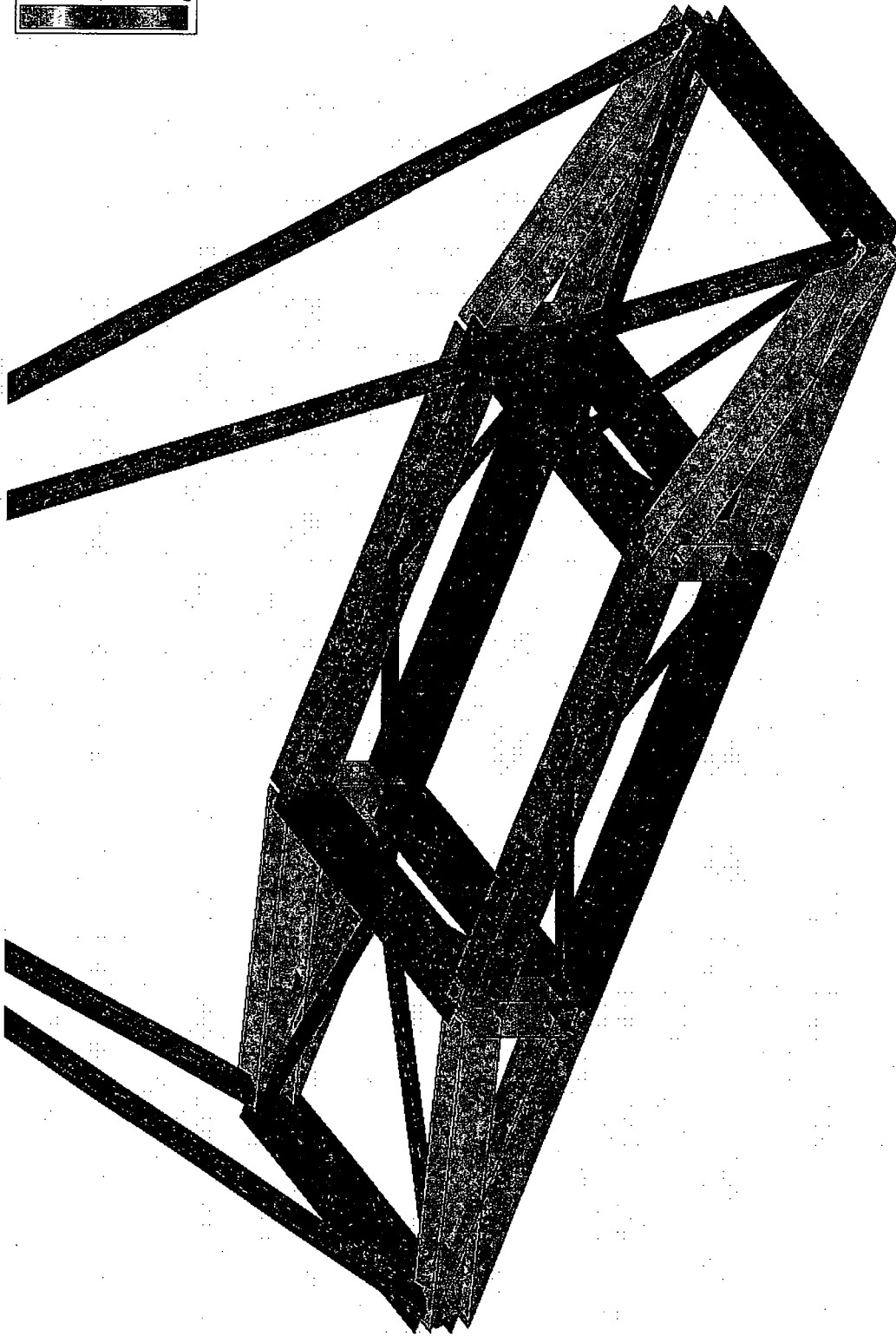
EQUAL LOAD

EQUAL LOAD DISTRIBUTION DIAGRAM



Static Case: EQUAL LOAD M_z (kN-m)

BENDING STRESS DIAGRAM



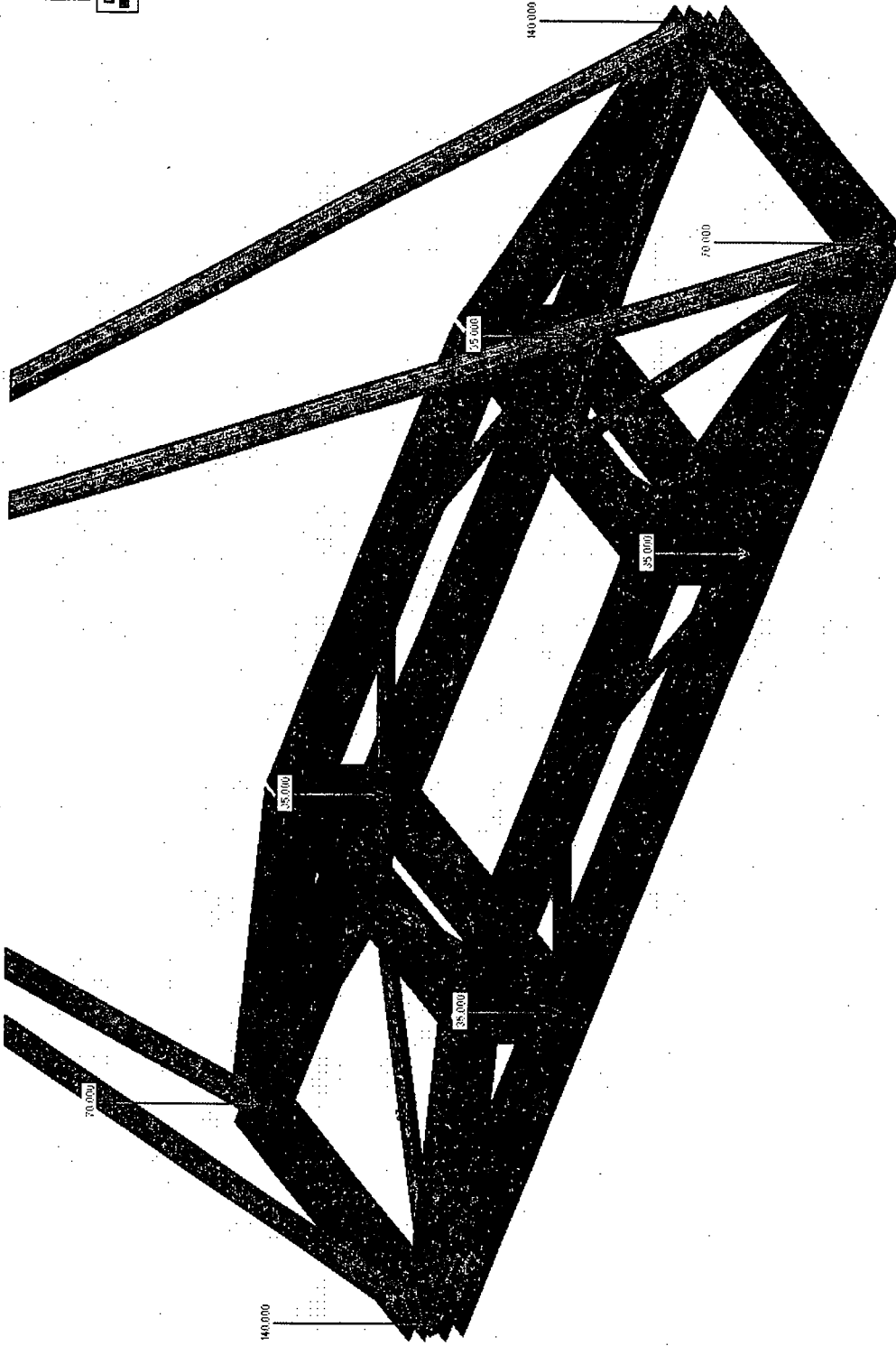
Static Case: EQUAL LOAD VY (tonne)

SHEAR STRESS DIAGRAM

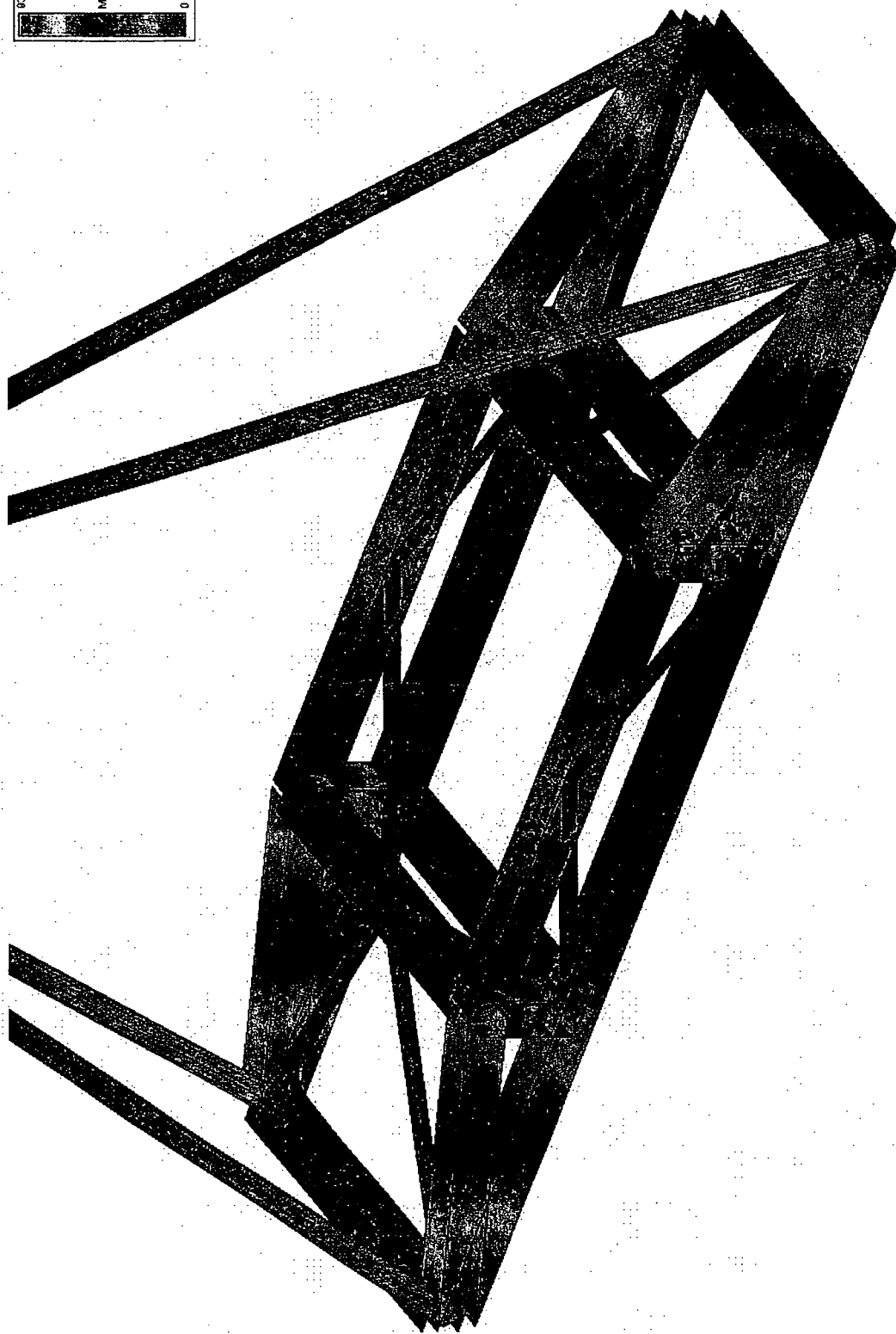
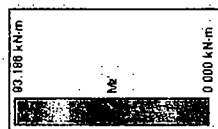
Appendix B

MULTIFRAME Model & Graphic Plot Unequal Loading Condition

Sections	
■	W12x87
■	CHS 114.3 x 6
■	SLING
Default Colour	
■	All loads

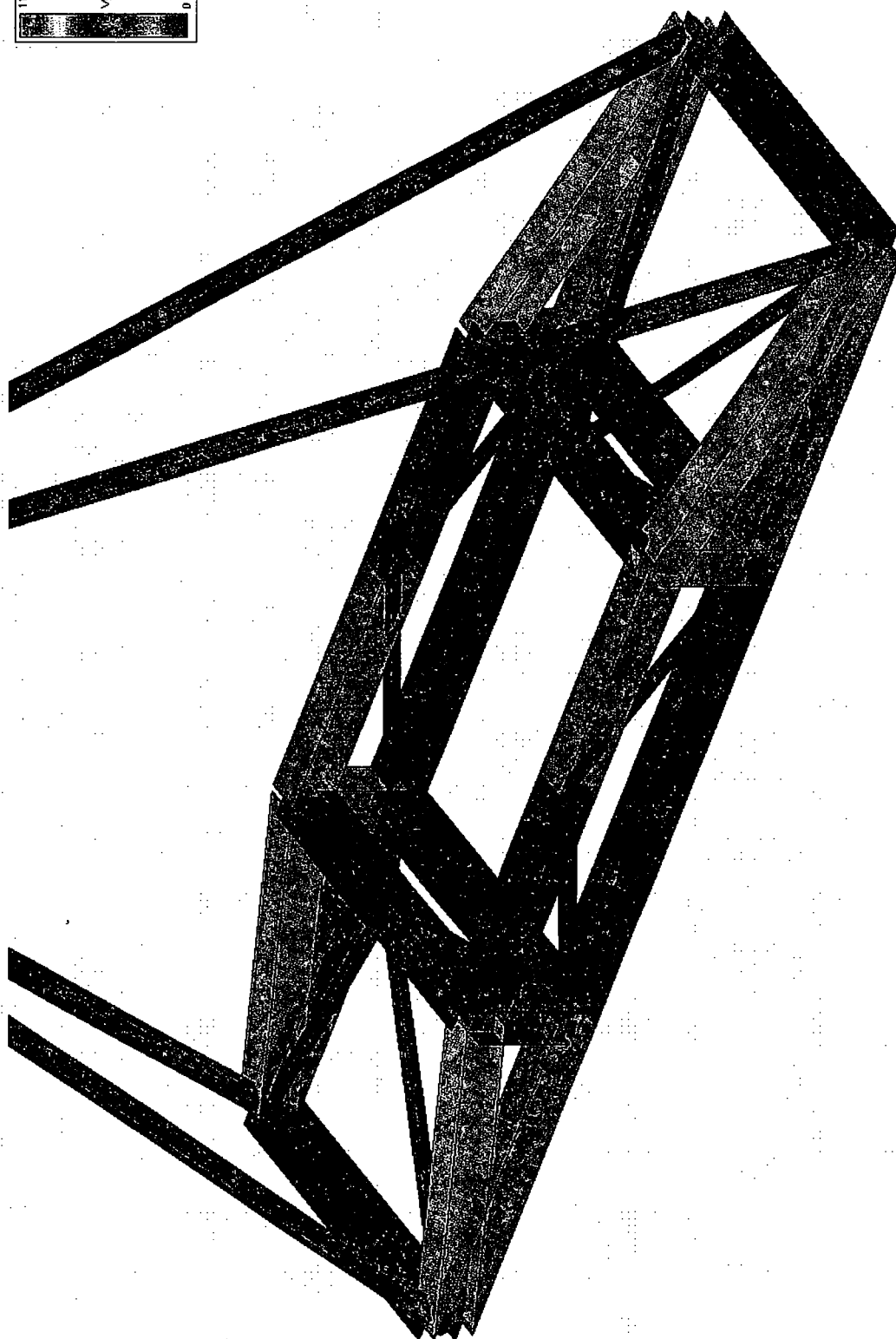
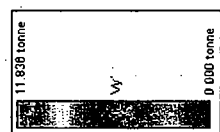


UNEQUAL LOAD DISTRIBUTION DIAGRAM



Static Case: UNEQUAL LOAD Mz (kN-m)

BENDING STRESS DIAGRAM



Static Case: UNEQUAL LOAD V_y (tonne)

SHEAR STRESS DIAGRAM

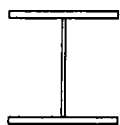
Appendix C

**Steel design report to ASIC ASD
Equal Loading Condition**

Steel Design Report

Checking design member 1

Members: 1
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_b \leq L_c \therefore \phi 0 \quad \Phi_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 1, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 41.5 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 41.5 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Design Member 1, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 8.15 \leq 142.0 \text{ OK } 94\% \text{ under}$$

Design Member 1, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.94 \leq 10.8 \text{ mm OK } 45\% \text{ under}$$

Design Member 1, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.93 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.93 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Design Member 1, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.1 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 1, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.09 \leq 10.8 \text{ mm OK } 99\% \text{ under}$$

Design Member 1, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 7.04 \leq 213.0 \text{ OK } 97\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 7.04 \leq 245.0 \text{ OK } 97\% \text{ under}$$

Design Member 1, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 300.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 300.0 \text{ OK } 88\% \text{ under}$$

Design Member 1, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 1, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 7.04 / 213.0 + 41.5 / 234.3 + 3.93 / 266.25 = 0.22 \leq 1 \text{ OK } 78\% \text{ under}$$

Design Member 1, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta z} / \Phi_{\beta z} + \phi_{\beta y} / \Phi_{\beta y} = 0.0 / 188.12 + 41.5 / 234.3 + 3.93 / 266.25 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Design Member 1, EQUAL LOAD, Sway

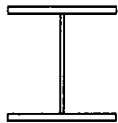
$$\Delta \leq Y/300.0, 0.15 \leq 0.0/300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 2

Members: 2

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 4000.0 / 136.65, 1.0 * 4000.0 / 77.98) = 51.3$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 51.3^2 / (2 * 105.44^2)) * 355.0 / 1.83 = 170.59 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξις:

$$\Lambda_\beta > \Lambda_\chi \therefore \phi 0 \quad \Phi_\beta = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$F_b = (2/3 - F_y * (l/r_t)^2 / (1530 * 10^3 * C_b)) * F_y = (2/3 - 355.0 * (4000.0 / 84.78)^2 / (1530 * 10^3 * 1.0)) * 355.0 = 210.07 \text{ MPa}$$

$$F_b = 12 * 10^3 * C_b / (l * d / \Lambda_\beta) = 12 * 10^3 * 1.0 / (4000.0 * 317.5 / 63.23) = 411.94 \text{ MPa}$$

$$F_b > 0.6 * F_y \therefore \phi 0 \quad \Phi_\beta = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 2, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 17.67 \leq 213.0 \text{ OK } 92\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 17.67 \leq 213.0 \text{ OK } 92\% \text{ under}$$

Design Member 2, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 2, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 1.11 \leq 16.0 \text{ mm OK } 93\% \text{ under}$$

Design Member 2, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Design Member 2, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 2, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.05 \leq 16.0 \text{ mm OK } 100\% \text{ under}$$

Design Member 2, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 14.49 \leq 213.0 \text{ OK } 93\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 14.49 \leq 245.0 \text{ OK } 94\% \text{ under}$$

Design Member 2, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 4000.0 / 136.65 = 29.27 \leq 300.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 4000.0 / 77.98 = 51.3 \leq 300.0 \text{ OK } 83\% \text{ under}$$

Design Member 2, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 170.59 \text{ OK } 100\% \text{ under}$$

Design Member 2, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 14.49 / 213.0 + 17.67 / 213.0 + 0.84 / 266.25 = 0.15 \leq 1 \text{ OK } 85\% \text{ under}$$

Design Member 2, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 170.59 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0 / 170.59 + 17.67 / 213.0 + 0.84 / 266.25 = 0.09 \leq 1 \text{ OK } 91\% \text{ under}$$

Design Member 2, EQUAL LOAD, Sway

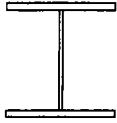
$$\Delta \leq Y/300.0, 0.14 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 3

Members: 3

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * I/r_x, K_y * I/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 3, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 41.5 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 41.5 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Design Member 3, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 8.15 \leq 142.0 \text{ OK } 94\% \text{ under}$$

Design Member 3, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.94 \leq 10.8 \text{ mm OK } 45\% \text{ under}$$

Design Member 3, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.93 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.93 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Design Member 3, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.1 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 3, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.11 \leq 10.8 \text{ mm OK } 99\% \text{ under}$$

Design Member 3, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 7.04 \leq 213.0 \text{ OK } 97\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 7.04 \leq 245.0 \text{ OK } 97\% \text{ under}$$

Design Member 3, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 300.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 300.0 \text{ OK } 88\% \text{ under}$$

Design Member 3, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 3, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 7.04 / 213.0 + 41.5 / 234.3 + 3.93 / 266.25 = 0.22 \leq 1 \text{ OK } 78\% \text{ under}$$

Design Member 3, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

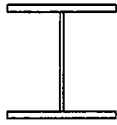
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\zeta} / \Phi_{\beta\zeta} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 188.12 + 41.5 / 234.3 + 3.93 / 266.25 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Design Member 3, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.26 \leq 0.0/300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 4

Members: 4
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * L_x / r_x, K_y * L_y / r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξιo:

$$\Lambda_p \leq L_c \therefore \phi 0 \quad \Phi_p = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 4, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.05 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.05 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 4, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 4, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.0 \leq 10.8 \text{ mm OK } 100\% \text{ under}$$

Design Member 4, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.45 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.45 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Design Member 4, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 4, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.04 \leq 10.8 \text{ mm OK } 100\% \text{ under}$$

Design Member 4, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 4, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 200.0 \text{ OK } 83\% \text{ under}$$

Design Member 4, EQUAL LOAD, Compression

$$f_a \leq F_a, 13.87 \leq 188.12 \text{ OK } 93\% \text{ under}$$

Design Member 4, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.05 / 234.3 + 1.45 / 266.25 = 0.01 \leq 1 \text{ OK } 99\% \text{ under}$$

Design Member 4, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 13.87 / 188.12 = 0.07 \leq 0.15 \therefore \phi 0$$

$$\phi_a / \Phi_a + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 13.87 / 188.12 + 0.05 / 234.3 + 1.45 / 266.25 = 0.08 \leq 1 \text{ OK } 92\% \text{ under}$$

Design Member 4, EQUAL LOAD, Sway

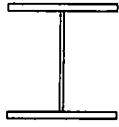
$$\Delta \leq Y/300.0, 0.26 \leq 0.0/300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 5

Members: 5

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 5, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.2 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.2 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 5, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 5, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.01 \leq 10.8 \text{ mm OK } 100\% \text{ under}$$

Design Member 5, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.25 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.25 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Design Member 5, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 5, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.04 \leq 10.8 \text{ mm OK } 100\% \text{ under}$$

Design Member 5, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 5, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 200.0 \text{ OK } 83\% \text{ under}$$

Design Member 5, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.59 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 5, EQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.2 / 234.3 + 1.25 / 266.25 = 0.01 \leq 1 \text{ OK } 99\% \text{ under}$$

Design Member 5, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.59 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

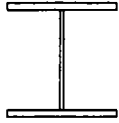
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.59 / 188.12 + 0.2 / 234.3 + 1.25 / 266.25 = 0.01 \leq 1 \text{ OK } 99\% \text{ under}$$

Design Member 5, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.15 \leq 0.0/300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 6

Members: 6
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σελτίον ις Χομπάχι}$$

Μαφop Aξίς:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 6, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.2 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.2 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 6, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 6, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.01 \leq 10.8 \text{ mm OK } 100\% \text{ under}$$

Design Member 6, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.25 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.25 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Design Member 6, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 6, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.04 \leq 10.8 \text{ mm OK } 100\% \text{ under}$$

Design Member 6, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 6, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 200.0 \text{ OK } 83\% \text{ under}$$

Design Member 6, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.59 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 6, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.2 / 234.3 + 1.25 / 266.25 = 0.01 \leq 1 \text{ OK } 99\% \text{ under}$$

Design Member 6, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.59 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.59 / 188.12 + 0.2 / 234.3 + 1.25 / 266.25 = 0.01 \leq 1 \text{ OK } 99\% \text{ under}$$

Design Member 6, EQUAL LOAD, Sway

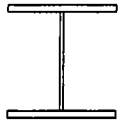
$$\Delta \leq Y/300.0, 0.14 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 7

Members: 7

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_b \leq L_c \therefore \phi 0 \quad \Phi_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 7, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.05 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.05 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 7, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 7, EQUAL LOAD, Major Deflection

$$\delta \leq L / 250, 0.0 \leq 10.8 \text{ mm OK } 100\% \text{ under}$$

Design Member 7, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.45 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.45 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Design Member 7, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 7, EQUAL LOAD, Minor Deflection

$$\delta \leq L / 250, 0.04 \leq 10.8 \text{ mm OK } 100\% \text{ under}$$

Design Member 7, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 7, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 200.0 \text{ OK } 83\% \text{ under}$$

Design Member 7, EQUAL LOAD, Compression

$$f_a \leq F_a, 13.87 \leq 188.12 \text{ OK } 93\% \text{ under}$$

Design Member 7, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.05 / 234.3 + 1.45 / 266.25 = 0.01 \leq 1 \text{ OK } 99\% \text{ under}$$

Design Member 7, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 13.87 / 188.12 = 0.07 \leq 0.15 \therefore \phi 0$$

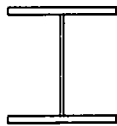
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 13.87 / 188.12 + 0.05 / 234.3 + 1.45 / 266.25 = 0.08 \leq 1 \text{ OK } 92\% \text{ under}$$

Design Member 7, EQUAL LOAD, Sway

$$\Delta \leq Y / 300.0, 0.26 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 8

Members: 8
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_y = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σχετιον ισ Χομπαχτ}$$

Μαφop Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 8, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 41.5 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 41.5 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Design Member 8, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 8.15 \leq 142.0 \text{ OK } 94\% \text{ under}$$

Design Member 8, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.94 \leq 10.8 \text{ mm OK } 45\% \text{ under}$$

Design Member 8, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.93 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.93 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Design Member 8, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.1 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 8, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.09 \leq 10.8 \text{ mm OK } 99\% \text{ under}$$

Design Member 8, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 7.04 \leq 213.0 \text{ OK } 97\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 7.04 \leq 245.0 \text{ OK } 97\% \text{ under}$$

Design Member 8, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 300.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 300.0 \text{ OK } 88\% \text{ under}$$

Design Member 8, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 8, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 7.04 / 213.0 + 41.5 / 234.3 + 3.93 / 266.25 = 0.22 \leq 1 \text{ OK } 78\% \text{ under}$$

Design Member 8, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 188.12 + 41.5 / 234.3 + 3.93 / 266.25 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Design Member 8, EQUAL LOAD, Sway

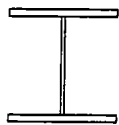
$$\Delta \leq Y/300.0, 0.15 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 9

Members: 9

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$K_l/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 4000.0 / 136.65, 1.0 * 4000.0 / 77.98) = 51.3$$

$$F_a = (1 - (K_l/r)^2 / (2 * C_c^2)) * F_y / F_S = (1 - 51.3^2 / (2 * 105.44^2)) * 355.0 / 1.83 = 170.59 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σελτιον ισ Χομπαχτ}$$

Μαφορ Αξις:

$$\Lambda_\beta > \Lambda_\chi \therefore \phi 0 \quad \Phi_\beta = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$F_b = (2/3 - F_y * (l/r_y)^2 / (1530 * 10^3 * C_b)) * F_y = (2/3 - 355.0 * (4000.0 / 84.78)^2 / (1530 * 10^3 * 1.0)) * 355.0 = 210.07 \text{ MPa}$$

$$F_b = 12 * 10^3 * C_b / (1 * d / A_f) = 12 * 10^3 * 1.0 / (4000.0 * 317.5 / 63.23) = 411.94 \text{ MPa}$$

$$F_b > 0.6 * F_y \therefore \phi 0 \quad \Phi_\beta = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 9, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 17.67 \leq 213.0 \text{ OK } 92\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 17.67 \leq 213.0 \text{ OK } 92\% \text{ under}$$

Design Member 9, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 9, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 1.11 \leq 16.0 \text{ mm OK } 93\% \text{ under}$$

Design Member 9, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Design Member 9, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.0 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 9, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.05 \leq 16.0 \text{ mm OK } 100\% \text{ under}$$

Design Member 9, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 14.49 \leq 213.0 \text{ OK } 93\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 14.49 \leq 245.0 \text{ OK } 94\% \text{ under}$$

Design Member 9, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 4000.0 / 136.65 = 29.27 \leq 300.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 4000.0 / 77.98 = 51.3 \leq 300.0 \text{ OK } 83\% \text{ under}$$

Design Member 9, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 170.59 \text{ OK } 100\% \text{ under}$$

Design Member 9, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 14.49 / 213.0 + 17.67 / 213.0 + 0.84 / 266.25 = 0.15 \leq 1 \text{ OK } 85\% \text{ under}$$

Design Member 9, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 170.59 = 0.0 \leq 0.15 \therefore \phi 0$$

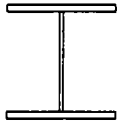
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta x} / \Phi_{\beta x} + \phi_{\beta y} / \Phi_{\beta y} = 0.0 / 170.59 + 17.67 / 213.0 - 0.84 / 266.25 = 0.09 \leq 1 \text{ OK } 91\% \text{ under}$$

Design Member 9, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.14 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 10

Members: 10
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_b \leq L_c \therefore \phi 0 \quad \Phi_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 10, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 41.5 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 41.5 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Design Member 10, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 8.15 \leq 142.0 \text{ OK } 94\% \text{ under}$$

Design Member 10, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.94 \leq 10.8 \text{ mm OK } 45\% \text{ under}$$

Design Member 10, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.93 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.93 \leq 266.25 \text{ OK } 99\% \text{ under}$$

Design Member 10, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.1 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 10, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.11 \leq 10.8 \text{ mm OK } 99\% \text{ under}$$

Design Member 10, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 7.04 \leq 213.0 \text{ OK } 97\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 7.04 \leq 245.0 \text{ OK } 97\% \text{ under}$$

Design Member 10, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 300.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 300.0 \text{ OK } 88\% \text{ under}$$

Design Member 10, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 10, EQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 7.04 / 213.0 + 41.5 / 234.3 + 3.93 / 266.25 = 0.22 \leq 1 \text{ OK } 78\% \text{ under}$$

Design Member 10, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\Phi_\alpha / \Phi_\alpha + \Phi_{\beta\zeta} / \Phi_{\beta\zeta} + \Phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 188.12 + 41.5 / 234.3 + 3.93 / 266.25 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Design Member 10, EQUAL LOAD, Sway

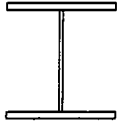
$$\Delta \leq Y/300.0, 0.26 \leq 0.0 / 300.0 = 0.0 \text{ mm OK } -2147483548\% \text{ under}$$

Checking design member 11

Members: 11

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * L_x / r_x, K_y * L_y / r_y) = \max(1.0 * 800.0 / 136.65, 1.0 * 800.0 / 77.98) = 10.26$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 10.26^2 / (2 * 105.44^2)) * 355.0 / 1.7 = 207.46 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 11, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 23.68 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 23.68 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Design Member 11, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 22.5 \leq 142.0 \text{ OK } 84\% \text{ under}$$

Design Member 11, EQUAL LOAD, Major Deflection

$$\delta \leq L / 250, 0.78 \leq 3.2 \text{ mm OK } 76\% \text{ under}$$

Design Member 11, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Design Member 11, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.07 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 11, EQUAL LOAD, Minor Deflection

$$\delta \leq L / 250, 0.01 \leq 3.2 \text{ mm OK } 100\% \text{ under}$$

Design Member 11, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 19.09 \leq 213.0 \text{ OK } 91\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 19.09 \leq 245.0 \text{ OK } 92\% \text{ under}$$

Design Member 11, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 800.0 / 136.65 = 5.85 \leq 300.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 800.0 / 77.98 = 10.26 \leq 300.0 \text{ OK } 97\% \text{ under}$$

Design Member 11, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 207.46 \text{ OK } 100\% \text{ under}$$

Design Member 11, EQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 19.09 / 213.0 + 23.68 / 234.3 + 0.84 / 266.25 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Design Member 11, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 207.46 = 0.0 \leq 0.15 \therefore \phi 0$$

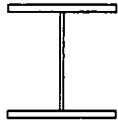
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 207.46 + 23.68 / 234.3 + 0.84 / 266.25 = 0.1 \leq 1 \text{ OK } 90\% \text{ under}$$

Design Member 11, EQUAL LOAD, Sway

$$\Delta \leq Y / 300.0, 0.63 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 12

Members: 12
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * L_x / r_x, K_y * L_y / r_y) = \max(1.0 * 800.0 / 136.65, 1.0 * 800.0 / 77.98) = 10.26$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 10.26^2 / (2 * 105.44^2)) * 355.0 / 1.7 = 207.46 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σχετιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 12, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 23.68 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 23.68 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Design Member 12, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 22.5 \leq 142.0 \text{ OK } 84\% \text{ under}$$

Design Member 12, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.78 \leq 3.2 \text{ mm OK } 76\% \text{ under}$$

Design Member 12, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Design Member 12, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.07 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 12, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.01 \leq 3.2 \text{ mm OK } 100\% \text{ under}$$

Design Member 12, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 19.09 \leq 213.0 \text{ OK } 91\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 19.09 \leq 245.0 \text{ OK } 92\% \text{ under}$$

Design Member 12, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 800.0 / 136.65 = 5.85 \leq 300.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 800.0 / 77.98 = 10.26 \leq 300.0 \text{ OK } 97\% \text{ under}$$

Design Member 12, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 207.46 \text{ OK } 100\% \text{ under}$$

Design Member 12, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 19.09 / 213.0 + 23.68 / 234.3 + 0.84 / 266.25 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Design Member 12, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 207.46 = 0.0 \leq 0.15 \therefore \phi 0$$

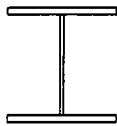
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 207.46 + 23.68 / 234.3 + 0.84 / 266.25 = 0.1 \leq 1 \text{ OK } 90\% \text{ under}$$

Design Member 12, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.63 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 13

Members: 13
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 800.0 / 136.65, 1.0 * 800.0 / 77.98) = 10.26$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 10.26^2 / (2 * 105.44^2)) * 355.0 / 1.7 = 207.46 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi_0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi_0 \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 13, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 23.68 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 23.68 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Design Member 13, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 22.5 \leq 142.0 \text{ OK } 84\% \text{ under}$$

Design Member 13, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.78 \leq 3.2 \text{ mm OK } 76\% \text{ under}$$

Design Member 13, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Design Member 13, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.07 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 13, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.01 \leq 3.2 \text{ mm OK } 100\% \text{ under}$$

Design Member 13, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 19.09 \leq 213.0 \text{ OK } 91\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 19.09 \leq 245.0 \text{ OK } 92\% \text{ under}$$

Design Member 13, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 800.0 / 136.65 = 5.85 \leq 300.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 800.0 / 77.98 = 10.26 \leq 300.0 \text{ OK } 97\% \text{ under}$$

Design Member 13, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 207.46 \text{ OK } 100\% \text{ under}$$

Design Member 13, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 19.09 / 213.0 + 23.68 / 234.3 + 0.84 / 266.25 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Design Member 13, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 207.46 = 0.0 \leq 0.15 \therefore \phi_0$$

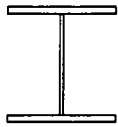
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 207.46 + 23.68 / 234.3 + 0.84 / 266.25 = 0.1 \leq 1 \text{ OK } 90\% \text{ under}$$

Design Member 13, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.63 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 14

Members: 14
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * L/r_x, K_y * L/r_y) = \max(1.0 * 800.0 / 136.65, 1.0 * 800.0 / 77.98) = 10.26$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 10.26^2 / (2 * 105.44^2)) * 355.0 / 1.7 = 207.46 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφορ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 14, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 23.68 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 23.68 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Design Member 14, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 22.5 \leq 142.0 \text{ OK } 84\% \text{ under}$$

Design Member 14, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.78 \leq 3.2 \text{ mm OK } 76\% \text{ under}$$

Design Member 14, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.84 \leq 266.25 \text{ OK } 100\% \text{ under}$$

Design Member 14, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.07 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 14, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.01 \leq 3.2 \text{ mm OK } 100\% \text{ under}$$

Design Member 14, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 19.09 \leq 213.0 \text{ OK } 91\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 19.09 \leq 245.0 \text{ OK } 92\% \text{ under}$$

Design Member 14, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 800.0 / 136.65 = 5.85 \leq 300.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 800.0 / 77.98 = 10.26 \leq 300.0 \text{ OK } 97\% \text{ under}$$

Design Member 14, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 207.46 \text{ OK } 100\% \text{ under}$$

Design Member 14, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 19.09 / 213.0 + 23.68 / 234.3 + 0.84 / 266.25 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Design Member 14, EQUAL LOAD, Bending + Compression

$$f_a / F_c = 0.0 / 207.46 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0 / 207.46 + 23.68 / 234.3 + 0.84 / 266.25 = 0.1 \leq 1 \text{ OK } 90\% \text{ under}$$

Design Member 14, EQUAL LOAD, Sway

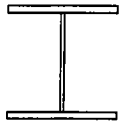
$$\Delta \leq Y/300.0, 0.63 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 15

Members: 15

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2816.03 / 136.65, 1.0 * 2816.03 / 77.98) = 36.11$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 36.11^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 186.68 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi_0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi_0 \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 15, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 36.9 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 36.9 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Design Member 15, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 6.13 \leq 142.0 \text{ OK } 96\% \text{ under}$$

Design Member 15, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.87 \leq 11.26 \text{ mm OK } 48\% \text{ under}$$

Design Member 15, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 14.91 \leq 266.25 \text{ OK } 94\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 14.91 \leq 266.25 \text{ OK } 94\% \text{ under}$$

Design Member 15, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.35 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 15, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.13 \leq 11.26 \text{ mm OK } 99\% \text{ under}$$

Design Member 15, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 15, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2816.03 / 136.65 = 20.61 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2816.03 / 77.98 = 36.11 \leq 200.0 \text{ OK } 82\% \text{ under}$$

Design Member 15, EQUAL LOAD, Compression

$$f_a \leq F_a, 58.81 \leq 186.68 \text{ OK } 68\% \text{ under}$$

Design Member 15, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 36.9 / 234.3 + 14.91 / 266.25 = 0.21 \leq 1 \text{ OK } 79\% \text{ under}$$

Design Member 15, EQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 58.81 / 186.68 = 0.32$$

$$\text{Major Ratio} = C_m x * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 36.9 / ((1 - 58.81 / 2424.62) * 234.3) = 0.14$$

$$\text{Minor Ratio} = C_m y * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 14.91 / ((1 - 58.81 / 789.51) * 266.25) = 0.05$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.14 + 0.05 = 0.5 \leq 1 \text{ OK } 50\% \text{ under}$$

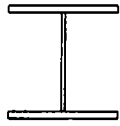
$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 58.81 / (0.6 * 355.0) + 36.9 / 234.3 + 14.91 / 266.25 = 0.49 \leq 1 \text{ OK } 51\% \text{ under}$$

Design Member 15, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.63 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 16

Members: 16
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2000.0 / 136.65, 1.0 * 2000.0 / 77.98) = 25.65$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 25.65^2 / (2 * 105.44^2)) * 355.0 / 1.76 = 196.17 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σελχιον ις Χομπαχτ}$$

Μαφop Αξίς:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 16, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 21.97 \leq 234.3 \text{ OK } 91\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 21.97 \leq 234.3 \text{ OK } 91\% \text{ under}$$

Design Member 16, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 2.81 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 16, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.87 \leq 8.0 \text{ mm OK } 89\% \text{ under}$$

Design Member 16, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 7.09 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 7.09 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Design Member 16, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.02 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 16, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.43 \leq 8.0 \text{ mm OK } 95\% \text{ under}$$

Design Member 16, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 16, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2000.0 / 136.65 = 14.64 \leq 200.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2000.0 / 77.98 = 25.65 \leq 200.0 \text{ OK } 87\% \text{ under}$$

Design Member 16, EQUAL LOAD, Compression

$$f_a \leq F_a, 63.45 \leq 196.17 \text{ OK } 68\% \text{ under}$$

Design Member 16, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 21.97 / 234.3 + 7.09 / 266.25 = 0.12 \leq 1 \text{ OK } 88\% \text{ under}$$

Design Member 16, EQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 63.45 / 196.17 = 0.32$$

$$\text{Major Ratio} = C_{mx} * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 21.97 / ((1 - 63.45 / 4806.82) * 234.3) = 0.08$$

$$\text{Minor Ratio} = C_{my} * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 7.09 / ((1 - 63.45 / 1565.2) * 266.25) = 0.02$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.08 + 0.02 = 0.43 \leq 1 \text{ OK } 57\% \text{ under}$$

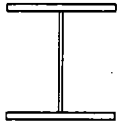
$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 63.45 / (0.6 * 355.0) + 21.97 / 234.3 + 7.09 / 266.25 = 0.42 \geq 1 \text{ OK } 58\% \text{ under}$$

Design Member 16, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.43 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 84\% \text{ under}$$

Checking design member 17

Members: 17
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2000.0 / 136.65, 1.0 * 2000.0 / 77.98) = 25.65$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 25.65^2 / (2 * 105.44^2)) * 355.0 / 1.76 = 196.17 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 17, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 21.97 \leq 234.3 \text{ OK } 91\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 21.97 \leq 234.3 \text{ OK } 91\% \text{ under}$$

Design Member 17, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 2.81 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 17, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.87 \leq 8.0 \text{ mm OK } 89\% \text{ under}$$

Design Member 17, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 7.09 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 7.09 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Design Member 17, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.02 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 17, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.43 \leq 8.0 \text{ mm OK } 95\% \text{ under}$$

Design Member 17, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 17, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2000.0 / 136.65 = 14.64 \leq 200.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2000.0 / 77.98 = 25.65 \leq 200.0 \text{ OK } 87\% \text{ under}$$

Design Member 17, EQUAL LOAD, Compression

$$f_a \leq F_a, 63.45 \leq 196.17 \text{ OK } 68\% \text{ under}$$

Design Member 17, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 21.97 / 234.3 + 7.09 / 266.25 = 0.12 \leq 1 \text{ OK } 88\% \text{ under}$$

Design Member 17, EQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 63.45 / 196.17 = 0.32$$

$$\text{Major Ratio} = C_{mx} * f_{bx} / ((1 - f_a / F_{ex}) * F_{bx}) = 0.85 * 21.97 / ((1 - 63.45 / 4806.82) * 234.3) = 0.08$$

$$\text{Minor Ratio} = C_{my} * f_{by} / ((1 - f_a / F_{ey}) * F_{by}) = 0.85 * 7.09 / ((1 - 63.45 / 1565.2) * 266.25) = 0.02$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.08 + 0.02 = 0.43 \leq 1 \text{ OK } 57\% \text{ under}$$

$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 63.45 / (0.6 * 355.0) + 21.97 / 234.3 + 7.09 / 266.25 = 0.42 \geq 1 \text{ OK } 58\% \text{ under}$$

Design Member 17, EQUAL LOAD, Sway

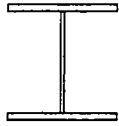
$$\Delta \leq Y / 300.0, 0.63 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 18

Members: 18

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2816.03 / 136.65, 1.0 * 2816.03 / 77.98) = 36.11$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 36.11^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 186.68 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφωρ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 18, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 36.9 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 36.9 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Design Member 18, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 6.13 \leq 142.0 \text{ OK } 96\% \text{ under}$$

Design Member 18, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.87 \leq 11.26 \text{ mm OK } 48\% \text{ under}$$

Design Member 18, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 14.91 \leq 266.25 \text{ OK } 94\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 14.91 \leq 266.25 \text{ OK } 94\% \text{ under}$$

Design Member 18, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.35 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 18, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.22 \leq 11.26 \text{ mm OK } 98\% \text{ under}$$

Design Member 18, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 18, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2816.03 / 136.65 = 20.61 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2816.03 / 77.98 = 36.11 \leq 200.0 \text{ OK } 82\% \text{ under}$$

Design Member 18, EQUAL LOAD, Compression

$$f_a \leq F_a, 58.81 \leq 186.68 \text{ OK } 68\% \text{ under}$$

Design Member 18, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 36.9 / 234.3 + 14.91 / 266.25 = 0.21 \leq 1 \text{ OK } 79\% \text{ under}$$

Design Member 18, EQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 58.81 / 186.68 = 0.32$$

$$\text{Major Ratio} = C_{mx} * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 36.9 / ((1 - 58.81 / 2424.62) * 234.3) = 0.14$$

$$\text{Minor Ratio} = C_{my} * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 14.91 / ((1 - 58.81 / 789.51) * 266.25) = 0.05$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.14 + 0.05 = 0.5 \leq 1 \text{ OK } 50\% \text{ under}$$

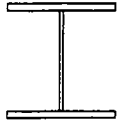
$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 58.81 / (0.6 * 355.0) + 36.9 / 234.3 + 14.91 / 266.25 = 0.49 \geq 1 \text{ OK } 51\% \text{ under}$$

Design Member 18, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.63 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 19

Members: 19
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1350.0 / 136.65, 1.0 * 1350.0 / 77.98) = 17.31$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / F_S = (1 - 17.31^2 / (2 * 105.44^2)) * 355.0 / 1.73 = 202.71 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 19, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.14 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.14 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 19, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.78 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 19, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.01 \leq 5.4 \text{ mm OK } 100\% \text{ under}$$

Design Member 19, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 41.56 \leq 266.25 \text{ OK } 84\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 41.56 \leq 266.25 \text{ OK } 84\% \text{ under}$$

Design Member 19, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 2.4 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 19, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.61 \leq 5.4 \text{ mm OK } 89\% \text{ under}$$

Design Member 19, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.21 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.21 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 19, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1350.0 / 136.65 = 9.88 \leq 300.0 \text{ OK } 97\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1350.0 / 77.98 = 17.31 \leq 300.0 \text{ OK } 94\% \text{ under}$$

Design Member 19, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 202.71 \text{ OK } 100\% \text{ under}$$

Design Member 19, EQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.21 / 213.0 + 1.14 / 234.3 + 41.56 / 266.25 = 0.16 \leq 1 \text{ OK } 84\% \text{ under}$$

Design Member 19, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 202.71 = 0.0 \leq 0.15 \therefore \phi 0$$

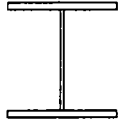
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 202.71 + 1.14 / 234.3 + 41.56 / 266.25 = 0.16 \leq 1 \text{ OK } 84\% \text{ under}$$

Design Member 19, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 1.24 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 53\% \text{ under}$$

Checking design member 20

Members: 20
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1350.0 / 136.65, 1.0 * 1350.0 / 77.98) = 17.31$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 17.31^2 / (2 * 105.44^2)) * 355.0 / 1.73 = 202.71 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 20, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.14 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.14 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 20, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.78 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 20, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.01 \leq 5.4 \text{ mm OK } 100\% \text{ under}$$

Design Member 20, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 41.56 \leq 266.25 \text{ OK } 84\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 41.56 \leq 266.25 \text{ OK } 84\% \text{ under}$$

Design Member 20, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 2.4 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 20, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.61 \leq 5.4 \text{ mm OK } 89\% \text{ under}$$

Design Member 20, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.21 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.21 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 20, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1350.0 / 136.65 = 9.88 \leq 300.0 \text{ OK } 97\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1350.0 / 77.98 = 17.31 \leq 300.0 \text{ OK } 94\% \text{ under}$$

Design Member 20, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 202.71 \text{ OK } 100\% \text{ under}$$

Design Member 20, EQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.21 / 213.0 + 1.14 / 234.3 + 41.56 / 266.25 = 0.16 \leq 1 \text{ OK } 84\% \text{ under}$$

Design Member 20, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 202.71 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0 / 202.71 + 1.14 / 234.3 + 41.56 / 266.25 = 0.16 \leq 1 \text{ OK } 84\% \text{ under}$$

Design Member 20, EQUAL LOAD, Sway

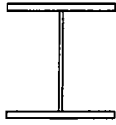
$$\Delta \leq Y/300.0, 0.63 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 21

Members: 21

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * I/r_x, K_y * I/r_y) = \max(1.0 * 1350.0 / 136.65, 1.0 * 1350.0 / 77.98) = 17.31$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 17.31^2 / (2 * 105.44^2)) * 355.0 / 1.73 = 202.71 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 21, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.14 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.14 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 21, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.78 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 21, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.01 \leq 5.4 \text{ mm OK } 100\% \text{ under}$$

Design Member 21, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 41.56 \leq 266.25 \text{ OK } 84\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 41.56 \leq 266.25 \text{ OK } 84\% \text{ under}$$

Design Member 21, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 2.4 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 21, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.61 \leq 5.4 \text{ mm OK } 89\% \text{ under}$$

Design Member 21, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.21 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.21 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 21, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1350.0 / 136.65 = 9.88 \leq 300.0 \text{ OK } 97\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1350.0 / 77.98 = 17.31 \leq 300.0 \text{ OK } 94\% \text{ under}$$

Design Member 21, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 202.71 \text{ OK } 100\% \text{ under}$$

Design Member 21, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.21 / 213.0 + 1.14 / 234.3 + 41.56 / 266.25 = 0.16 \leq 1 \text{ OK } 84\% \text{ under}$$

Design Member 21, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 202.71 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 202.71 + 1.14 / 234.3 + 41.56 / 266.25 = 0.16 \leq 1 \text{ OK } 84\% \text{ under}$$

Design Member 21, EQUAL LOAD, Sway

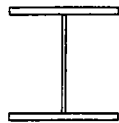
$$\Delta \leq Y/300.0, 1.24 \leq 800.0/300.0 = 2.67 \text{ mm OK } 53\% \text{ under}$$

Checking design member 22

Members: 22

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1350.0 / 136.65, 1.0 * 1350.0 / 77.98) = 17.31$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 17.31^2 / (2 * 105.44^2)) * 355.0 / 1.73 = 202.71 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 22, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.14 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.14 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 22, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.78 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 22, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.01 \leq 5.4 \text{ mm OK } 100\% \text{ under}$$

Design Member 22, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 41.56 \leq 266.25 \text{ OK } 84\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 41.56 \leq 266.25 \text{ OK } 84\% \text{ under}$$

Design Member 22, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 2.4 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 22, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.61 \leq 5.4 \text{ mm OK } 89\% \text{ under}$$

Design Member 22, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.21 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.21 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 22, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1350.0 / 136.65 = 9.88 \leq 300.0 \text{ OK } 97\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1350.0 / 77.98 = 17.31 \leq 300.0 \text{ OK } 94\% \text{ under}$$

Design Member 22, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 202.71 \text{ OK } 100\% \text{ under}$$

Design Member 22, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.21 / 213.0 + 1.14 / 234.3 + 41.56 / 266.25 = 0.16 \leq 1 \text{ OK } 84\% \text{ under}$$

Design Member 22, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 202.71 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 202.71 + 1.14 / 234.3 + 41.56 / 266.25 = 0.16 \leq 1 \text{ OK } 84\% \text{ under}$$

Design Member 22, EQUAL LOAD, Sway

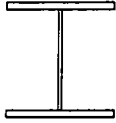
$$\Delta \leq Y/300.0, 0.63 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 23

Members: 23

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * I/r_x, K_y * I/r_y) = \max(1.0 * 2816.03 / 136.65, 1.0 * 2816.03 / 77.98) = 36.11$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 36.11^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 186.68 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 23, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 36.9 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 36.9 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Design Member 23, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 6.13 \leq 142.0 \text{ OK } 96\% \text{ under}$$

Design Member 23, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.87 \leq 11.26 \text{ mm OK } 48\% \text{ under}$$

Design Member 23, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 14.91 \leq 266.25 \text{ OK } 94\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 14.91 \leq 266.25 \text{ OK } 94\% \text{ under}$$

Design Member 23, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.35 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 23, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.13 \leq 11.26 \text{ mm OK } 99\% \text{ under}$$

Design Member 23, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 23, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2816.03 / 136.65 = 20.61 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2816.03 / 77.98 = 36.11 \leq 200.0 \text{ OK } 82\% \text{ under}$$

Design Member 23, EQUAL LOAD, Compression

$$f_a \leq F_a, 58.81 \leq 186.68 \text{ OK } 68\% \text{ under}$$

Design Member 23, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 36.9 / 234.3 + 14.91 / 266.25 = 0.21 \leq 1 \text{ OK } 79\% \text{ under}$$

Design Member 23, EQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 58.81 / 186.68 = 0.32$$

$$\text{Major Ratio} = C_m * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 36.9 / ((1 - 58.81 / 2424.62) * 234.3) = 0.14$$

$$\text{Minor Ratio} = C_m * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 14.91 / ((1 - 58.81 / 789.51) * 266.25) = 0.05$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.14 + 0.05 = 0.5 \leq 1 \text{ OK } 50\% \text{ under}$$

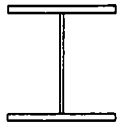
$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 58.81 / (0.6 * 355.0) + 36.9 / 234.3 + 14.91 / 266.25 = 0.49 \geq 1 \text{ OK } 51\% \text{ under}$$

Design Member 23, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.63 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 24

Members: 24
Group: W
Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2000.0 / 136.65, 1.0 * 2000.0 / 77.98) = 25.65$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 25.65^2 / (2 * 105.44^2)) * 355.0 / 1.76 = 196.17 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 24, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 21.97 \leq 234.3 \text{ OK } 91\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 21.97 \leq 234.3 \text{ OK } 91\% \text{ under}$$

Design Member 24, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 2.81 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 24, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.87 \leq 8.0 \text{ mm OK } 89\% \text{ under}$$

Design Member 24, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 7.09 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 7.09 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Design Member 24, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.02 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 24, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.43 \leq 8.0 \text{ mm OK } 95\% \text{ under}$$

Design Member 24, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 24, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2000.0 / 136.65 = 14.64 \leq 200.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2000.0 / 77.98 = 25.65 \leq 200.0 \text{ OK } 87\% \text{ under}$$

Design Member 24, EQUAL LOAD, Compression

$$f_a \leq F_a, 63.45 \leq 196.17 \text{ OK } 68\% \text{ under}$$

Design Member 24, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 21.97 / 234.3 + 7.09 / 266.25 = 0.12 \leq 1 \text{ OK } 88\% \text{ under}$$

Design Member 24, EQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 63.45 / 196.17 = 0.32$$

$$\text{Major Ratio} = C_m * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 21.97 / ((1 - 63.45 / 4806.82) * 234.3) = 0.08$$

$$\text{Minor Ratio} = C_m * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 7.09 / ((1 - 63.45 / 1565.2) * 266.25) = 0.02$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.08 + 0.02 = 0.43 \leq 1 \text{ OK } 57\% \text{ under}$$

$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 63.45 / (0.6 * 355.0) + 21.97 / 234.3 + 7.09 / 266.25 = 0.42 > 1 \text{ OK } 58\% \text{ under}$$

Design Member 24, EQUAL LOAD, Sway

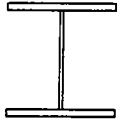
$$\Delta \leq Y/300.0, 0.43 \leq 800.0/300.0 = 2.67 \text{ mm OK } 84\% \text{ under}$$

Checking design member 25

Members: 25

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 \cdot F_y = 0.6 \cdot 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 \cdot F_u = 0.5 \cdot 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 \cdot F_y = 0.4 \cdot 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 2000.0/136.65, 1.0 \cdot 2000.0/77.98) = 25.65$$

$$F_a = (1 - (Kl/r)^2 / (2 \cdot C_c^2)) \cdot F_y / FS = (1 - 25.65^2 / (2 \cdot 105.44^2)) \cdot 355.0 / 1.76 = 196.17 \text{ MPa}$$

$$b/t = 153.67/20.57 = 7.47 \leq 65/\sqrt{F_y} = 65/\sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαθωρ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 \cdot F_y = 0.66 \cdot 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 \cdot F_y = 0.75 \cdot 355.0 = 266.25 \text{ MPa}$$

Design Member 25, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 21.97 \leq 234.3 \text{ OK } 91\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 21.97 \leq 234.3 \text{ OK } 91\% \text{ under}$$

Design Member 25, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 2.81 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 25, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.87 \leq 8.0 \text{ mm OK } 89\% \text{ under}$$

Design Member 25, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 7.09 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 7.09 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Design Member 25, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.02 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 25, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.43 \leq 8.0 \text{ mm OK } 95\% \text{ under}$$

Design Member 25, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 25, EQUAL LOAD, Slenderness

$$K_x \cdot L_x / r_x = 1.0 \cdot 2000.0 / 136.65 = 14.64 \leq 200.0 \text{ OK } 93\% \text{ under}$$

$$K_y \cdot L_y / r_y = 1.0 \cdot 2000.0 / 77.98 = 25.65 \leq 200.0 \text{ OK } 87\% \text{ under}$$

Design Member 25, EQUAL LOAD, Compression

$$f_a \leq F_a, 63.45 \leq 196.17 \text{ OK } 68\% \text{ under}$$

Design Member 25, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 21.97 / 234.3 + 7.09 / 266.25 = 0.12 \leq 1 \text{ OK } 88\% \text{ under}$$

Design Member 25, EQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 63.45 / 196.17 = 0.32$$

$$\text{Major Ratio} = C_{mx} \cdot f_{bx} / ((1 - f_a / F'_{ex}) \cdot F_{bx}) = 0.85 \cdot 21.97 / ((1 - 63.45 / 4806.82) \cdot 234.3) = 0.08$$

$$\text{Minor Ratio} = C_{my} \cdot f_{by} / ((1 - f_a / F'_{ey}) \cdot F_{by}) = 0.85 \cdot 7.09 / ((1 - 63.45 / 1565.2) \cdot 266.25) = 0.02$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.08 + 0.02 = 0.43 \leq 1 \text{ OK } 57\% \text{ under}$$

$$f_a / (0.6 \cdot F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 63.45 / (0.6 \cdot 355.0) + 21.97 / 234.3 + 7.09 / 266.25 = 0.42 \leq 1 \text{ OK } 58\% \text{ under}$$

Design Member 25, EQUAL LOAD, Sway

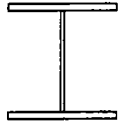
$$\Delta \leq Y/300.0, 0.63 \leq 800.0/300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 26

Members: 26

Group: W

Section: W12x87



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2816.03 / 136.65, 1.0 * 2816.03 / 77.98) = 36.11$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 36.11^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 186.68 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 26, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 36.9 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 36.9 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Design Member 26, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 6.13 \leq 142.0 \text{ OK } 96\% \text{ under}$$

Design Member 26, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.87 \leq 11.26 \text{ mm OK } 48\% \text{ under}$$

Design Member 26, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 14.91 \leq 266.25 \text{ OK } 94\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 14.91 \leq 266.25 \text{ OK } 94\% \text{ under}$$

Design Member 26, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.35 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 26, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.22 \leq 11.26 \text{ mm OK } 98\% \text{ under}$$

Design Member 26, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 26, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2816.03 / 136.65 = 20.61 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2816.03 / 77.98 = 36.11 \leq 200.0 \text{ OK } 82\% \text{ under}$$

Design Member 26, EQUAL LOAD, Compression

$$f_a \leq F_a, 58.81 \leq 186.68 \text{ OK } 68\% \text{ under}$$

Design Member 26, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 36.9 / 234.3 + 14.91 / 266.25 = 0.21 \leq 1 \text{ OK } 79\% \text{ under}$$

Design Member 26, EQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 58.81 / 186.68 = 0.32$$

$$\text{Major Ratio} = C_m * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 36.9 / ((1 - 58.81 / 2424.62) * 234.3) = 0.14$$

$$\text{Minor Ratio} = C_m * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 14.91 / ((1 - 58.81 / 789.51) * 266.25) = 0.05$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.14 + 0.05 = 0.5 \leq 1 \text{ OK } 50\% \text{ under}$$

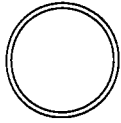
$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 58.81 / (0.6 * 355.0) + 36.9 / 234.3 + 14.91 / 266.25 = 0.49 \geq 1 \text{ OK } 51\% \text{ under}$$

Design Member 26, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.63 \leq 800.0 / 300.0 = 2.67 \text{ mm OK } 76\% \text{ under}$$

Checking design member 27

Members: 27
Group: Custom2
Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 3122.9/38.35, 1.0 * 3122.9/38.35) = 81.43$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 81.43^2 / (2 * 108.06^2)) * 355.0 / 1.9 = 134.08 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 27, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.82 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.82 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Design Member 27, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.02 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 27, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.99 \leq 12.49 \text{ mm OK } 52\% \text{ under}$$

Design Member 27, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.6 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.6 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 27, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.01 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 27, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.75 \leq 12.49 \text{ mm OK } 94\% \text{ under}$$

Design Member 27, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 27, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 3122.9 / 38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 3122.9 / 38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

Design Member 27, EQUAL LOAD, Compression

$$f_a \leq F_a, 17.45 \leq 134.08 \text{ OK } 87\% \text{ under}$$

Design Member 27, EQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 3.82 / 234.3 + 0.6 / 234.3 = 0.02 \leq 1 \text{ OK } 98\% \text{ under}$$

Design Member 27, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 17.45 / 134.08 = 0.13 \leq 0.15 \therefore \phi 0$$

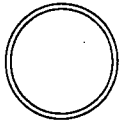
$$\phi_a / \Phi_a + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 17.45 / 134.08 + 3.82 / 234.3 + 0.6 / 234.3 = 0.15 \leq 1 \text{ OK } 85\% \text{ under}$$

Design Member 27, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 1.24 \leq 800.0/300.0 = 2.67 \text{ mm OK } 53\% \text{ under}$$

Checking design member 28

Members: 28
Group: Custom2
Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 3122.9/38.35, 1.0 * 3122.9/38.35) = 81.43$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 81.43^2 / (2 * 108.06^2)) * 355.0 / 1.9 = 134.08 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 28, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.82 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.82 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Design Member 28, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.02 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 28, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.99 \leq 12.49 \text{ mm OK } 52\% \text{ under}$$

Design Member 28, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.6 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.6 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 28, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.01 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 28, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.75 \leq 12.49 \text{ mm OK } 94\% \text{ under}$$

Design Member 28, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 28, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 3122.9/38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 3122.9/38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

Design Member 28, EQUAL LOAD, Compression

$$f_a \leq F_a, 17.45 \leq 134.08 \text{ OK } 87\% \text{ under}$$

Design Member 28, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 3.82 / 234.3 + 0.6 / 234.3 = 0.02 \leq 1 \text{ OK } 98\% \text{ under}$$

Design Member 28, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 17.45 / 134.08 = 0.13 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 17.45 / 134.08 + 3.82 / 234.3 + 0.6 / 234.3 = 0.15 \leq 1 \text{ OK } 85\% \text{ under}$$

Design Member 28, EQUAL LOAD, Sway

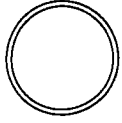
$$\Delta \leq Y/300.0, 1.24 \leq 800.0/300.0 = 2.67 \text{ mm OK } 53\% \text{ under}$$

Checking design member 29

Members: 29

Group: Custom2

Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1569.24/38.35, 1.0 * 1569.24/38.35) = 40.92$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 40.92^2 / (2 * 108.06^2)) * 355.0 / 1.8 = 182.89 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 29, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 2.13 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 2.13 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 29, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.11 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 29, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.08 \leq 6.28 \text{ mm OK } 99\% \text{ under}$$

Design Member 29, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 8.22 \leq 234.3 \text{ OK } 96\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 8.22 \leq 234.3 \text{ OK } 96\% \text{ under}$$

Design Member 29, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.33 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 29, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.39 \leq 6.28 \text{ mm OK } 78\% \text{ under}$$

Design Member 29, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 5.51 \leq 213.0 \text{ OK } 97\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 5.51 \leq 245.0 \text{ OK } 98\% \text{ under}$$

Design Member 29, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1569.24 / 38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1569.24 / 38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

Design Member 29, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 182.89 \text{ OK } 100\% \text{ under}$$

Design Member 29, EQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 5.51 / 213.0 + 2.13 / 234.3 + 8.22 / 234.3 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Design Member 29, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 182.89 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0 / 182.89 + 2.13 / 234.3 + 8.22 / 234.3 = 0.04 \leq 1 \text{ OK } 96\% \text{ under}$$

Design Member 29, EQUAL LOAD, Sway

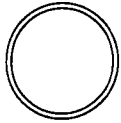
$$\Delta \leq Y/300.0, 1.24 \leq 800.0/300.0 = 2.67 \text{ mm OK } 53\% \text{ under}$$

Checking design member 30

Members: 30

Group: Custom2

Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1569.24/38.35, 1.0 * 1569.24/38.35) = 40.92$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 40.92^2 / (2 * 108.06^2)) * 355.0 / 1.8 = 182.89 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 30, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 2.13 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 2.13 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 30, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.11 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 30, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.08 \leq 6.28 \text{ mm OK } 99\% \text{ under}$$

Design Member 30, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 8.22 \leq 234.3 \text{ OK } 96\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 8.22 \leq 234.3 \text{ OK } 96\% \text{ under}$$

Design Member 30, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.33 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 30, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.39 \leq 6.28 \text{ mm OK } 78\% \text{ under}$$

Design Member 30, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 5.51 \leq 213.0 \text{ OK } 97\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 5.51 \leq 245.0 \text{ OK } 98\% \text{ under}$$

Design Member 30, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1569.24 / 38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1569.24 / 38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

Design Member 30, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 182.89 \text{ OK } 100\% \text{ under}$$

Design Member 30, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 5.51 / 213.0 + 2.13 / 234.3 + 8.22 / 234.3 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Design Member 30, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 182.89 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta x} / \Phi_{\beta x} + \phi_{\beta y} / \Phi_{\beta y} = 0.0 / 182.89 + 2.13 / 234.3 + 8.22 / 234.3 = 0.04 \leq 1 \text{ OK } 96\% \text{ under}$$

Design Member 30, EQUAL LOAD, Sway

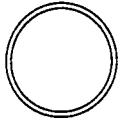
$$\Delta \leq Y/300.0, 1.24 \leq 800.0/300.0 = 2.67 \text{ mm OK } 53\% \text{ under}$$

Checking design member 31

Members: 31

Group: Custom2

Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2154.07/38.35, 1.0 * 2154.07/38.35) = 56.17$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 56.17^2 / (2 * 108.06^2)) * 355.0 / 1.84 = 166.5 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 31, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 12.41 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 12.41 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Design Member 31, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.25 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 31, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.79 \leq 8.62 \text{ mm OK } 91\% \text{ under}$$

Design Member 31, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 4.48 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 4.48 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Design Member 31, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.17 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 31, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.44 \leq 8.62 \text{ mm OK } 95\% \text{ under}$$

Design Member 31, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 31, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

Design Member 31, EQUAL LOAD, Compression

$$f_a \leq F_a, 15.77 \leq 166.5 \text{ OK } 91\% \text{ under}$$

Design Member 31, EQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 12.41 / 234.3 + 4.48 / 234.3 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Design Member 31, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 15.77 / 166.5 = 0.09 \leq 0.15 \therefore \phi 0$$

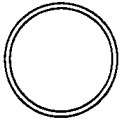
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta x} / \Phi_{\beta x} + \phi_{\beta y} / \Phi_{\beta y} = 15.77 / 166.5 + 12.41 / 234.3 + 4.48 / 234.3 = 0.17 \leq 1 \text{ OK } 83\% \text{ under}$$

Design Member 31, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.43 \leq 800.0/300.0 = 2.67 \text{ mm OK } 84\% \text{ under}$$

Checking design member 32

Members: 32
Group: Custom2
Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2154.07/38.35, 1.0 * 2154.07/38.35) = 56.17$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 56.17^2 / (2 * 108.06^2)) * 355.0 / 1.84 = 166.5 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 32, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 12.41 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 12.41 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Design Member 32, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.25 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 32, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.79 \leq 8.62 \text{ mm OK } 91\% \text{ under}$$

Design Member 32, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 4.48 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 4.48 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Design Member 32, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.17 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 32, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.44 \leq 8.62 \text{ mm OK } 95\% \text{ under}$$

Design Member 32, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 32, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

Design Member 32, EQUAL LOAD, Compression

$$f_a \leq F_a, 15.77 \leq 166.5 \text{ OK } 91\% \text{ under}$$

Design Member 32, EQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0/245.0 + 12.41/234.3 + 4.48/234.3 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Design Member 32, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 15.77/166.5 = 0.09 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 15.77/166.5 + 12.41/234.3 + 4.48/234.3 = 0.17 \leq 1 \text{ OK } 83\% \text{ under}$$

Design Member 32, EQUAL LOAD, Sway

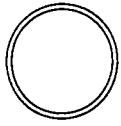
$$\Delta \leq Y/300.0, 0.43 \leq 800.0/300.0 = 2.67 \text{ mm OK } 84\% \text{ under}$$

Checking design member 33

Members: 33

Group: Custom2

Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2154.07/38.35, 1.0 * 2154.07/38.35) = 56.17$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 56.17^2 / (2 * 108.06^2)) * 355.0 / 1.84 = 166.5 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 33, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 12.41 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 12.41 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Design Member 33, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.25 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 33, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.79 \leq 8.62 \text{ mm OK } 91\% \text{ under}$$

Design Member 33, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 4.48 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 4.48 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Design Member 33, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.17 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 33, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.44 \leq 8.62 \text{ mm OK } 95\% \text{ under}$$

Design Member 33, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 33, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

Design Member 33, EQUAL LOAD, Compression

$$f_a \leq F_a, 15.77 \leq 166.5 \text{ OK } 91\% \text{ under}$$

Design Member 33, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 12.41 / 234.3 + 4.48 / 234.3 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Design Member 33, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 15.77 / 166.5 = 0.09 \leq 0.15 \therefore \phi 0$$

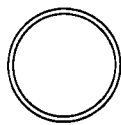
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 15.77 / 166.5 + 12.41 / 234.3 + 4.48 / 234.3 = 0.17 \leq 1 \text{ OK } 83\% \text{ under}$$

Design Member 33, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 0.43 \leq 800.0/300.0 = 2.67 \text{ mm OK } 84\% \text{ under}$$

Checking design member 34

Members: 34
Group: Custom2
Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2154.07/38.35, 1.0 * 2154.07/38.35) = 56.17$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 56.17^2 / (2 * 108.06^2)) * 355.0 / 1.84 = 166.5 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 34, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 12.41 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 12.41 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Design Member 34, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.25 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 34, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.79 \leq 8.62 \text{ mm OK } 91\% \text{ under}$$

Design Member 34, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 4.48 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 4.48 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Design Member 34, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.17 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 34, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.44 \leq 8.62 \text{ mm OK } 95\% \text{ under}$$

Design Member 34, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 34, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

Design Member 34, EQUAL LOAD, Compression

$$f_a \leq F_a, 15.77 \leq 166.5 \text{ OK } 91\% \text{ under}$$

Design Member 34, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 12.41 / 234.3 + 4.48 / 234.3 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Design Member 34, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 15.77 / 166.5 = 0.09 \leq 0.15 \therefore \phi 0$$

$$\phi_a / \Phi_a + \phi_{\beta\xi} / \Phi_{\beta\xi} - \phi_{\beta\psi} / \Phi_{\beta\psi} = 15.77 / 166.5 + 12.41 / 234.3 + 4.48 / 234.3 = 0.17 \leq 1 \text{ OK } 83\% \text{ under}$$

Design Member 34, EQUAL LOAD, Sway

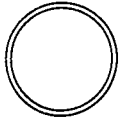
$$\Delta \leq Y/300.0, 0.43 \leq 800.0/300.0 = 2.67 \text{ mm OK } 84\% \text{ under}$$

Checking design member 35

Members: 35

Group: Custom2

Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1569.24/38.35, 1.0 * 1569.24/38.35) = 40.92$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 40.92^2 / (2 * 108.06^2)) * 355.0 / 1.8 = 182.89 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 35, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 2.13 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 2.13 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 35, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.11 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 35, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.08 \leq 6.28 \text{ mm OK } 99\% \text{ under}$$

Design Member 35, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 8.22 \leq 234.3 \text{ OK } 96\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 8.22 \leq 234.3 \text{ OK } 96\% \text{ under}$$

Design Member 35, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.33 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 35, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.39 \leq 6.28 \text{ mm OK } 78\% \text{ under}$$

Design Member 35, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 5.51 \leq 213.0 \text{ OK } 97\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 5.51 \leq 245.0 \text{ OK } 98\% \text{ under}$$

Design Member 35, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1569.24/38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1569.24/38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

Design Member 35, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 182.89 \text{ OK } 100\% \text{ under}$$

Design Member 35, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 5.51/213.0 + 2.13/234.3 + 8.22/234.3 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Design Member 35, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0/182.89 = 0.0 \leq 0.15 \therefore \phi 0$$

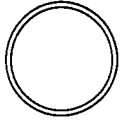
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0/182.89 + 2.13/234.3 + 8.22/234.3 = 0.04 \leq 1 \text{ OK } 96\% \text{ under}$$

Design Member 35, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 1.24 \leq 800.0/300.0 = 2.67 \text{ mm OK } 53\% \text{ under}$$

Checking design member 36

Members: 36
Group: Custom2
Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1569.24/38.35, 1.0 * 1569.24/38.35) = 40.92$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / F_s = (1 - 40.92^2 / (2 * 108.06^2)) * 355.0 / 1.8 = 182.89 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 36, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 2.13 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 2.13 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 36, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.11 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 36, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.08 \leq 6.28 \text{ mm OK } 99\% \text{ under}$$

Design Member 36, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 8.22 \leq 234.3 \text{ OK } 96\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 8.22 \leq 234.3 \text{ OK } 96\% \text{ under}$$

Design Member 36, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.33 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 36, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.39 \leq 6.28 \text{ mm OK } 78\% \text{ under}$$

Design Member 36, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 5.51 \leq 213.0 \text{ OK } 97\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 5.51 \leq 245.0 \text{ OK } 98\% \text{ under}$$

Design Member 36, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1569.24 / 38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1569.24 / 38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

Design Member 36, EQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 182.89 \text{ OK } 100\% \text{ under}$$

Design Member 36, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 5.51 / 213.0 + 2.13 / 234.3 + 8.22 / 234.3 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Design Member 36, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 182.89 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0 / 182.89 + 2.13 / 234.3 + 8.22 / 234.3 = 0.04 \leq 1 \text{ OK } 96\% \text{ under}$$

Design Member 36, EQUAL LOAD, Sway

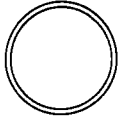
$$\Delta \leq Y/300.0, 1.24 \leq 800.0/300.0 = 2.67 \text{ mm OK } 53\% \text{ under}$$

Checking design member 37

Members: 37

Group: Custom2

Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 3122.9/38.35, 1.0 * 3122.9/38.35) = 81.43$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 81.43^2 / (2 * 108.06^2)) * 355.0 / 1.9 = 134.08 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 37, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.82 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.82 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Design Member 37, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.02 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 37, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.99 \leq 12.49 \text{ mm OK } 52\% \text{ under}$$

Design Member 37, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.6 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.6 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 37, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.01 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 37, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.75 \leq 12.49 \text{ mm OK } 94\% \text{ under}$$

Design Member 37, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 37, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 3122.9/38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 3122.9/38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

Design Member 37, EQUAL LOAD, Compression

$$f_a \leq F_a, 17.45 \leq 134.08 \text{ OK } 87\% \text{ under}$$

Design Member 37, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0/245.0 + 3.82/234.3 + 0.6/234.3 = 0.02 \leq 1 \text{ OK } 98\% \text{ under}$$

Design Member 37, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 17.45/134.08 = 0.13 \leq 0.15 \therefore \phi 0$$

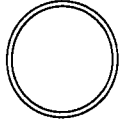
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_5} / \Phi_{\beta_5} + \phi_{\beta_v} / \Phi_{\beta_v} = 17.45/134.08 + 3.82/234.3 + 0.6/234.3 = 0.15 \leq 1 \text{ OK } 85\% \text{ under}$$

Design Member 37, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 1.24 \leq 800.0/300.0 = 2.67 \text{ mm OK } 53\% \text{ under}$$

Checking design member 38

Members: 38
Group: Custom2
Section: CHS 114.3 x 6



Load Case: EQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 3122.9/38.35, 1.0 * 3122.9/38.35) = 81.43$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 81.43^2 / (2 * 108.06^2)) * 355.0 / 1.9 = 134.08 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 38, EQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.82 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.82 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Design Member 38, EQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.02 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 38, EQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.99 \leq 12.49 \text{ mm OK } 52\% \text{ under}$$

Design Member 38, EQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.6 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.6 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 38, EQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.01 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 38, EQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.75 \leq 12.49 \text{ mm OK } 94\% \text{ under}$$

Design Member 38, EQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 38, EQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 3122.9/38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 3122.9/38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

Design Member 38, EQUAL LOAD, Compression

$$f_a \leq F_a, 17.45 \leq 134.08 \text{ OK } 87\% \text{ under}$$

Design Member 38, EQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0/245.0 + 3.82/234.3 + 0.6/234.3 = 0.02 \leq 1 \text{ OK } 98\% \text{ under}$$

Design Member 38, EQUAL LOAD, Bending + Compression

$$f_a / F_a = 17.45/134.08 = 0.13 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 17.45/134.08 - 3.82/234.3 + 0.6/234.3 = 0.15 \leq 1 \text{ OK } 85\% \text{ under}$$

Design Member 38, EQUAL LOAD, Sway

$$\Delta \leq Y/300.0, 1.24 \leq 800.0/300.0 = 2.67 \text{ mm OK } 53\% \text{ under}$$

End of check

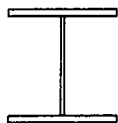
Appendix D

**Steel design report to ASIC ASD
Unequal Loading Condition**

Steel Design Report

Checking design member 1

Members: 1
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_{\beta} \leq L_c \therefore \phi 0 \quad \Phi_{\beta} = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 1, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 43.52 \leq 234.3 \text{ OK } 81\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 43.52 \leq 234.3 \text{ OK } 81\% \text{ under}$$

Design Member 1, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 8.46 \leq 142.0 \text{ OK } 94\% \text{ under}$$

Design Member 1, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.16 \leq 10.8 \text{ mm OK } 52\% \text{ under}$$

Design Member 1, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 25.29 \leq 266.25 \text{ OK } 91\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 25.29 \leq 266.25 \text{ OK } 91\% \text{ under}$$

Design Member 1, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.53 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 1, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.53 \leq 10.8 \text{ mm OK } 86\% \text{ under}$$

Design Member 1, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 12.09 \leq 213.0 \text{ OK } 94\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 12.09 \leq 245.0 \text{ OK } 95\% \text{ under}$$

Design Member 1, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 300.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 300.0 \text{ OK } 88\% \text{ under}$$

Design Member 1, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 1, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 12.09 / 213.0 + 43.52 / 234.3 + 25.29 / 266.25 = 0.34 \leq 1 \text{ OK } 66\% \text{ under}$$

Design Member 1, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

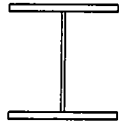
$$\phi_{\alpha} / \Phi_{\alpha} + \phi_{\beta x} / \Phi_{\beta x} + \phi_{\beta y} / \Phi_{\beta y} = 0.0 / 188.12 + 43.52 / 234.3 + 25.29 / 266.25 = 0.28 \leq 1 \text{ OK } 72\% \text{ under}$$

Checking design member 2

Members: 2

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 \cdot F_y = 0.6 \cdot 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 \cdot F_u = 0.5 \cdot 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 \cdot F_y = 0.4 \cdot 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 4000.0/136.65, 1.0 \cdot 4000.0/77.98) = 51.3$$

$$F_a = (1 - (Kl/r)^2 / (2 \cdot C_c^2)) \cdot F_y / FS = (1 - 51.3^2 / (2 \cdot 105.44^2)) \cdot 355.0 / 1.83 = 170.59 \text{ MPa}$$

$$b/t = 153.67/20.57 = 7.47 \leq 65/\sqrt{F_y} = 65/\sqrt{355.0} = 9.06 \therefore \phi_0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφορ Αξισ:

$$\Lambda_\beta > \Lambda_\chi \therefore \phi_0 \quad \Phi_\beta = 0.6 \cdot F_y = 0.6 \cdot 355.0 = 213.0 \text{ MPa}$$

$$F_b = 12 \times 10^3 \cdot C_b / (1 + d/A_f) = 12 \times 10^3 \cdot 1.2 / (4000.0 \cdot 317.5/63.23) = 494.95 \text{ MPa}$$

$$F_b > 0.6 \cdot F_y \therefore \phi_0 \quad \Phi_\beta = 0.6 \cdot F_y = 0.6 \cdot 355.0 = 213.0 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 \cdot F_y = 0.75 \cdot 355.0 = 266.25 \text{ MPa}$$

Design Member 2, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 23.88 \leq 213.0 \text{ OK } 89\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 23.88 \leq 213.0 \text{ OK } 89\% \text{ under}$$

Design Member 2, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 1.0 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 2, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 1.52 \leq 16.0 \text{ mm OK } 90\% \text{ under}$$

Design Member 2, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 84.64 \leq 266.25 \text{ OK } 68\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 84.64 \leq 266.25 \text{ OK } 68\% \text{ under}$$

Design Member 2, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 2.16 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 2, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 10.53 \leq 16.0 \text{ mm OK } 34\% \text{ under}$$

Design Member 2, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 23.87 \leq 213.0 \text{ OK } 89\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 23.87 \leq 245.0 \text{ OK } 90\% \text{ under}$$

Design Member 2, UNEQUAL LOAD, Slenderness

$$K_x \cdot L_x / r_x = 1.0 \cdot 4000.0 / 136.65 = 29.27 \leq 300.0 \text{ OK } 90\% \text{ under}$$

$$K_y \cdot L_y / r_y = 1.0 \cdot 4000.0 / 77.98 = 51.3 \leq 300.0 \text{ OK } 83\% \text{ under}$$

Design Member 2, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 170.59 \text{ OK } 100\% \text{ under}$$

Design Member 2, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 23.87/213.0 + 23.88/213.0 + 84.64/266.25 = 0.54 \leq 1 \text{ OK } 46\% \text{ under}$$

Design Member 2, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0/170.59 = 0.0 \leq 0.15 \therefore \phi_0$$

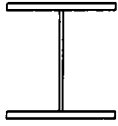
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0/170.59 + 23.88/213.0 + 84.64/266.25 = 0.43 \leq 1 \text{ OK } 57\% \text{ under}$$

Checking design member 3

Members: 3

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * L_x / r_x, K_y * L_y / r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / F_S = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ.}$$

Μαφωρ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 3, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 48.18 \leq 234.3 \text{ OK } 79\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 48.18 \leq 234.3 \text{ OK } 79\% \text{ under}$$

Design Member 3, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 9.42 \leq 142.0 \text{ OK } 93\% \text{ under}$$

Design Member 3, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 8.02 \leq 10.8 \text{ mm OK } 26\% \text{ under}$$

Design Member 3, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 17.63 \leq 266.25 \text{ OK } 93\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 17.63 \leq 266.25 \text{ OK } 93\% \text{ under}$$

Design Member 3, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.34 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 3, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.39 \leq 10.8 \text{ mm OK } 87\% \text{ under}$$

Design Member 3, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 19.79 \leq 213.0 \text{ OK } 91\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 19.79 \leq 245.0 \text{ OK } 92\% \text{ under}$$

Design Member 3, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 300.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 300.0 \text{ OK } 88\% \text{ under}$$

Design Member 3, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 3, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 19.79 / 213.0 + 48.18 / 234.3 + 17.63 / 266.25 = 0.36 \leq 1 \text{ OK } 64\% \text{ under}$$

Design Member 3, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

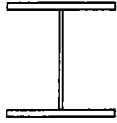
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta x} / \Phi_{\beta x} + \phi_{\beta y} / \Phi_{\beta y} = 0.0 / 188.12 + 48.18 / 234.3 + 17.63 / 266.25 = 0.27 \leq 1 \text{ OK } 73\% \text{ under}$$

Checking design member 4

Members: 4

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$K_l/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (K_l/r)^2 / (2 * C_c^2)) * F_y / F_S = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 4, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.64 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.64 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 4, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.2 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 4, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 4.39 \leq 10.8 \text{ mm OK } 59\% \text{ under}$$

Design Member 4, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 28.93 \leq 266.25 \text{ OK } 89\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 28.93 \leq 266.25 \text{ OK } 89\% \text{ under}$$

Design Member 4, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 1.04 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 4, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.26 \leq 10.8 \text{ mm OK } 88\% \text{ under}$$

Design Member 4, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 4, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 200.0 \text{ OK } 83\% \text{ under}$$

Design Member 4, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 10.97 \leq 188.12 \text{ OK } 94\% \text{ under}$$

Design Member 4, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.64 / 234.3 + 28.93 / 266.25 = 0.11 \leq 1 \text{ OK } 89\% \text{ under}$$

Design Member 4, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 10.97 / 188.12 = 0.06 \leq 0.15 \therefore \phi 0$$

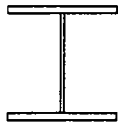
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\eta} / \Phi_{\beta\eta} = 10.97 / 188.12 + 0.64 / 234.3 + 28.93 / 266.25 = 0.17 \leq 1 \text{ OK } 83\% \text{ under}$$

Checking design member 5

Members: 5

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σχετιον ις Χομπαχτ}$$

Μαφορ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 5, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 2.26 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 2.26 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 5, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.71 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 5, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 1.52 \leq 10.8 \text{ mm OK } 86\% \text{ under}$$

Design Member 5, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 86.56 \leq 266.25 \text{ OK } 67\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 86.56 \leq 266.25 \text{ OK } 67\% \text{ under}$$

Design Member 5, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 3.26 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 5, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.27 \leq 10.8 \text{ mm OK } 88\% \text{ under}$$

Design Member 5, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 5, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 200.0 \text{ OK } 83\% \text{ under}$$

Design Member 5, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.58 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 5, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 2.26 / 234.3 + 86.56 / 266.25 = 0.33 \leq 1 \text{ OK } 67\% \text{ under}$$

Design Member 5, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.58 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

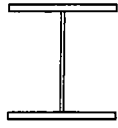
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.58 / 188.12 + 2.26 / 234.3 + 86.56 / 266.25 = 0.34 \leq 1 \text{ OK } 66\% \text{ under}$$

Checking design member 6

Members: 6

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 \cdot F_y = 0.6 \cdot 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 \cdot F_u = 0.5 \cdot 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 \cdot F_y = 0.4 \cdot 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 2700.0 / 136.65, 1.0 \cdot 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (Kl/r)^2 / (2 \cdot C_c^2)) \cdot F_y / FS = (1 - 34.63^2 / (2 \cdot 105.44^2)) \cdot 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 \cdot F_y = 0.66 \cdot 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 \cdot F_y = 0.75 \cdot 355.0 = 266.25 \text{ MPa}$$

Design Member 6, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 2.26 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 2.26 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 6, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.71 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 6, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 1.52 \leq 10.8 \text{ mm OK } 86\% \text{ under}$$

Design Member 6, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 86.56 \leq 266.25 \text{ OK } 67\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 86.56 \leq 266.25 \text{ OK } 67\% \text{ under}$$

Design Member 6, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 3.26 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 6, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.3 \leq 10.8 \text{ mm OK } 88\% \text{ under}$$

Design Member 6, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 6, UNEQUAL LOAD, Slenderness

$$K_x \cdot L_x / r_x = 1.0 \cdot 2700.0 / 136.65 = 19.76 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y \cdot L_y / r_y = 1.0 \cdot 2700.0 / 77.98 = 34.63 \leq 200.0 \text{ OK } 83\% \text{ under}$$

Design Member 6, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.58 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 6, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 2.26 / 234.3 + 86.56 / 266.25 = 0.33 \leq 1 \text{ OK } 67\% \text{ under}$$

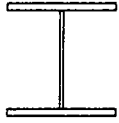
Design Member 6, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.58 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.58 / 188.12 + 2.26 / 234.3 + 86.56 / 266.25 = 0.34 \leq 1 \text{ OK } 66\% \text{ under}$$

Checking design member 7

Members: 7
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_{\beta} \leq L_c \therefore \phi 0 \quad \Phi_{\beta} = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 7, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 0.64 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 0.64 \leq 234.3 \text{ OK } 100\% \text{ under}$$

Design Member 7, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.2 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 7, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 4.39 \leq 10.8 \text{ mm OK } 59\% \text{ under}$$

Design Member 7, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 28.93 \leq 266.25 \text{ OK } 89\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 28.93 \leq 266.25 \text{ OK } 89\% \text{ under}$$

Design Member 7, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 1.04 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 7, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.26 \leq 10.8 \text{ mm OK } 88\% \text{ under}$$

Design Member 7, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 7, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 200.0 \text{ OK } 83\% \text{ under}$$

Design Member 7, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 10.97 \leq 188.12 \text{ OK } 94\% \text{ under}$$

Design Member 7, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 0.64 / 234.3 + 28.93 / 266.25 = 0.11 \leq 1 \text{ OK } 89\% \text{ under}$$

Design Member 7, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 10.97 / 188.12 = 0.06 \leq 0.15 \therefore \phi 0$$

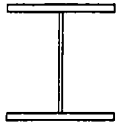
$$\phi_{\alpha} / \Phi_{\alpha} + \phi_{\beta z} / \Phi_{\beta z} + \phi_{\beta y} / \Phi_{\beta y} = 10.97 / 188.12 + 0.64 / 234.3 + 28.93 / 266.25 = 0.17 \leq 1 \text{ OK } 83\% \text{ under}$$

Checking design member 8

Members: 8

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σελτιον ις Χομπαχτ}$$

Μαφορ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 8, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 48.18 \leq 234.3 \text{ OK } 79\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 48.18 \leq 234.3 \text{ OK } 79\% \text{ under}$$

Design Member 8, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 9.42 \leq 142.0 \text{ OK } 93\% \text{ under}$$

Design Member 8, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 8.02 \leq 10.8 \text{ mm OK } 26\% \text{ under}$$

Design Member 8, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 17.63 \leq 266.25 \text{ OK } 93\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 17.63 \leq 266.25 \text{ OK } 93\% \text{ under}$$

Design Member 8, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.34 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 8, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.39 \leq 10.8 \text{ mm OK } 87\% \text{ under}$$

Design Member 8, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 19.79 \leq 213.0 \text{ OK } 91\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 19.79 \leq 245.0 \text{ OK } 92\% \text{ under}$$

Design Member 8, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 300.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 300.0 \text{ OK } 88\% \text{ under}$$

Design Member 8, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 8, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 19.79 / 213.0 + 48.18 / 234.3 + 17.63 / 266.25 = 0.36 \leq 1 \text{ OK } 64\% \text{ under}$$

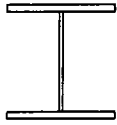
Design Member 8, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha - \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 188.12 - 48.18 / 234.3 + 17.63 / 266.25 = 0.27 \leq 1 \text{ OK } 73\% \text{ under}$$

Checking design member 9

Members: 9
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 4000.0 / 136.65, 1.0 * 4000.0 / 77.98) = 51.3$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 51.3^2 / (2 * 105.44^2)) * 355.0 / 1.83 = 170.59 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Αξισ:

$$\Lambda_\beta > \Lambda_\chi \therefore \phi 0 \quad \Phi_\beta = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$F_b = 12 * 10^3 * C_b / (l * d / A_f) = 12 * 10^3 * 1.2 / (4000.0 * 317.5 / 63.23) = 494.95 \text{ MPa}$$

$$F_b > 0.6 * F_y \therefore \phi 0 \quad \Phi_\beta = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 9, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 23.88 \leq 213.0 \text{ OK } 89\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 23.88 \leq 213.0 \text{ OK } 89\% \text{ under}$$

Design Member 9, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 1.0 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 9, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 2.08 \leq 16.0 \text{ mm OK } 87\% \text{ under}$$

Design Member 9, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 84.64 \leq 266.25 \text{ OK } 68\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 84.64 \leq 266.25 \text{ OK } 68\% \text{ under}$$

Design Member 9, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 2.16 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 9, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 10.53 \leq 16.0 \text{ mm OK } 34\% \text{ under}$$

Design Member 9, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 23.87 \leq 213.0 \text{ OK } 89\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 23.87 \leq 245.0 \text{ OK } 90\% \text{ under}$$

Design Member 9, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 4000.0 / 136.65 = 29.27 \leq 300.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 4000.0 / 77.98 = 51.3 \leq 300.0 \text{ OK } 83\% \text{ under}$$

Design Member 9, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 170.59 \text{ OK } 100\% \text{ under}$$

Design Member 9, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 23.87 / 213.0 + 23.88 / 213.0 + 84.64 / 266.25 = 0.54 \leq 1 \text{ OK } 46\% \text{ under}$$

Design Member 9, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 170.59 = 0.0 \leq 0.15 \therefore \phi 0$$

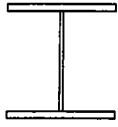
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\zeta} / \Phi_{\beta\zeta} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 170.59 + 23.88 / 213.0 + 84.64 / 266.25 = 0.43 \leq 1 \text{ OK } 57\% \text{ under}$$

Checking design member 10

Members: 10

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2700.0 / 136.65, 1.0 * 2700.0 / 77.98) = 34.63$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 34.63^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 188.12 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαθωρ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 10, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 43.52 \leq 234.3 \text{ OK } 81\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 43.52 \leq 234.3 \text{ OK } 81\% \text{ under}$$

Design Member 10, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 8.46 \leq 142.0 \text{ OK } 94\% \text{ under}$$

Design Member 10, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.16 \leq 10.8 \text{ mm OK } 52\% \text{ under}$$

Design Member 10, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 25.29 \leq 266.25 \text{ OK } 91\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 25.29 \leq 266.25 \text{ OK } 91\% \text{ under}$$

Design Member 10, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.53 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 10, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.54 \leq 10.8 \text{ mm OK } 86\% \text{ under}$$

Design Member 10, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 12.09 \leq 213.0 \text{ OK } 94\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 12.09 \leq 245.0 \text{ OK } 95\% \text{ under}$$

Design Member 10, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2700.0 / 136.65 = 19.76 \leq 300.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2700.0 / 77.98 = 34.63 \leq 300.0 \text{ OK } 88\% \text{ under}$$

Design Member 10, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 188.12 \text{ OK } 100\% \text{ under}$$

Design Member 10, UNEQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 12.09 / 213.0 + 43.52 / 234.3 + 25.29 / 266.25 = 0.34 \leq 1 \text{ OK } 66\% \text{ under}$$

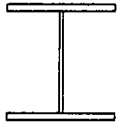
Design Member 10, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 188.12 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\eta} / \Phi_{\beta\eta} = 0.0 / 188.12 + 43.52 / 234.3 + 25.29 / 266.25 = 0.28 \leq 1 \text{ OK } 72\% \text{ under}$$

Checking design member 11

Members: 11
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * L/r_x, K_y * L/r_y) = \max(1.0 * 800.0 / 136.65, 1.0 * 800.0 / 77.98) = 10.26$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 10.26^2 / (2 * 105.44^2)) * 355.0 / 1.7 = 207.46 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφορ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 11, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 28.01 \leq 234.3 \text{ OK } 88\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 28.01 \leq 234.3 \text{ OK } 88\% \text{ under}$$

Design Member 11, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 27.95 \leq 142.0 \text{ OK } 80\% \text{ under}$$

Design Member 11, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.49 \leq 3.2 \text{ mm OK } 85\% \text{ under}$$

Design Member 11, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 6.27 \leq 266.25 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 6.27 \leq 266.25 \text{ OK } 98\% \text{ under}$$

Design Member 11, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.72 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 11, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.41 \leq 3.2 \text{ mm OK } 87\% \text{ under}$$

Design Member 11, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 18.81 \leq 213.0 \text{ OK } 91\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 18.81 \leq 245.0 \text{ OK } 92\% \text{ under}$$

Design Member 11, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 800.0 / 136.65 = 5.85 \leq 300.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 800.0 / 77.98 = 10.26 \leq 300.0 \text{ OK } 97\% \text{ under}$$

Design Member 11, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 207.46 \text{ OK } 100\% \text{ under}$$

Design Member 11, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 18.81 / 213.0 + 28.01 / 234.3 + 6.27 / 266.25 = 0.23 \leq 1 \text{ OK } 77\% \text{ under}$$

Design Member 11, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 207.46 = 0.0 \leq 0.15 \therefore \phi 0$$

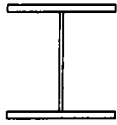
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 207.46 + 28.01 / 234.3 + 6.27 / 266.25 = 0.14 \leq 1 \text{ OK } 86\% \text{ under}$$

Checking design member 12

Members: 12

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 800.0 / 136.65, 1.0 * 800.0 / 77.98) = 10.26$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 10.26^2 / (2 * 105.44^2)) * 355.0 / 1.7 = 207.46 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 12, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 24.26 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 24.26 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Design Member 12, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 23.5 \leq 142.0 \text{ OK } 83\% \text{ under}$$

Design Member 12, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 1.25 \leq 3.2 \text{ mm OK } 61\% \text{ under}$$

Design Member 12, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 6.7 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 6.7 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Design Member 12, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.86 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 12, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.4 \leq 3.2 \text{ mm OK } 88\% \text{ under}$$

Design Member 12, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 18.72 \leq 213.0 \text{ OK } 91\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 18.72 \leq 245.0 \text{ OK } 92\% \text{ under}$$

Design Member 12, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 800.0 / 136.65 = 5.85 \leq 300.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 800.0 / 77.98 = 10.26 \leq 300.0 \text{ OK } 97\% \text{ under}$$

Design Member 12, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 207.46 \text{ OK } 100\% \text{ under}$$

Design Member 12, UNEQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 18.72 / 213.0 + 24.26 / 234.3 + 6.7 / 266.25 = 0.22 \leq 1 \text{ OK } 78\% \text{ under}$$

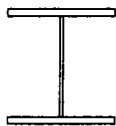
Design Member 12, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 207.46 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha - \phi_{\beta\xi} / \Phi_{\beta\xi} - \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 207.46 + 24.26 / 234.3 + 6.7 / 266.25 = 0.13 \leq 1 \text{ OK } 87\% \text{ under}$$

Checking design member 13

Members: 13
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 800.0 / 136.65, 1.0 * 800.0 / 77.98) = 10.26$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 10.26^2 / (2 * 105.44^2)) * 355.0 / 1.7 = 207.46 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 13, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 24.26 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 24.26 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Design Member 13, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 23.5 \leq 142.0 \text{ OK } 83\% \text{ under}$$

Design Member 13, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 1.25 \leq 3.2 \text{ mm OK } 61\% \text{ under}$$

Design Member 13, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 6.7 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 6.7 \leq 266.25 \text{ OK } 97\% \text{ under}$$

Design Member 13, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.86 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 13, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.4 \leq 3.2 \text{ mm OK } 88\% \text{ under}$$

Design Member 13, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 18.72 \leq 213.0 \text{ OK } 91\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 18.72 \leq 245.0 \text{ OK } 92\% \text{ under}$$

Design Member 13, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 800.0 / 136.65 = 5.85 \leq 300.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 800.0 / 77.98 = 10.26 \leq 300.0 \text{ OK } 97\% \text{ under}$$

Design Member 13, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 207.46 \text{ OK } 100\% \text{ under}$$

Design Member 13, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 18.72 / 213.0 + 24.26 / 234.3 + 6.7 / 266.25 = 0.22 \leq 1 \text{ OK } 78\% \text{ under}$$

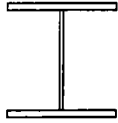
Design Member 13, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 207.46 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 207.46 + 24.26 / 234.3 + 6.7 / 266.25 = 0.13 \leq 1 \text{ OK } 87\% \text{ under}$$

Checking design member 14

Members: 14
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 800.0 / 136.65, 1.0 * 800.0 / 77.98) = 10.26$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 10.26^2 / (2 * 105.44^2)) * 355.0 / 1.7 = 207.46 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 14, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 28.01 \leq 234.3 \text{ OK } 88\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 28.01 \leq 234.3 \text{ OK } 88\% \text{ under}$$

Design Member 14, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 27.95 \leq 142.0 \text{ OK } 80\% \text{ under}$$

Design Member 14, UNEQUAL LOAD, Major Deflection

$$\delta \leq L / 250, 0.49 \leq 3.2 \text{ mm OK } 85\% \text{ under}$$

Design Member 14, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 6.27 \leq 266.25 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 6.27 \leq 266.25 \text{ OK } 98\% \text{ under}$$

Design Member 14, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.72 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 14, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L / 250, 0.41 \leq 3.2 \text{ mm OK } 87\% \text{ under}$$

Design Member 14, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 18.81 \leq 213.0 \text{ OK } 91\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 18.81 \leq 245.0 \text{ OK } 92\% \text{ under}$$

Design Member 14, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 800.0 / 136.65 = 5.85 \leq 300.0 \text{ OK } 98\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 800.0 / 77.98 = 10.26 \leq 300.0 \text{ OK } 97\% \text{ under}$$

Design Member 14, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 207.46 \text{ OK } 100\% \text{ under}$$

Design Member 14, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 18.81 / 213.0 + 28.01 / 234.3 + 6.27 / 266.25 = 0.23 \leq 1 \text{ OK } 77\% \text{ under}$$

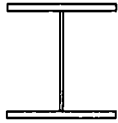
Design Member 14, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 207.46 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\zeta} / \Phi_{\beta\zeta} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 207.46 + 28.01 / 234.3 + 6.27 / 266.25 = 0.14 \leq 1 \text{ OK } 86\% \text{ under}$$

Checking design member 15

Members: 15
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2816.03 / 136.65, 1.0 * 2816.03 / 77.98) = 36.11$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / F_s = (1 - 36.11^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 186.68 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 15, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 38.51 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 38.51 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Design Member 15, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 6.34 \leq 142.0 \text{ OK } 96\% \text{ under}$$

Design Member 15, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.06 \leq 11.26 \text{ mm OK } 55\% \text{ under}$$

Design Member 15, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 21.26 \leq 266.25 \text{ OK } 92\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 21.26 \leq 266.25 \text{ OK } 92\% \text{ under}$$

Design Member 15, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.37 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 15, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.94 \leq 11.26 \text{ mm OK } 83\% \text{ under}$$

Design Member 15, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 15, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2816.03 / 136.65 = 20.61 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2816.03 / 77.98 = 36.11 \leq 200.0 \text{ OK } 82\% \text{ under}$$

Design Member 15, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 58.28 \leq 186.68 \text{ OK } 69\% \text{ under}$$

Design Member 15, UNEQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 38.51 / 234.3 + 21.26 / 266.25 = 0.24 \leq 1 \text{ OK } 76\% \text{ under}$$

Design Member 15, UNEQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 58.28 / 186.68 = 0.31$$

$$\text{Major Ratio} = C_m * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 38.51 / ((1 - 58.28 / 2424.62) * 234.3) = 0.14$$

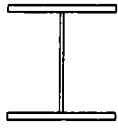
$$\text{Minor Ratio} = C_m * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 21.26 / ((1 - 58.28 / 789.51) * 266.25) = 0.07$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.31 + 0.14 + 0.07 = 0.53 \leq 1 \text{ OK } 47\% \text{ under}$$

$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 58.28 / (0.6 * 355.0) + 38.51 / 234.3 + 21.26 / 266.25 = 0.52 \geq 1 \text{ OK } 48\% \text{ under}$$

Checking design member 16

Members: 16
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * L_x / r_x, K_y * L_y / r_y) = \max(1.0 * 2000.0 / 136.65, 1.0 * 2000.0 / 77.98) = 25.65$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 25.65^2 / (2 * 105.44^2)) * 355.0 / 1.76 = 196.17 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαρορ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 16, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 18.57 \leq 234.3 \text{ OK } 92\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 18.57 \leq 234.3 \text{ OK } 92\% \text{ under}$$

Design Member 16, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 1.28 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 16, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.39 \leq 8.0 \text{ mm OK } 95\% \text{ under}$$

Design Member 16, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 67.02 \leq 266.25 \text{ OK } 75\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 67.02 \leq 266.25 \text{ OK } 75\% \text{ under}$$

Design Member 16, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 1.88 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 16, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 5.28 \leq 8.0 \text{ mm OK } 34\% \text{ under}$$

Design Member 16, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 16, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2000.0 / 136.65 = 14.64 \leq 200.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2000.0 / 77.98 = 25.65 \leq 200.0 \text{ OK } 87\% \text{ under}$$

Design Member 16, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 62.25 \leq 196.17 \text{ OK } 68\% \text{ under}$$

Design Member 16, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 18.57 / 234.3 + 67.02 / 266.25 = 0.33 \leq 1 \text{ OK } 67\% \text{ under}$$

Design Member 16, UNEQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 62.25 / 196.17 = 0.32$$

$$\text{Major Ratio} = C_{mx} * f_{bx} / ((1 - f_a / F_{ex}) * F_{bx}) = 0.85 * 18.57 / ((1 - 62.25 / 4806.82) * 234.3) = 0.07$$

$$\text{Minor Ratio} = C_{my} * f_{by} / ((1 - f_a / F_{ey}) * F_{by}) = 0.85 * 67.02 / ((1 - 62.25 / 1565.2) * 266.25) = 0.22$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.07 + 0.22 = 0.61 \leq 1 \text{ OK } 39\% \text{ under}$$

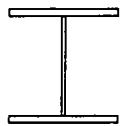
$$f_a / (0.6 * F_y) - f_{bx} / F_{bx} - f_{by} / F_{by} = 62.25 / (0.6 * 355.0) + 18.57 / 234.3 + 67.02 / 266.25 = 0.62 \geq 1 \text{ OK } 38\% \text{ under}$$

Checking design member 17

Members: 17

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2000.0 / 136.65, 1.0 * 2000.0 / 77.98) = 25.65$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / F_s = (1 - 25.65^2 / (2 * 105.44^2)) * 355.0 / 1.76 = 196.17 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 17, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 27.12 \leq 234.3 \text{ OK } 88\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 27.12 \leq 234.3 \text{ OK } 88\% \text{ under}$$

Design Member 17, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 3.27 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 17, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 1.79 \leq 8.0 \text{ mm OK } 78\% \text{ under}$$

Design Member 17, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 80.71 \leq 266.25 \text{ OK } 70\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 80.71 \leq 266.25 \text{ OK } 70\% \text{ under}$$

Design Member 17, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 1.91 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 17, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 4.45 \leq 8.0 \text{ mm OK } 44\% \text{ under}$$

Design Member 17, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 17, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2000.0 / 136.65 = 14.64 \leq 200.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2000.0 / 77.98 = 25.65 \leq 200.0 \text{ OK } 87\% \text{ under}$$

Design Member 17, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 63.72 \leq 196.17 \text{ OK } 68\% \text{ under}$$

Design Member 17, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 27.12 / 234.3 + 80.71 / 266.25 = 0.42 \leq 1 \text{ OK } 58\% \text{ under}$$

Design Member 17, UNEQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 63.72 / 196.17 = 0.32$$

$$\text{Major Ratio} = C_m x * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 27.12 / ((1 - 63.72 / 4806.82) * 234.3) = 0.1$$

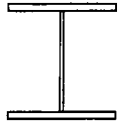
$$\text{Minor Ratio} = C_m y * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 80.71 / ((1 - 63.72 / 1565.2) * 266.25) = 0.27$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.1 + 0.27 = 0.69 \leq 1 \text{ OK } 31\% \text{ under}$$

$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 63.72 / (0.6 * 355.0) + 27.12 / 234.3 + 80.71 / 266.25 = 0.72 \leq 1 \text{ OK } 28\% \text{ under}$$

Checking design member 18

Members: 18
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2816.03 / 136.65, 1.0 * 2816.03 / 77.98) = 36.11$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 36.11^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 186.68 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi_0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαζορ Αξίς:

$$\Lambda_\beta \leq L_c \therefore \phi_0 \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 18, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 43.22 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 43.22 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Design Member 18, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 7.29 \leq 142.0 \text{ OK } 95\% \text{ under}$$

Design Member 18, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 8.05 \leq 11.26 \text{ mm OK } 29\% \text{ under}$$

Design Member 18, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 9.72 \leq 266.25 \text{ OK } 96\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 9.72 \leq 266.25 \text{ OK } 96\% \text{ under}$$

Design Member 18, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.32 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 18, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.79 \leq 11.26 \text{ mm OK } 84\% \text{ under}$$

Design Member 18, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 18, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2816.03 / 136.65 = 20.61 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2816.03 / 77.98 = 36.11 \leq 200.0 \text{ OK } 82\% \text{ under}$$

Design Member 18, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 56.89 \leq 186.68 \text{ OK } 70\% \text{ under}$$

Design Member 18, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 43.22 / 234.3 + 9.72 / 266.25 = 0.22 \leq 1 \text{ OK } 78\% \text{ under}$$

Design Member 18, UNEQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 56.89 / 186.68 = 0.3$$

$$\text{Major Ratio} = C_{mx} * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 43.22 / ((1 - 56.89 / 2424.62) * 234.3) = 0.16$$

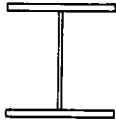
$$\text{Minor Ratio} = C_{my} * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 9.72 / ((1 - 56.89 / 789.51) * 266.25) = 0.03$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.3 + 0.16 + 0.03 = 0.5 \leq 1 \text{ OK } 50\% \text{ under}$$

$$f_a / (0.6 * F_y) - f_{bx} / F_{bx} + f_{by} / F_{by} = 56.89 / (0.6 * 355.0) + 43.22 / 234.3 + 9.72 / 266.25 = 0.49 \geq 1 \text{ OK } 51\% \text{ under}$$

Checking design member 19

Members: 19
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 \cdot F_y = 0.6 \cdot 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 \cdot F_u = 0.5 \cdot 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 \cdot F_y = 0.4 \cdot 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x \cdot l/r_x, K_y \cdot l/r_y) = \max(1.0 \cdot 1350.0/136.65, 1.0 \cdot 1350.0/77.98) = 17.31$$

$$F_a = (1 - (Kl/r)^2 / (2 \cdot C_c^2)) \cdot F_y / FS = (1 - 17.31^2 / (2 \cdot 105.44^2)) \cdot 355.0 / 1.73 = 202.71 \text{ MPa}$$

$$b/t = 153.67/20.57 = 7.47 \leq 65/\sqrt{F_y} = 65/\sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_b \leq L_c \therefore \phi 0 \quad \Phi_b = 0.66 \cdot F_y = 0.66 \cdot 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 \cdot F_y = 0.75 \cdot 355.0 = 266.25 \text{ MPa}$$

Design Member 19, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.67 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.67 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Design Member 19, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 1.59 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 19, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.77 \leq 5.4 \text{ mm OK } 86\% \text{ under}$$

Design Member 19, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 46.47 \leq 266.25 \text{ OK } 83\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 46.47 \leq 266.25 \text{ OK } 83\% \text{ under}$$

Design Member 19, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.27 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 19, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.54 \leq 5.4 \text{ mm OK } 90\% \text{ under}$$

Design Member 19, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 2.27 \leq 213.0 \text{ OK } 99\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 2.27 \leq 245.0 \text{ OK } 99\% \text{ under}$$

Design Member 19, UNEQUAL LOAD, Slenderness

$$K_x \cdot L_x / r_x = 1.0 \cdot 1350.0 / 136.65 = 9.88 \leq 300.0 \text{ OK } 97\% \text{ under}$$

$$K_y \cdot L_y / r_y = 1.0 \cdot 1350.0 / 77.98 = 17.31 \leq 300.0 \text{ OK } 94\% \text{ under}$$

Design Member 19, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 202.71 \text{ OK } 100\% \text{ under}$$

Design Member 19, UNEQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 2.27/213.0 + 3.67/234.3 + 46.47/266.25 = 0.2 \leq 1 \text{ OK } 80\% \text{ under}$$

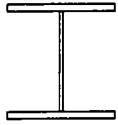
Design Member 19, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0/202.71 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0/202.71 + 3.67/234.3 + 46.47/266.25 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Checking design member 20

Members: 20
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1350.0 / 136.65, 1.0 * 1350.0 / 77.98) = 17.31$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 17.31^2 / (2 * 105.44^2)) * 355.0 / 1.73 = 202.71 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σελτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 20, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.49 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.49 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 20, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.08 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 20, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.75 \leq 5.4 \text{ mm OK } 86\% \text{ under}$$

Design Member 20, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 88.41 \leq 266.25 \text{ OK } 67\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 88.41 \leq 266.25 \text{ OK } 67\% \text{ under}$$

Design Member 20, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 4.94 \leq 142.0 \text{ OK } 97\% \text{ under}$$

Design Member 20, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.81 \leq 5.4 \text{ mm OK } 85\% \text{ under}$$

Design Member 20, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 20, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1350.0 / 136.65 = 9.88 \leq 200.0 \text{ OK } 95\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1350.0 / 77.98 = 17.31 \leq 200.0 \text{ OK } 91\% \text{ under}$$

Design Member 20, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 1.88 \leq 202.71 \text{ OK } 99\% \text{ under}$$

Design Member 20, UNEQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 1.49 / 234.3 + 88.41 / 266.25 = 0.34 \leq 1 \text{ OK } 66\% \text{ under}$$

Design Member 20, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 1.88 / 202.71 = 0.01 \leq 0.15 \therefore \phi 0$$

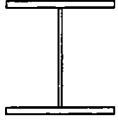
$$\phi_\alpha / \Phi_\alpha - \phi_{\beta\xi} / \Phi_{\beta\xi} - \phi_{\beta\eta} / \Phi_{\beta\eta} = 1.88 / 202.71 + 1.49 / 234.3 + 88.41 / 266.25 = 0.35 \leq 1 \text{ OK } 65\% \text{ under}$$

Checking design member 21

Members: 21

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1350.0 / 136.65, 1.0 * 1350.0 / 77.98) = 17.31$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 17.31^2 / (2 * 105.44^2)) * 355.0 / 1.73 = 202.71 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σχετιον ισ Χομπαχτ}$$

Μαφορ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 21, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.49 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.49 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 21, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.08 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 21, UNEQUAL LOAD, Major Deflection

$$\delta \leq L / 250, 0.75 \leq 5.4 \text{ mm OK } 86\% \text{ under}$$

Design Member 21, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 88.41 \leq 266.25 \text{ OK } 67\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 88.41 \leq 266.25 \text{ OK } 67\% \text{ under}$$

Design Member 21, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 4.94 \leq 142.0 \text{ OK } 97\% \text{ under}$$

Design Member 21, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L / 250, 0.78 \leq 5.4 \text{ mm OK } 85\% \text{ under}$$

Design Member 21, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 21, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1350.0 / 136.65 = 9.88 \leq 200.0 \text{ OK } 95\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1350.0 / 77.98 = 17.31 \leq 200.0 \text{ OK } 91\% \text{ under}$$

Design Member 21, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 1.88 \leq 202.71 \text{ OK } 99\% \text{ under}$$

Design Member 21, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 1.49 / 234.3 + 88.41 / 266.25 = 0.34 \leq 1 \text{ OK } 66\% \text{ under}$$

Design Member 21, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 1.88 / 202.71 = 0.01 \leq 0.15 \therefore \phi 0$$

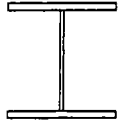
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 1.88 / 202.71 + 1.49 / 234.3 + 88.41 / 266.25 = 0.35 \leq 1 \text{ OK } 65\% \text{ under}$$

Checking design member 22

Members: 22

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1350.0 / 136.65, 1.0 * 1350.0 / 77.98) = 17.31$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 17.31^2 / (2 * 105.44^2)) * 355.0 / 1.73 = 202.71 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ις Χομπαχτ}$$

Μαφωρ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 22, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.67 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.67 \leq 234.3 \text{ OK } 98\% \text{ under}$$

Design Member 22, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 1.59 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 22, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.77 \leq 5.4 \text{ mm OK } 86\% \text{ under}$$

Design Member 22, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 46.47 \leq 266.25 \text{ OK } 83\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 46.47 \leq 266.25 \text{ OK } 83\% \text{ under}$$

Design Member 22, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.27 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 22, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.39 \leq 5.4 \text{ mm OK } 93\% \text{ under}$$

Design Member 22, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 2.27 \leq 213.0 \text{ OK } 99\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 2.27 \leq 245.0 \text{ OK } 99\% \text{ under}$$

Design Member 22, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1350.0 / 136.65 = 9.88 \leq 300.0 \text{ OK } 97\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1350.0 / 77.98 = 17.31 \leq 300.0 \text{ OK } 94\% \text{ under}$$

Design Member 22, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 202.71 \text{ OK } 100\% \text{ under}$$

Design Member 22, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 2.27 / 213.0 + 3.67 / 234.3 + 46.47 / 266.25 = 0.2 \leq 1 \text{ OK } 80\% \text{ under}$$

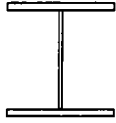
Design Member 22, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 202.71 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0 / 202.71 + 3.67 / 234.3 + 46.47 / 266.25 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Checking design member 23

Members: 23
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2816.03 / 136.65, 1.0 * 2816.03 / 77.98) = 36.11$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 36.11^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 186.68 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 23, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 43.22 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 43.22 \leq 234.3 \text{ OK } 82\% \text{ under}$$

Design Member 23, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 7.29 \leq 142.0 \text{ OK } 95\% \text{ under}$$

Design Member 23, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 8.05 \leq 11.26 \text{ mm OK } 29\% \text{ under}$$

Design Member 23, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 9.72 \leq 266.25 \text{ OK } 96\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 9.72 \leq 266.25 \text{ OK } 96\% \text{ under}$$

Design Member 23, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.32 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 23, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.79 \leq 11.26 \text{ mm OK } 84\% \text{ under}$$

Design Member 23, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 23, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2816.03 / 136.65 = 20.61 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2816.03 / 77.98 = 36.11 \leq 200.0 \text{ OK } 82\% \text{ under}$$

Design Member 23, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 56.89 \leq 186.68 \text{ OK } 70\% \text{ under}$$

Design Member 23, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 43.22 / 234.3 + 9.72 / 266.25 = 0.22 \leq 1 \text{ OK } 78\% \text{ under}$$

Design Member 23, UNEQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 56.89 / 186.68 = 0.3$$

$$\text{Major Ratio} = C_{mx} * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 43.22 / ((1 - 56.89 / 2424.62) * 234.3) = 0.16$$

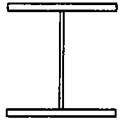
$$\text{Minor Ratio} = C_{my} * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 9.72 / ((1 - 56.89 / 789.51) * 266.25) = 0.03$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.3 + 0.16 + 0.03 = 0.5 \leq 1 \text{ OK } 50\% \text{ under}$$

$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 56.89 / (0.6 * 355.0) + 43.22 / 234.3 + 9.72 / 266.25 = 0.49 \geq 1 \text{ OK } 51\% \text{ under}$$

Checking design member 24

Members: 24
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2000.0 / 136.65, 1.0 * 2000.0 / 77.98) = 25.65$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 25.65^2 / (2 * 105.44^2)) * 355.0 / 1.76 = 196.17 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi_0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαρορ Αξισ:

$$\Lambda_\beta \leq L_c \therefore \phi_0 \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 24, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 27.12 \leq 234.3 \text{ OK } 88\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 27.12 \leq 234.3 \text{ OK } 88\% \text{ under}$$

Design Member 24, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 3.27 \leq 142.0 \text{ OK } 98\% \text{ under}$$

Design Member 24, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 1.79 \leq 8.0 \text{ mm OK } 78\% \text{ under}$$

Design Member 24, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 80.71 \leq 266.25 \text{ OK } 70\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 80.71 \leq 266.25 \text{ OK } 70\% \text{ under}$$

Design Member 24, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 1.91 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 24, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 4.45 \leq 8.0 \text{ mm OK } 44\% \text{ under}$$

Design Member 24, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 24, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2000.0 / 136.65 = 14.64 \leq 200.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2000.0 / 77.98 = 25.65 \leq 200.0 \text{ OK } 87\% \text{ under}$$

Design Member 24, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 63.72 \leq 196.17 \text{ OK } 68\% \text{ under}$$

Design Member 24, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 27.12 / 234.3 + 80.71 / 266.25 = 0.42 \leq 1 \text{ OK } 58\% \text{ under}$$

Design Member 24, UNEQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 63.72 / 196.17 = 0.32$$

$$\text{Major Ratio} = C_{mx} * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 27.12 / ((1 - 63.72 / 4806.82) * 234.3) = 0.1$$

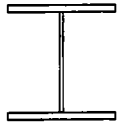
$$\text{Minor Ratio} = C_{my} * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 80.71 / ((1 - 63.72 / 1565.2) * 266.25) = 0.27$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.1 + 0.27 = 0.69 \leq 1 \text{ OK } 31\% \text{ under}$$

$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 63.72 / (0.6 * 355.0) + 27.12 / 234.3 + 80.71 / 266.25 = 0.72 \geq 1 \text{ OK } 28\% \text{ under}$$

Checking design member 25

Members: 25
Group: W
Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * L/r_x, K_y * L/r_y) = \max(1.0 * 2000.0 / 136.65, 1.0 * 2000.0 / 77.98) = 25.65$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / F_S = (1 - 25.65^2 / (2 * 105.44^2)) * 355.0 / 1.76 = 196.17 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 25, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 18.57 \leq 234.3 \text{ OK } 92\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 18.57 \leq 234.3 \text{ OK } 92\% \text{ under}$$

Design Member 25, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 1.28 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 25, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.26 \leq 8.0 \text{ mm OK } 97\% \text{ under}$$

Design Member 25, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 67.02 \leq 266.25 \text{ OK } 75\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 67.02 \leq 266.25 \text{ OK } 75\% \text{ under}$$

Design Member 25, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 1.88 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 25, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 5.28 \leq 8.0 \text{ mm OK } 34\% \text{ under}$$

Design Member 25, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 25, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2000.0 / 136.65 = 14.64 \leq 200.0 \text{ OK } 93\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2000.0 / 77.98 = 25.65 \leq 200.0 \text{ OK } 87\% \text{ under}$$

Design Member 25, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 62.25 \leq 196.17 \text{ OK } 68\% \text{ under}$$

Design Member 25, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 18.57 / 234.3 + 67.02 / 266.25 = 0.33 \leq 1 \text{ OK } 67\% \text{ under}$$

Design Member 25, UNEQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 62.25 / 196.17 = 0.32$$

$$\text{Major Ratio} = C_m x * f_{bx} / ((1 - f_a / F_{ex}) * F_{bx}) = 0.85 * 18.57 / ((1 - 62.25 / 4806.82) * 234.3) = 0.07$$

$$\text{Minor Ratio} = C_m y * f_{by} / ((1 - f_a / F_{ey}) * F_{by}) = 0.85 * 67.02 / ((1 - 62.25 / 1565.2) * 266.25) = 0.22$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.32 + 0.07 + 0.22 = 0.61 \leq 1 \text{ OK } 39\% \text{ under}$$

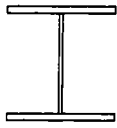
$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 62.25 / (0.6 * 355.0) + 18.57 / 234.3 + 67.02 / 266.25 = 0.62 \geq 1 \text{ OK } 38\% \text{ under}$$

Checking design member 26

Members: 26

Group: W

Section: W12x87



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2816.03 / 136.65, 1.0 * 2816.03 / 77.98) = 36.11$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 36.11^2 / (2 * 105.44^2)) * 355.0 / 1.79 = 186.68 \text{ MPa}$$

$$b/t = 153.67 / 20.57 = 7.47 \leq 65 / \sqrt{F_y} = 65 / \sqrt{355.0} = 9.06 \therefore \phi 0 \text{ Σεχτιον ισ Χομπαχτ}$$

Μαφop Aξισ:

$$\Lambda_\beta \leq L_c \therefore \phi 0 \quad \Phi_\beta = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.75 * F_y = 0.75 * 355.0 = 266.25 \text{ MPa}$$

Design Member 26, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 38.51 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 38.51 \leq 234.3 \text{ OK } 84\% \text{ under}$$

Design Member 26, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 6.34 \leq 142.0 \text{ OK } 96\% \text{ under}$$

Design Member 26, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 5.06 \leq 11.26 \text{ mm OK } 55\% \text{ under}$$

Design Member 26, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 21.26 \leq 266.25 \text{ OK } 92\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 21.26 \leq 266.25 \text{ OK } 92\% \text{ under}$$

Design Member 26, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.37 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 26, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 1.94 \leq 11.26 \text{ mm OK } 83\% \text{ under}$$

Design Member 26, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 26, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2816.03 / 136.65 = 20.61 \leq 200.0 \text{ OK } 90\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2816.03 / 77.98 = 36.11 \leq 200.0 \text{ OK } 82\% \text{ under}$$

Design Member 26, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 58.28 \leq 186.68 \text{ OK } 69\% \text{ under}$$

Design Member 26, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 38.51 / 234.3 + 21.26 / 266.25 = 0.24 \leq 1 \text{ OK } 76\% \text{ under}$$

Design Member 26, UNEQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 58.28 / 186.68 = 0.31$$

$$\text{Major Ratio} = C_{mx} * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 38.51 / ((1 - 58.28 / 2424.62) * 234.3) = 0.14$$

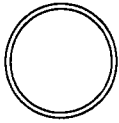
$$\text{Minor Ratio} = C_{my} * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 21.26 / ((1 - 58.28 / 789.51) * 266.25) = 0.07$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.31 + 0.14 + 0.07 = 0.53 \leq 1 \text{ OK } 47\% \text{ under}$$

$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 58.28 / (0.6 * 355.0) + 38.51 / 234.3 + 21.26 / 266.25 = 0.52 \geq 1 \text{ OK } 48\% \text{ under}$$

Checking design member 27

Members: 27
Group: Custom2
Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$K_l/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 3122.9/38.35, 1.0 * 3122.9/38.35) = 81.43$$

$$F_a = (1 - (K_l/r)^2 / (2 * C_c^2)) * F_y / F_s = (1 - 81.43^2 / (2 * 108.06^2)) * 355.0 / 1.9 = 134.08 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 27, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.86 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.86 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 27, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.05 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 27, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 4.18 \leq 12.49 \text{ mm OK } 67\% \text{ under}$$

Design Member 27, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 16.11 \leq 234.3 \text{ OK } 93\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 16.11 \leq 234.3 \text{ OK } 93\% \text{ under}$$

Design Member 27, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.36 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 27, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 2.21 \leq 12.49 \text{ mm OK } 82\% \text{ under}$$

Design Member 27, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 27, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 3122.9/38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 3122.9/38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

Design Member 27, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 69.58 \leq 134.08 \text{ OK } 48\% \text{ under}$$

Design Member 27, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 1.86 / 234.3 + 16.11 / 234.3 = 0.08 \leq 1 \text{ OK } 92\% \text{ under}$$

Design Member 27, UNEQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 69.58 / 134.08 = 0.52$$

$$\text{Major Ratio} = C_{mx} * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 1.86 / ((1 - 69.58 / 163.06) * 234.3) = 0.01$$

$$\text{Minor Ratio} = C_{my} * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 16.11 / ((1 - 69.58 / 163.06) * 234.3) = 0.1$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.52 + 0.01 + 0.1 = 0.63 \leq 1 \text{ OK } 37\% \text{ under}$$

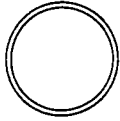
$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 69.58 / (0.6 * 355.0) + 1.86 / 234.3 + 16.11 / 234.3 = 0.4 \leq 1 \text{ OK } 60\% \text{ under}$$

Checking design member 28

Members: 28

Group: Custom2

Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_y = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$K_l/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 3122.9/38.35, 1.0 * 3122.9/38.35) = 81.43$$

$$F_a = (1 - (K_l/r)^2 / (2 * C_c^2)) * F_y / F_S = (1 - 81.43^2 / (2 * 108.06^2)) * 355.0 / 1.9 = 134.08 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 28, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 7.99 \leq 234.3 \text{ OK } 97\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 7.99 \leq 234.3 \text{ OK } 97\% \text{ under}$$

Design Member 28, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.02 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 28, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 9.14 \leq 12.49 \text{ mm OK } 27\% \text{ under}$$

Design Member 28, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 14.87 \leq 234.3 \text{ OK } 94\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 14.87 \leq 234.3 \text{ OK } 94\% \text{ under}$$

Design Member 28, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.34 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 28, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.56 \leq 12.49 \text{ mm OK } 96\% \text{ under}$$

Design Member 28, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 35.71 \leq 213.0 \text{ OK } 83\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 35.71 \leq 245.0 \text{ OK } 85\% \text{ under}$$

Design Member 28, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 3122.9/38.35 = 81.43 \leq 300.0 \text{ OK } 73\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 3122.9/38.35 = 81.43 \leq 300.0 \text{ OK } 73\% \text{ under}$$

Design Member 28, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 134.08 \text{ OK } 100\% \text{ under}$$

Design Member 28, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 35.71/213.0 + 7.99/234.3 + 14.87/234.3 = 0.27 \leq 1 \text{ OK } 73\% \text{ under}$$

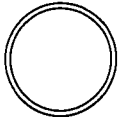
Design Member 28, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0/134.08 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\zeta} / \Phi_{\beta\zeta} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0/134.08 + 7.99/234.3 + 14.87/234.3 = 0.1 \leq 1 \text{ OK } 90\% \text{ under}$$

Checking design member 29

Members: 29
Group: Custom2
Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1569.24 / 38.35, 1.0 * 1569.24 / 38.35) = 40.92$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 40.92^2 / (2 * 108.06^2)) * 355.0 / 1.8 = 182.89 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 29, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.61 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.61 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 29, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.07 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 29, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.93 \leq 6.28 \text{ mm OK } 85\% \text{ under}$$

Design Member 29, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 15.55 \leq 234.3 \text{ OK } 93\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 15.55 \leq 234.3 \text{ OK } 93\% \text{ under}$$

Design Member 29, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.56 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 29, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.88 \leq 6.28 \text{ mm OK } 86\% \text{ under}$$

Design Member 29, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 12.53 \leq 213.0 \text{ OK } 94\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 12.53 \leq 245.0 \text{ OK } 95\% \text{ under}$$

Design Member 29, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1569.24 / 38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1569.24 / 38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

Design Member 29, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 182.89 \text{ OK } 100\% \text{ under}$$

Design Member 29, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 12.53 / 213.0 + 1.61 / 234.3 + 15.55 / 234.3 = 0.13 \leq 1 \text{ OK } 87\% \text{ under}$$

Design Member 29, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0 / 182.89 = 0.0 \leq 0.15 \therefore \phi 0$$

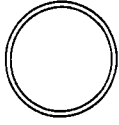
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0 / 182.89 + 1.61 / 234.3 + 15.55 / 234.3 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Checking design member 30

Members: 30

Group: Custom2

Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1569.24/38.35, 1.0 * 1569.24/38.35) = 40.92$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 40.92^2 / (2 * 108.06^2)) * 355.0 / 1.8 = 182.89 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 30, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.18 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.18 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 30, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.15 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 30, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.78 \leq 6.28 \text{ mm OK } 88\% \text{ under}$$

Design Member 30, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 30.28 \leq 234.3 \text{ OK } 87\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 30.28 \leq 234.3 \text{ OK } 87\% \text{ under}$$

Design Member 30, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 1.11 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 30, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 2.04 \leq 6.28 \text{ mm OK } 68\% \text{ under}$$

Design Member 30, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 30, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1569.24/38.35 = 40.92 \leq 200.0 \text{ OK } 80\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1569.24/38.35 = 40.92 \leq 200.0 \text{ OK } 80\% \text{ under}$$

Design Member 30, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 1.76 \leq 182.89 \text{ OK } 99\% \text{ under}$$

Design Member 30, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0/245.0 + 3.18/234.3 + 30.28/234.3 = 0.14 \leq 1 \text{ OK } 86\% \text{ under}$$

Design Member 30, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 1.76/182.89 = 0.01 \leq 0.15 \therefore \phi 0$$

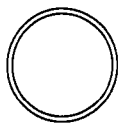
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 1.76/182.89 + 3.18/234.3 + 30.28/234.3 = 0.15 \leq 1 \text{ OK } 85\% \text{ under}$$

Checking design member 31

Members: 31

Group: Custom2

Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2154.07/38.35, 1.0 * 2154.07/38.35) = 56.17$$

$$F_a = (1 - (Kl/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 56.17^2 / (2 * 108.06^2)) * 355.0 / 1.84 = 166.5 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 31, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 11.22 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 11.22 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Design Member 31, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.2 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 31, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.36 \leq 8.62 \text{ mm OK } 96\% \text{ under}$$

Design Member 31, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 31.3 \leq 234.3 \text{ OK } 87\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 31.3 \leq 234.3 \text{ OK } 87\% \text{ under}$$

Design Member 31, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.78 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 31, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 5.69 \leq 8.62 \text{ mm OK } 34\% \text{ under}$$

Design Member 31, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 31, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

Design Member 31, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 19.21 \leq 166.5 \text{ OK } 88\% \text{ under}$$

Design Member 31, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 11.22 / 234.3 + 31.3 / 234.3 = 0.18 \leq 1 \text{ OK } 82\% \text{ under}$$

Design Member 31, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 19.21 / 166.5 = 0.12 \leq 0.15 \therefore \phi 0$$

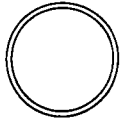
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 19.21 / 166.5 + 11.22 / 234.3 + 31.3 / 234.3 = 0.3 \leq 1 \text{ OK } 70\% \text{ under}$$

Checking design member 32

Members: 32

Group: Custom2

Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2154.07/38.35, 1.0 * 2154.07/38.35) = 56.17$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 56.17^2 / (2 * 108.06^2)) * 355.0 / 1.84 = 166.5 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 32, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 13.43 \leq 234.3 \text{ OK } 94\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 13.43 \leq 234.3 \text{ OK } 94\% \text{ under}$$

Design Member 32, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.23 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 32, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 1.82 \leq 8.62 \text{ mm OK } 79\% \text{ under}$$

Design Member 32, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 22.52 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 22.52 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Design Member 32, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.45 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 32, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 4.84 \leq 8.62 \text{ mm OK } 44\% \text{ under}$$

Design Member 32, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 32, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

Design Member 32, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 6.39 \leq 166.5 \text{ OK } 96\% \text{ under}$$

Design Member 32, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 13.43 / 234.3 + 22.52 / 234.3 = 0.15 \leq 1 \text{ OK } 85\% \text{ under}$$

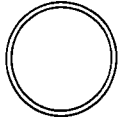
Design Member 32, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 6.39 / 166.5 = 0.04 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\xi} / \Phi_{\beta\xi} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 6.39 / 166.5 + 13.43 / 234.3 + 22.52 / 234.3 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Checking design member 33

Members: 33
Group: Custom2
Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2154.07/38.35, 1.0 * 2154.07/38.35) = 56.17$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 56.17^2 / (2 * 108.06^2)) * 355.0 / 1.84 = 166.5 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 33, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 13.43 \leq 234.3 \text{ OK } 94\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 13.43 \leq 234.3 \text{ OK } 94\% \text{ under}$$

Design Member 33, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.23 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 33, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 1.82 \leq 8.62 \text{ mm OK } 79\% \text{ under}$$

Design Member 33, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 22.52 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 22.52 \leq 234.3 \text{ OK } 90\% \text{ under}$$

Design Member 33, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.45 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 33, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 4.84 \leq 8.62 \text{ mm OK } 44\% \text{ under}$$

Design Member 33, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 33, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

Design Member 33, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 6.39 \leq 166.5 \text{ OK } 96\% \text{ under}$$

Design Member 33, UNEQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 13.43 / 234.3 + 22.52 / 234.3 = 0.15 \leq 1 \text{ OK } 85\% \text{ under}$$

Design Member 33, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 6.39 / 166.5 = 0.04 \leq 0.15 \therefore \phi 0$$

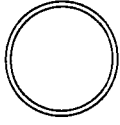
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\zeta} / \Phi_{\beta\zeta} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 6.39 / 166.5 + 13.43 / 234.3 + 22.52 / 234.3 = 0.19 \leq 1 \text{ OK } 81\% \text{ under}$$

Checking design member 34

Members: 34

Group: Custom2

Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 2154.07/38.35, 1.0 * 2154.07/38.35) = 56.17$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 56.17^2 / (2 * 108.06^2)) * 355.0 / 1.84 = 166.5 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 34, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 11.22 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 11.22 \leq 234.3 \text{ OK } 95\% \text{ under}$$

Design Member 34, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.2 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 34, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.23 \leq 8.62 \text{ mm OK } 97\% \text{ under}$$

Design Member 34, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 31.3 \leq 234.3 \text{ OK } 87\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 31.3 \leq 234.3 \text{ OK } 87\% \text{ under}$$

Design Member 34, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.78 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 34, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 5.69 \leq 8.62 \text{ mm OK } 34\% \text{ under}$$

Design Member 34, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 34, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 2154.07/38.35 = 56.17 \leq 200.0 \text{ OK } 72\% \text{ under}$$

Design Member 34, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 19.21 \leq 166.5 \text{ OK } 88\% \text{ under}$$

Design Member 34, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0/245.0 + 11.22/234.3 + 31.3/234.3 = 0.18 \leq 1 \text{ OK } 82\% \text{ under}$$

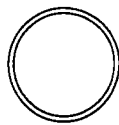
Design Member 34, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 19.21/166.5 = 0.12 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_z} / \Phi_{\beta_z} + \phi_{\beta_y} / \Phi_{\beta_y} = 19.21/166.5 + 11.22/234.3 + 31.3/234.3 = 0.3 \leq 1 \text{ OK } 70\% \text{ under}$$

Checking design member 35

Members: 35
Group: Custom2
Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1569.24/38.35, 1.0 * 1569.24/38.35) = 40.92$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 40.92^2 / (2 * 108.06^2)) * 355.0 / 1.8 = 182.89 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 35, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 3.18 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 3.18 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 35, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.15 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 35, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.78 \leq 6.28 \text{ mm OK } 88\% \text{ under}$$

Design Member 35, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 30.28 \leq 234.3 \text{ OK } 87\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 30.28 \leq 234.3 \text{ OK } 87\% \text{ under}$$

Design Member 35, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 1.11 \leq 142.0 \text{ OK } 99\% \text{ under}$$

Design Member 35, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 2.04 \leq 6.28 \text{ mm OK } 68\% \text{ under}$$

Design Member 35, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 35, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1569.24/38.35 = 40.92 \leq 200.0 \text{ OK } 80\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1569.24/38.35 = 40.92 \leq 200.0 \text{ OK } 80\% \text{ under}$$

Design Member 35, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 1.76 \leq 182.89 \text{ OK } 99\% \text{ under}$$

Design Member 35, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 3.18 / 234.3 + 30.28 / 234.3 = 0.14 \leq 1 \text{ OK } 86\% \text{ under}$$

Design Member 35, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 1.76 / 182.89 = 0.01 \leq 0.15 \therefore \phi 0$$

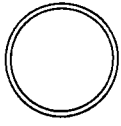
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta x} / \Phi_{\beta x} + \phi_{\beta y} / \Phi_{\beta y} = 1.76 / 182.89 + 3.18 / 234.3 + 30.28 / 234.3 = 0.15 \leq 1 \text{ OK } 85\% \text{ under}$$

Checking design member 36

Members: 36

Group: Custom2

Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$K_l/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 1569.24/38.35, 1.0 * 1569.24/38.35) = 40.92$$

$$F_a = (1 - (K_l/r)^2 / (2 * C_c^2)) * F_y / F_S = (1 - 40.92^2 / (2 * 108.06^2)) * 355.0 / 1.8 = 182.89 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 36, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.61 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.61 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 36, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.07 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 36, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 0.93 \leq 6.28 \text{ mm OK } 85\% \text{ under}$$

Design Member 36, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 15.55 \leq 234.3 \text{ OK } 93\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 15.55 \leq 234.3 \text{ OK } 93\% \text{ under}$$

Design Member 36, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.56 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 36, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.88 \leq 6.28 \text{ mm OK } 86\% \text{ under}$$

Design Member 36, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 12.53 \leq 213.0 \text{ OK } 94\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 12.53 \leq 245.0 \text{ OK } 95\% \text{ under}$$

Design Member 36, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 1569.24/38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 1569.24/38.35 = 40.92 \leq 300.0 \text{ OK } 86\% \text{ under}$$

Design Member 36, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 182.89 \text{ OK } 100\% \text{ under}$$

Design Member 36, UNEQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 12.53/213.0 + 1.61/234.3 + 15.55/234.3 = 0.13 \leq 1 \text{ OK } 87\% \text{ under}$$

Design Member 36, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0/182.89 = 0.0 \leq 0.15 \therefore \phi_0$$

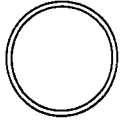
$$\phi_\alpha / \Phi_\alpha + \phi_{\beta\zeta} / \Phi_{\beta\zeta} + \phi_{\beta\psi} / \Phi_{\beta\psi} = 0.0/182.89 + 1.61/234.3 + 15.55/234.3 = 0.07 \leq 1 \text{ OK } 93\% \text{ under}$$

Checking design member 37

Members: 37

Group: Custom2

Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$Kl/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 3122.9/38.35, 1.0 * 3122.9/38.35) = 81.43$$

$$F_a = (1 - (Kl/r)^2 / (2 * Cc^2)) * F_y / FS = (1 - 81.43^2 / (2 * 108.06^2)) * 355.0 / 1.9 = 134.08 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 37, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 7.99 \leq 234.3 \text{ OK } 97\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 7.99 \leq 234.3 \text{ OK } 97\% \text{ under}$$

Design Member 37, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.02 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 37, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 9.14 \leq 12.49 \text{ mm OK } 27\% \text{ under}$$

Design Member 37, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 14.87 \leq 234.3 \text{ OK } 94\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 14.87 \leq 234.3 \text{ OK } 94\% \text{ under}$$

Design Member 37, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.34 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 37, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 0.77 \leq 12.49 \text{ mm OK } 94\% \text{ under}$$

Design Member 37, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 35.71 \leq 213.0 \text{ OK } 83\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 35.71 \leq 245.0 \text{ OK } 85\% \text{ under}$$

Design Member 37, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 3122.9/38.35 = 81.43 \leq 300.0 \text{ OK } 73\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 3122.9/38.35 = 81.43 \leq 300.0 \text{ OK } 73\% \text{ under}$$

Design Member 37, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 0.0 \leq 134.08 \text{ OK } 100\% \text{ under}$$

Design Member 37, UNEQUAL LOAD, Bending + Tension

$$f_a / F_t + f_{bx} / F_{bx} + f_{by} / F_{by} = 35.71/213.0 + 7.99/234.3 + 14.87/234.3 = 0.27 \leq 1 \text{ OK } 73\% \text{ under}$$

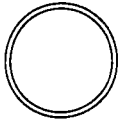
Design Member 37, UNEQUAL LOAD, Bending + Compression

$$f_a / F_a = 0.0/134.08 = 0.0 \leq 0.15 \therefore \phi 0$$

$$\phi_\alpha / \Phi_\alpha + \phi_{\beta_x} / \Phi_{\beta_x} + \phi_{\beta_y} / \Phi_{\beta_y} = 0.0/134.08 + 7.99/234.3 + 14.87/234.3 = 0.1 \leq 1 \text{ OK } 90\% \text{ under}$$

Checking design member 38

Members: 38
Group: Custom2
Section: CHS 114.3 x 6



Load Case: UNEQUAL LOAD

$$F_y = 355.0 \text{ MPa}$$

$$\text{On gross area } F_t = 0.6 * F_y = 0.6 * 355.0 = 213.0 \text{ MPa}$$

$$\text{On net area } F_t = 0.5 * F_u = 0.5 * 490.0 = 245.0 \text{ MPa}$$

$$F_v = 0.4 * F_y = 0.4 * 355.0 = 142.0 \text{ MPa}$$

$$KL/r = \max(K_x * l/r_x, K_y * l/r_y) = \max(1.0 * 3122.9/38.35, 1.0 * 3122.9/38.35) = 81.43$$

$$F_a = (1 - (KL/r)^2 / (2 * C_c^2)) * F_y / FS = (1 - 81.43^2 / (2 * 108.06^2)) * 355.0 / 1.9 = 134.08 \text{ MPa}$$

Major Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Minor Axis:

$$F_b = 0.66 * F_y = 0.66 * 355.0 = 234.3 \text{ MPa}$$

Design Member 38, UNEQUAL LOAD, Major Bending

Tensile Bending Stress:

$$f_b \leq F_b, 1.86 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 1.86 \leq 234.3 \text{ OK } 99\% \text{ under}$$

Design Member 38, UNEQUAL LOAD, Major Shear

$$f_v \leq F_v, 0.05 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 38, UNEQUAL LOAD, Major Deflection

$$\delta \leq L/250, 4.18 \leq 12.49 \text{ mm OK } 67\% \text{ under}$$

Design Member 38, UNEQUAL LOAD, Minor Bending

Tensile Bending Stress:

$$f_b \leq F_b, 16.11 \leq 234.3 \text{ OK } 93\% \text{ under}$$

Compressive Bending Stress:

$$f_b \leq F_b, 16.11 \leq 234.3 \text{ OK } 93\% \text{ under}$$

Design Member 38, UNEQUAL LOAD, Minor Shear

$$f_v \leq F_v, 0.36 \leq 142.0 \text{ OK } 100\% \text{ under}$$

Design Member 38, UNEQUAL LOAD, Minor Deflection

$$\delta \leq L/250, 2.19 \leq 12.49 \text{ mm OK } 82\% \text{ under}$$

Design Member 38, UNEQUAL LOAD, Tension

$$\text{On gross area } f_t \leq F_t, 0.0 \leq 213.0 \text{ OK } 100\% \text{ under}$$

$$\text{On net area } f_t \leq F_t, 0.0 \leq 245.0 \text{ OK } 100\% \text{ under}$$

Design Member 38, UNEQUAL LOAD, Slenderness

$$K_x * L_x / r_x = 1.0 * 3122.9/38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

$$K_y * L_y / r_y = 1.0 * 3122.9/38.35 = 81.43 \leq 200.0 \text{ OK } 59\% \text{ under}$$

Design Member 38, UNEQUAL LOAD, Compression

$$f_a \leq F_a, 69.58 \leq 134.08 \text{ OK } 48\% \text{ under}$$

Design Member 38, UNEQUAL LOAD, Bending + Tension

$$f_a / F_a + f_{bx} / F_{bx} + f_{by} / F_{by} = 0.0 / 245.0 + 1.86 / 234.3 + 16.11 / 234.3 = 0.08 \leq 1 \text{ OK } 92\% \text{ under}$$

Design Member 38, UNEQUAL LOAD, Bending + Compression

$$\text{Axial Ratio} = f_a / F_a = 69.58 / 134.08 = 0.52$$

$$\text{Major Ratio} = C_m * f_{bx} / ((1 - f_a / F'_{ex}) * F_{bx}) = 0.85 * 1.86 / ((1 - 69.58 / 163.06) * 234.3) = 0.01$$

$$\text{Minor Ratio} = C_m * f_{by} / ((1 - f_a / F'_{ey}) * F_{by}) = 0.85 * 16.11 / ((1 - 69.58 / 163.06) * 234.3) = 0.1$$

$$\text{Axial Ratio} + \text{Major Ratio} + \text{Minor Ratio} = 0.52 + 0.01 + 0.1 = 0.63 \leq 1 \text{ OK } 37\% \text{ under}$$

$$f_a / (0.6 * F_y) + f_{bx} / F_{bx} + f_{by} / F_{by} = 69.58 / (0.6 * 355.0) + 1.86 / 234.3 + 16.11 / 234.3 = 0.4 \geq 1 \text{ OK } 60\% \text{ under}$$

End of check

Appendix C

Lifting Lugs Design Report to ASIC ASD

DESIGN VERIFICATION - LIFTING LUG**ITEM IN THIS ANALYSIS :** 35 Tonne Lifting Lug for 700 Tonne Lifting Frame**DESIGN DATA****LOAD DATA**

Expected lifting load:

$$W_{\text{expect}} := 35 \cdot \text{tonne}$$

Load contingency:

$$f_{\text{contingency}} := 10\%$$

Dynamic Impact Factor:

$$f_{\text{lift}} := 1.5$$

Design lifting load:

$$\text{Load} := W_{\text{expect}} (1 + f_{\text{contingency}})$$

$$\text{Load} = 3.85 \times 10^4 \text{ kg}$$

No. of lugs

$$n_{\text{lug}} := 1$$

DETAIL OF SHACKLE

Shackle size & type considered: 55 Tonne S.W.L. GN Forged Rope Shackle

Shackle inside width at pin, A

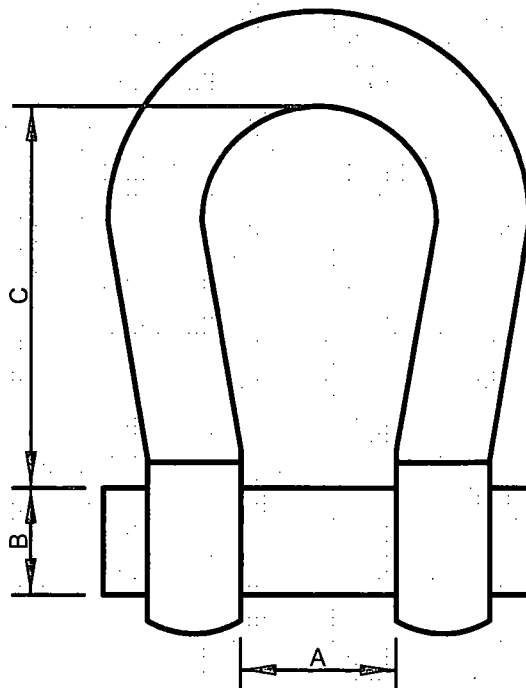
$$\text{Dim}_A := 90 \text{ mm}$$

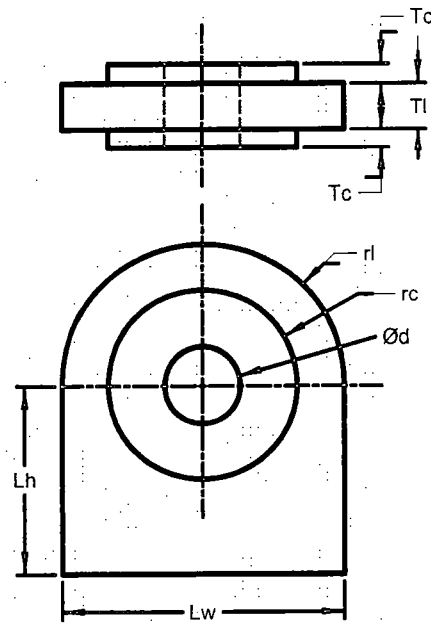
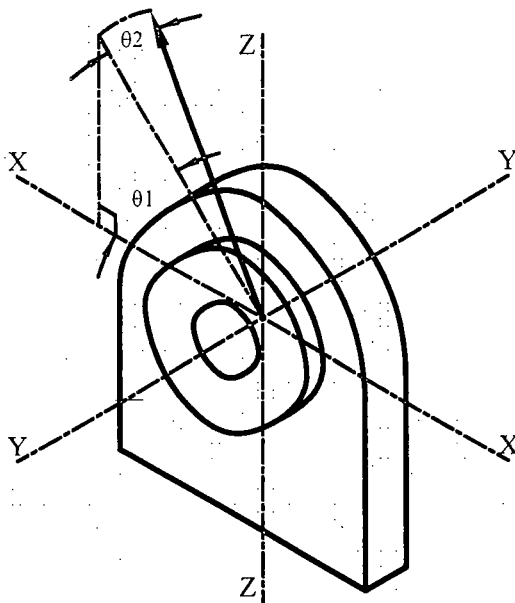
Shackle pin diameter, B

$$\text{Dim}_B := 56 \text{ mm}$$

Shackle inside height above pin, C

$$\text{Dim}_C := 240 \text{ mm}$$



LIFTING LUG DATA

Material used for lug:

Minimum yield strength of lug material:

Minimum tensile strength of lug material:

Minimum design lifting sling angle:

Maximum allowable side swing angle:

Lug hole diameter used:

Height of lug hole above lug base:

Radius of lug used:

Radius of cheek plate used:

Width of lug at base of attachment:

Thickness of lug used:

Thickness of cheek plate used:

GL-E36

$\sigma_{\text{yield}} := 340 \text{ MPa}$

$\sigma_{\text{tensile}} := 490 \text{ MPa}$

$\theta_1 := 90 \text{ deg}$

$\theta_2 := 0 \text{ deg}$

$d := 60 \text{ mm}$

$L_h := 100 \text{ mm}$

$r_l := 100 \text{ mm}$

$r_c := 0 \text{ mm}$

$L_w := 278 \text{ mm}$

$T_l := 50 \text{ mm}$

$T_c := 0 \text{ mm}$

CHECK ON LIFTING LUG TO SHACKLE DIMENSION INTERFACE

$$\frac{T_l + 2 \cdot T_c}{\text{Dim}_A} = 0.556 < 1$$

***** LUG THICKNESS TO SHACKLE INTERNAL WIDTH IS O.K. *****

$$\frac{\text{Dim}_B}{d} = 0.933 < 1$$

***** LUG HOLE TO SHACKLE PIN DIMETER IS O.K. *****

$$\frac{2 \cdot r_l}{\text{Dim}_C} = 0.833 < 1$$

***** LUG RADIUS TO SHACKLE INTERNAL HEIGHT IS O.K. *****

ALLOWABLE STRESS FOR LUG AS PER AISC - ASD MANUAL OF STEEL CONSTRUCTION

Allowable tensile stress:	$\sigma_t := 0.6 \cdot \sigma_{yield}$	$\sigma_t = 2.04 \times 10^8 \text{ Pa}$
Allowable shear stress:	$\sigma_s := 0.4 \cdot \sigma_{yield}$	$\sigma_s = 1.36 \times 10^8 \text{ Pa}$
Allowable bending stress:	$\sigma_b := 0.66 \cdot \sigma_{yield}$	$\sigma_b = 2.244 \times 10^8 \text{ Pa}$
Allowable bearing stress:	$\sigma_{bear} := 0.9 \cdot \sigma_{yield}$	$\sigma_{bear} = 3.06 \times 10^8 \text{ Pa}$

STRESSES IN LUG

Vertical design load of Lug:	$F_z := \frac{\text{Load}}{n_{lug}} \cdot g$	$F_z = 3.776 \times 10^5 \text{ N}$
Horizontal force in X direction:	$F_x := \frac{F_z}{\tan(\theta_1)}$	$F_x = 2.312 \times 10^{-11} \text{ N}$
Horizontal force in Y direction:	$F_y := F_z \cdot \tan(\theta_2)$	$F_y = 0 \text{ N}$
Resultant Force at lug:	$F_r := \sqrt{F_z^2 + F_x^2 + F_y^2}$	$F_r = 3.776 \times 10^5 \text{ N}$
Resultant load at shackle @ minimum sling angle		$\frac{F_r}{g} = 3.85 \times 10^4 \text{ kg}$
Bending moment about X-axis:	$M_x := F_y \cdot L_h$	$M_x = 0 \text{ J}$
Bending moment about Y-axis:	$M_y := F_x \cdot L_h$	$M_y = 2.312 \times 10^{-12} \text{ J}$
Bending stress about X-axis at lug base::	$S_{bx} := \frac{M_x}{\frac{L_w^2}{6} \cdot T_l}$	$S_{bx} = 0 \text{ Pa}$
Bending stress about Y-axis at lug base:	$S_{by} := \frac{M_y}{\frac{L_w^2}{6} \cdot T_l}$	$S_{by} = 3.59 \times 10^{-9} \text{ Pa}$
Tensile stress at lug base:	$S_t := \frac{F_z}{L_w \cdot T_l}$	$S_t = 2.716 \times 10^7 \text{ Pa}$
Shear Stress at lug base:	$\tau := \frac{\sqrt{F_x^2 + F_y^2}}{T_l \cdot L_w}$	$\tau = 1.663 \times 10^{-9} \text{ Pa}$

Unity Check:

$$\frac{S_{bx}}{\sigma_b} + \frac{S_{by}}{\sigma_b} + \frac{S_t}{\sigma_t} + \frac{\tau}{\sigma_s} = 0.133 < 1$$

***** BENDING STRESS AT LUG BASE IS ACCEPTABLE *****

Tensile stress above pin:

$$S_{tl} := \frac{F_r \cdot f_{lift}}{T_l \cdot (2 \cdot r_l - d) + 2 \cdot T_c \cdot (2 \cdot r_c - d)} \quad S_{tl} = 8.09 \times 10^7 \text{ Pa}$$

Unity Check:

$$\frac{S_{tl}}{0.45 \cdot \sigma_{yield}} = 0.529 < 1$$

***** TENSILE STRESS ABOVE PIN IS ACCEPTABLE *****

Shear stress above pin:

$$S_s := \frac{F_r \cdot f_{lift}}{T_l \cdot (2 \cdot r_l - d) + 2 \cdot T_c \cdot (2 \cdot r_c - d)} \quad S_s = 8.09 \times 10^7 \text{ Pa}$$

Unity Check:

$$\frac{S_s}{\sigma_s} = 0.595 < 1$$

***** SHEAR STRESS ABOVE PIN IS ACCEPTABLE *****

Cross sectional area at the thinnest section of lug:

$$A_l := T_l \cdot \left(r_l - \frac{d}{2} \right) + 2 \cdot T_c \cdot \left(r_c - \frac{d}{2} \right) \quad A_l = 3.5 \times 10^{-3} \text{ m}^2$$

Cross sectional area of shackle pin used:

$$A_s := \pi \left(\frac{\text{Dim}_B}{2} \right)^2 \quad A_s = 2.463 \times 10^{-3} \text{ m}^2$$

$$\frac{A_s}{A_l} = 0.704 < 1$$

***** SECTIONAL AREA CHECK IS ACCEPTABLE *****

Bearing stress at pin:

$$S_b := \frac{F_r \cdot f_{lift}}{\text{Dim}_B \cdot (T_l + 2 \cdot T_c)} \quad S_b = 2.023 \times 10^8 \text{ Pa}$$

Unity Check:

$$\frac{S_b}{\sigma_{bear}} = 0.661 < 1$$

***** BEARING STRESS IS ACCEPTABLE *****

DESIGN VERIFICATION - LIFTING LUG**ITEM IN THIS ANALYSIS :** 150 Tonne Lifting Lug for 700 Tonne Lifting Frame**DESIGN DATA****LOAD DATA**

Expected lifting load:

$$W_{\text{expect}} := 150 \text{ tonne}$$

Load contingency:

$$f_{\text{contingency}} := 10\%$$

Dynamic Impact Factor:

$$f_{\text{lift}} := 1.5$$

Design lifting load:

$$\text{Load} := W_{\text{expect}} (1 + f_{\text{contingency}})$$

$$\text{Load} = 1.65 \times 10^5 \text{ kg}$$

No. of lugs

$$n_{\text{lug}} := 1$$

DETAIL OF MASTER LINK

Load Cell size & type considered: 150 Tonne JCL Load Shackle

Shackle inside width at pin, A

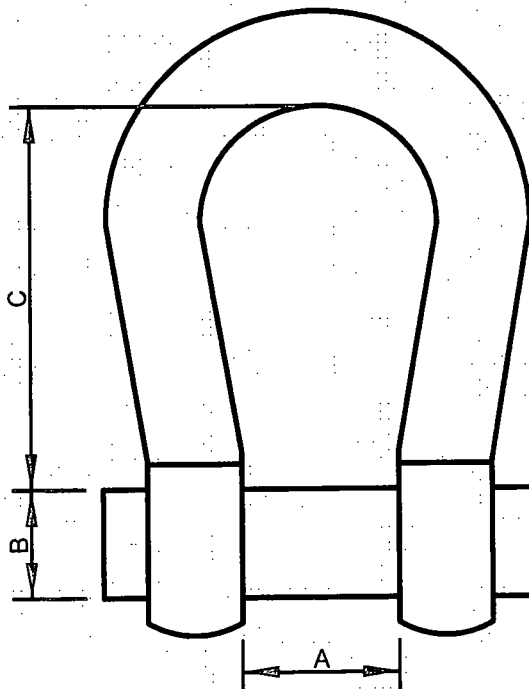
$$\text{Dim}_A := 170 \text{ mm}$$

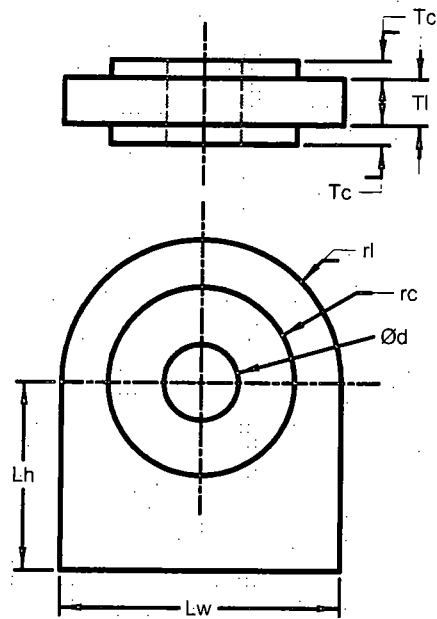
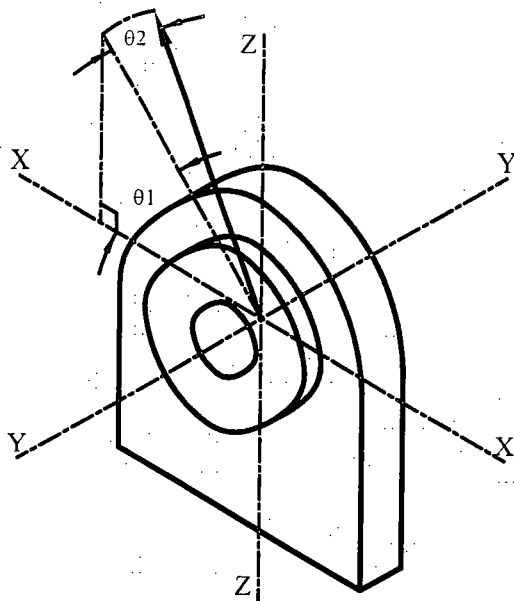
Shackle pin diameter, B

$$\text{Dim}_B := 108 \text{ mm}$$

Shackle inside height above pin, C

$$\text{Dim}_C := 400 \text{ mm}$$



LIFTING LUG DATA

Material used for lug:

GL-E36

Minimum yield strength of lug material:

$\sigma_{\text{yield}} := 340 \text{ MPa}$

Minimum tensile strength of lug material:

$\sigma_{\text{tensile}} := 490 \text{ MPa}$

Minimum design lifting sling angle:

$\theta_1 := 90 \text{ deg}$

Maximum allowable side swing angle:

$\theta_2 := 0 \text{ deg}$

Lug hole diameter used:

$d := 115 \text{ mm}$

Height of lug hole above lug base:

$L_h := 150 \text{ mm}$

Radius of lug used:

$r_l := 175 \text{ mm}$

Radius of cheek plate used:

$r_c := 110 \text{ mm}$

Width of lug at base of attachment:

$L_w := 450 \text{ mm}$

Thickness of lug used:

$T_l := 76 \text{ mm}$

Thickness of cheek plate used:

$T_c := 12 \text{ mm}$

CHECK ON LIFTING LUG TO SHACKLE DIMENSION INTERFACE

$$\frac{T_l + 2 \cdot T_c}{Dim_A} = 0.588 < 1$$

***** LUG THICKNESS TO SHACKLE INTERNAL WIDTH IS O.K. *****

$$\frac{Dim_B}{d} = 0.939 < 1$$

***** LUG HOLE TO SHACKLE PIN DIMETER IS O.K. *****

$$\frac{2 \cdot r_l}{Dim_C} = 0.875 < 1$$

***** LUG RADIUS TO SHACKLE INTERNAL HEIGHT IS O.K. *****

ALLOWABLE STRESS FOR LUG AS PER AISC - ASD MANUAL OF STEEL CONSTRUCTION

Allowable tensile stress:	$\sigma_t := 0.6 \cdot \sigma_{\text{yield}}$	$\sigma_t = 2.04 \times 10^8 \text{ Pa}$
Allowable shear stress:	$\sigma_s := 0.4 \cdot \sigma_{\text{yield}}$	$\sigma_s = 1.36 \times 10^8 \text{ Pa}$
Allowable bending stress:	$\sigma_b := 0.66 \cdot \sigma_{\text{yield}}$	$\sigma_b = 2.244 \times 10^8 \text{ Pa}$
Allowable bearing stress:	$\sigma_{\text{bear}} := 0.9 \cdot \sigma_{\text{yield}}$	$\sigma_{\text{bear}} = 3.06 \times 10^8 \text{ Pa}$

STRESSES IN LUG

Vertical design load of Lug:	$F_z := \frac{\text{Load}}{n_{\text{lug}}} \cdot g$	$F_z = 1.618 \times 10^6 \text{ N}$
Horizontal force in X direction:	$F_x := \frac{F_z}{\tan(\theta_1)}$	$F_x = 9.908 \times 10^{-11} \text{ N}$
Horizontal force in Y direction:	$F_y := F_z \cdot \tan(\theta_2)$	$F_y = 0 \text{ N}$
Resultant Force at lug:	$F_r := \sqrt{F_z^2 + F_x^2 + F_y^2}$	$F_r = 1.618 \times 10^6 \text{ N}$
Resultant load at shackle @ minimum sling angle		$\frac{F_r}{g} = 1.65 \times 10^5 \text{ kg}$
Bending moment about X-axis:	$M_x := F_y \cdot L_h$	$M_x = 0 \text{ J}$
Bending moment about Y-axis:	$M_y := F_x \cdot L_h$	$M_y = 1.486 \times 10^{-11} \text{ J}$
Bending stress about X-axis at lug base::	$S_{bx} := \frac{M_x}{\frac{L_w^2}{6} \cdot T_l}$	$S_{bx} = 0 \text{ Pa}$
Bending stress about Y-axis at lug base:	$S_{by} := \frac{M_y}{\frac{L_w^2}{6} \cdot T_l}$	$S_{by} = 5.794 \times 10^{-9} \text{ Pa}$
Tensile stress at lug base:	$S_t := \frac{F_z}{L_w \cdot T_l}$	$S_t = 4.731 \times 10^7 \text{ Pa}$
Shear Stress at lug base:	$\tau := \frac{\sqrt{F_x^2 + F_y^2}}{T_l \cdot L_w}$	$\tau = 2.897 \times 10^{-9} \text{ Pa}$

Unity Check:

$$\frac{S_{bx}}{\sigma_b} + \frac{S_{by}}{\sigma_b} + \frac{S_t}{\sigma_t} + \frac{\tau}{\sigma_s} = 0.232 < 1$$

***** BENDING STRESS AT LUG BASE IS ACCEPTABLE *****

Tensile stress above pin:

$$S_{tl} := \frac{F_r \cdot f_{lift}}{T_l \cdot (2 \cdot r_l - d) + 2 \cdot T_c \cdot (2 \cdot r_c - d)} \quad S_{tl} = 1.191 \times 10^8 \text{ Pa}$$

Unity Check:

$$\frac{S_{tl}}{0.45 \cdot \sigma_{yield}} = 0.778 < 1$$

***** TENSILE STRESS ABOVE PIN IS ACCEPTABLE *****

Shear stress above pin:

$$S_s := \frac{F_r \cdot f_{lift}}{T_l \cdot (2 \cdot r_l - d) + 2 \cdot T_c \cdot (2 \cdot r_c - d)} \quad S_s = 1.191 \times 10^8 \text{ Pa}$$

Unity Check:

$$\frac{S_s}{\sigma_s} = 0.876 < 1$$

***** SHEAR STRESS ABOVE PIN IS ACCEPTABLE *****

Cross sectional area at the thinnest section of lug:

$$A_l := T_l \cdot \left(r_l - \frac{d}{2} \right) + 2 \cdot T_c \cdot \left(r_c - \frac{d}{2} \right) \quad A_l = 0.01 \text{ m}^2$$

Cross sectional area of shackle pin used:

$$A_s := \pi \left(\frac{\text{Dim}_B}{2} \right)^2 \quad A_s = 9.161 \times 10^{-3} \text{ m}^2$$

$$\frac{A_s}{A_l} = 0.899 < 1$$

***** SECTIONAL AREA CHECK IS ACCEPTABLE *****

Bearing stress at pin:

$$S_b := \frac{F_r \cdot f_{lift}}{\text{Dim}_B \cdot (T_l + 2 \cdot T_c)} \quad S_b = 2.247 \times 10^8 \text{ Pa}$$

Unity Check:

$$\frac{S_b}{\sigma_{bear}} = 0.734 < 1$$

***** BEARING STRESS IS ACCEPTABLE *****

DESIGN VERIFICATION - LIFTING LUG**ITEM IN THIS ANALYSIS :** 700 Tonne Lifting Frame**DESIGN DATA****LOAD DATA**

Expected lifting load:

$$W_{\text{expect}} := 725 \cdot \text{tonne}$$

Load contingency:

$$f_{\text{contingency}} := 10\%$$

Dynamic Impact Factor:

$$f_{\text{lift}} := 1.5$$

Design lifting load:

$$\text{Load} := W_{\text{expect}} \cdot (1 + f_{\text{contingency}})$$

$$\text{Load} = 7.975 \times 10^5 \text{ kg}$$

No. of lugs

$$n_{\text{lug}} := 4$$

DETAIL OF MASTER LINK

Shackle size & type considered: 300 Tonne GN Forge Rope Shackle

Shackle inside width at pin, A

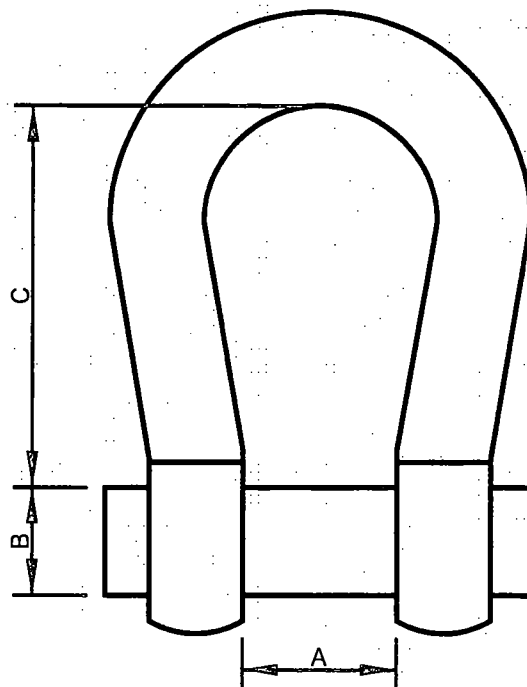
$$\text{Dim}_A := 185 \text{ mm}$$

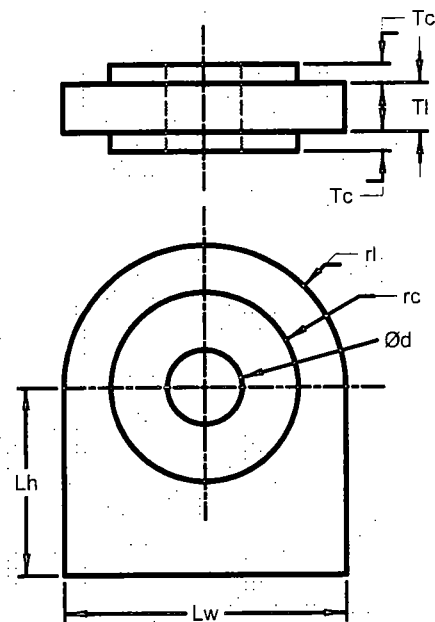
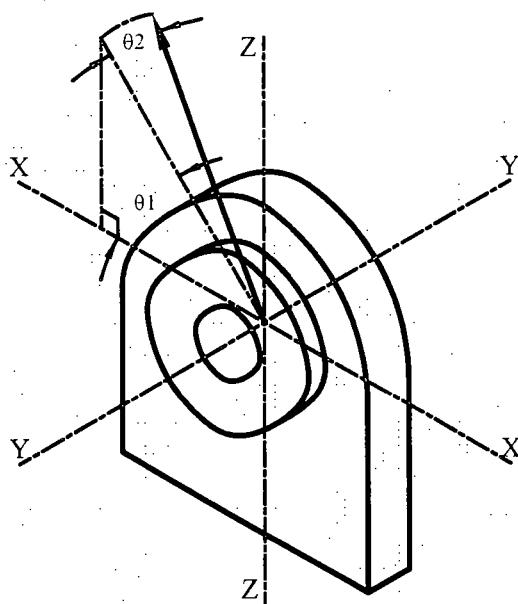
Shackle pin diameter, B

$$\text{Dim}_B := 134 \cdot \text{mm}$$

Shackle inside height above pin, C

$$\text{Dim}_C := 600 \cdot \text{mm}$$



LIFTING LUG DATA

Material used for lug:

Minimum yield strength of lug material:

Minimum tensile strength of lug material:

Minimum design lifting sling angle:

Maximum allowable side swing angle:

Lug hole diameter used:

Height of lug hole above lug base:

Radius of lug used:

Radius of cheek plate used:

Width of lug at base of attachment:

Thickness of lug used:

Thickness of cheek plate used:

GL-E36

$\sigma_{\text{yield}} := 340 \text{ MPa}$

$\sigma_{\text{tensile}} := 490 \text{ MPa}$

$\theta_1 := 60 \text{ deg}$

$\theta_2 := 0 \text{ deg}$

$d := 140 \text{ mm}$

$L_h := 175 \text{ mm}$

$r_l := 225 \text{ mm}$

$r_c := 150 \text{ mm}$

$L_w := 450 \text{ mm}$

$T_l := 76 \text{ mm}$

$T_c := 40 \text{ mm}$

CHECK ON LIFTING LUG TO SHACKLE DIMENSION INTERFACE

$$\frac{T_l + 2 \cdot T_c}{Dim_A} = 0.843 < 1$$

***** LUG THICKNESS TO SHACKLE INTERNAL WIDTH IS O.K. *****

$$\frac{Dim_B}{d} = 0.957 < 1$$

***** LUG HOLE TO SHACKLE PIN DIMETER IS O.K. *****

$$\frac{2 \cdot r_l}{Dim_C} = 0.75 < 1$$

***** LUG RADIUS TO SHACKLE INTERNAL HEIGHT IS O.K. *****

ALLOWABLE STRESS FOR LUG AS PER AISC - ASD MANUAL OF STEEL CONSTRUCTION

Allowable tensile stress:	$\sigma_t := 0.6 \cdot \sigma_{yield}$	$\sigma_t = 2.04 \times 10^8 \text{ Pa}$
Allowable shear stress:	$\sigma_s := 0.4 \cdot \sigma_{yield}$	$\sigma_s = 1.36 \times 10^8 \text{ Pa}$
Allowable bending stress:	$\sigma_b := 0.66 \cdot \sigma_{yield}$	$\sigma_b = 2.244 \times 10^8 \text{ Pa}$
Allowable bearing stress:	$\sigma_{bear} := 0.9 \cdot \sigma_{yield}$	$\sigma_{bear} = 3.06 \times 10^8 \text{ Pa}$

STRESSES IN LUG

Vertical design load of Lug:	$F_z := \frac{\text{Load}}{n_{lug}} \cdot g$	$F_z = 1.955 \times 10^6 \text{ N}$
Horizontal force in X direction:	$F_x := \frac{F_z}{\tan(\theta_1)}$	$F_x = 1.129 \times 10^6 \text{ N}$
Horizontal force in Y direction:	$F_y := F_z \cdot \tan(\theta_2)$	$F_y = 0 \text{ N}$
Resultant Force at lug:	$F_r := \sqrt{F_z^2 + F_x^2 + F_y^2}$	$F_r = 2.258 \times 10^6 \text{ N}$
Resultant load at shackle @ minimum sling angle		$\frac{F_r}{g} = 2.302 \times 10^5 \text{ kg}$
Bending moment about X-axis:	$M_x := F_y \cdot L_h$	$M_x = 0 \text{ J}$
Bending moment about Y-axis:	$M_y := F_x \cdot L_h$	$M_y = 1.975 \times 10^5 \text{ J}$
Bending stress about X-axis at lug base::	$S_{bx} := \frac{M_x}{\frac{T_1^2}{L_w} \cdot \frac{1}{6}}$	$S_{bx} = 0 \text{ Pa}$
Bending stress about Y-axis at lug base:	$S_{by} := \frac{M_y}{\frac{L_w^2}{6} \cdot T_1}$	$S_{by} = 7.702 \times 10^7 \text{ Pa}$
Tensile stress at lug base:	$S_t := \frac{F_z}{L_w \cdot T_1}$	$S_t = 5.717 \times 10^7 \text{ Pa}$
Shear Stress at lug base:	$\tau := \frac{\sqrt{F_x^2 + F_y^2}}{T_1 \cdot L_w}$	$\tau = 3.301 \times 10^7 \text{ Pa}$

Unity Check:

$$\frac{S_{bx}}{\sigma_b} + \frac{S_{by}}{\sigma_b} + \frac{S_t}{\sigma_t} + \frac{\tau}{\sigma_s} = 0.866 < 1$$

***** BENDING STRESS AT LUG BASE IS ACCEPTABLE *****

Tensile stress above pin:

$$S_{tl} := \frac{F_r \cdot f_{lift}}{T_l \cdot (2 \cdot r_l - d) + 2 \cdot T_c \cdot (2 \cdot r_c - d)} \quad S_{tl} = 9.314 \times 10^7 \text{ Pa}$$

Unity Check:

$$\frac{S_{tl}}{0.45 \cdot \sigma_{yield}} = 0.609 < 1$$

***** TENSILE STRESS ABOVE PIN IS ACCEPTABLE *****

Shear stress above pin:

$$S_s := \frac{F_r \cdot f_{lift}}{T_l \cdot (2 \cdot r_l - d) + 2 \cdot T_c \cdot (2 \cdot r_c - d)} \quad S_s = 9.314 \times 10^7 \text{ Pa}$$

Unity Check:

$$\frac{S_s}{\sigma_s} = 0.685 < 1$$

***** SHEAR STRESS ABOVE PIN IS ACCEPTABLE *****

Cross sectional area at the thinnest section of lug:

$$A_l := T_l \cdot \left(r_l - \frac{d}{2} \right) + 2 \cdot T_c \cdot \left(r_c - \frac{d}{2} \right) \quad A_l = 0.018 \text{ m}^2$$

Cross sectional area of shackle pin used:

$$A_s := \pi \left(\frac{\text{Dim}_B}{2} \right)^2 \quad A_s = 0.014 \text{ m}^2$$

$$\frac{A_s}{A_l} = 0.776 < 1$$

***** SECTIONAL AREA CHECK IS ACCEPTABLE *****

Bearing stress at pin:

$$S_b := \frac{F_r \cdot f_{lift}}{\text{Dim}_B \cdot (T_l + 2 \cdot T_c)} \quad S_b = 1.62 \times 10^8 \text{ Pa}$$

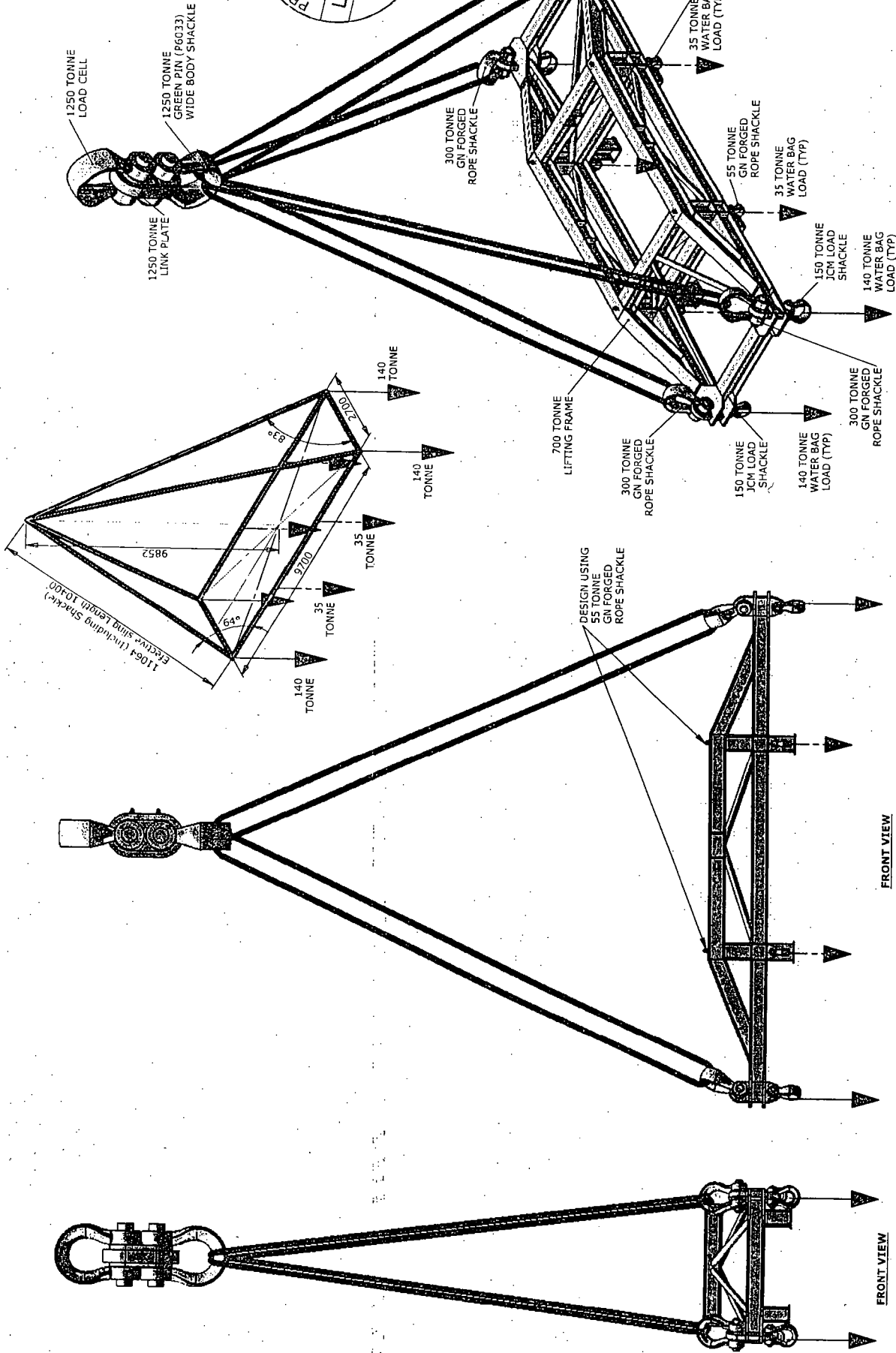
Unity Check:

$$\frac{S_b}{\sigma_{bear}} = 0.529 < 1$$

***** BEARING STRESS IS ACCEPTABLE *****

DCS
COPY

PROFESSIONAL ENGINEER
MECHANICAL
LING KUI MUK
3753
SINGAPORE
31 DEC '09



REALTEC

exploring infinity

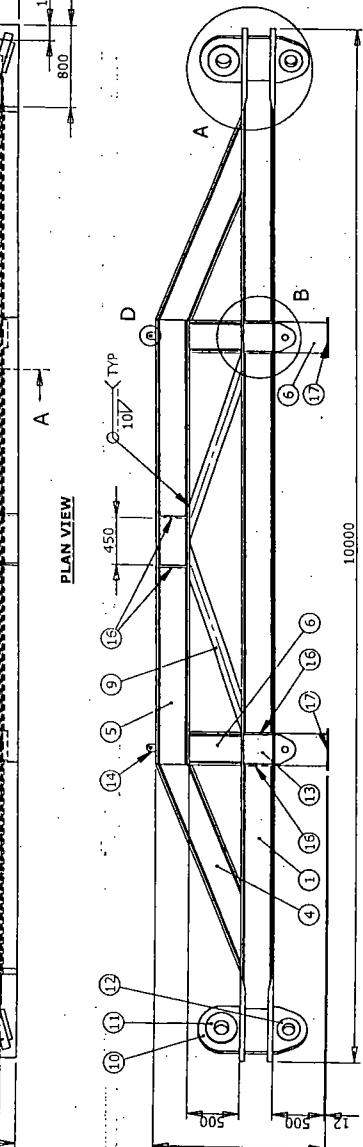
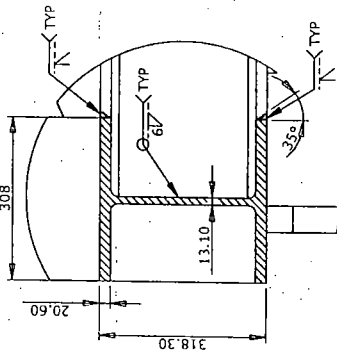
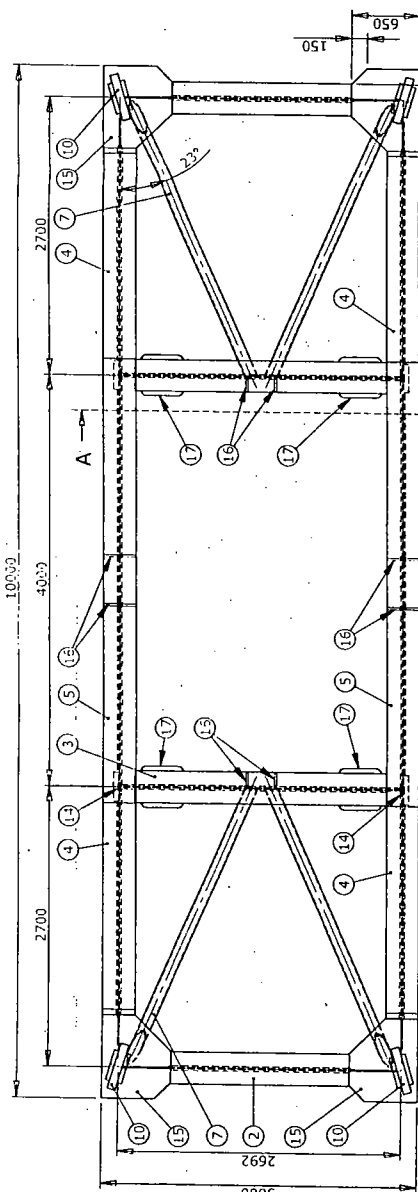
10 Admiralty Street, #03-88/89, North Link Building, Singapore 757695
Tel : +65 675 8878, Fax : +65 6853 8280

700 TONNE LIFTING FRAME
GENERAL LIFTING ARRANGEMENT

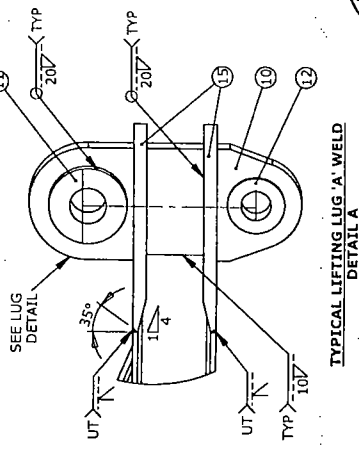
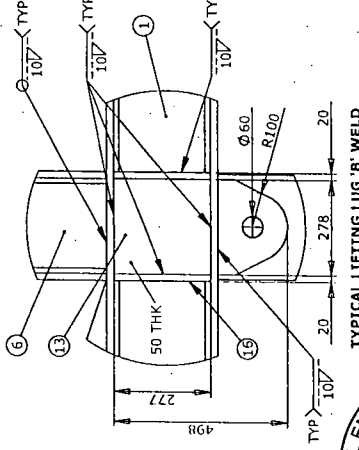
General Notes :										Title							
1. All dimension in mm Unless Otherwise Noted. 2. Weight - 9582 Kg. 3. Loading Conditions: • Water Bags are gradually filled. • Lifting Frame is NOT designed for day-to-day transportation or handling of goods.										REALTEC				700 TONNE LIFTING FRAME GENERAL LIFTING ARRANGEMENT			
										exploring infinity							
A				ISSUE FOR APPROVAL		S.K.	S.J.W.	T.T.	16/12/09	This drawing is property of REALTEC Pte Ltd & contain CONFIDENTIAL or proprietary information. This information shall not be copied in whole, or in part, disclosed or used in any way determined to the interest of REALTEC Pte Ltd & shall be returned upon request.							
Rev.		Description		Drawn		Check		Approve		Date							

DCS
COPY

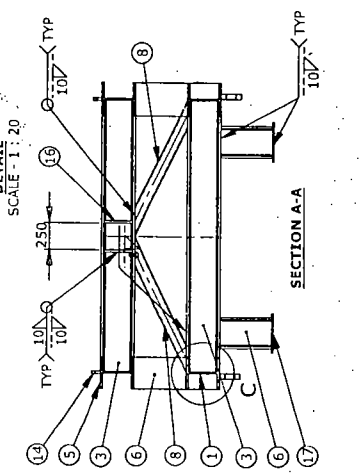
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1	UB - W12x12x87LBx300LG	S355 GR 50A	2
2	UB - W12x12x87LBx2592LG	S355 GR 50A	2
3	UB - W12x12x87LBx2592LG	S355 GR 50A	4
4	UB - W12x12x87LBx2150LG	S355 GR 50A	4
5	UB - W12x12x87LBx1319LG	S355 GR 50A	2
6	UB - W12x12x87LBx500LG	S355 GR 50A	8
7	CHS - OD114.3x6THKx3050LG	S355 GR 50A	4
8	CHS - OD114.3x6THKx1429LG	S355 GR 50A	4
9	CHS - OD114.3x6THKx1905LG	S355 GR 50A	4
10	LUG PL - 104x45x50x75THK	GL-E36	4
11	CHEEK PL - OD300x40THK	GL-E36	8
12	CHEEK PL - OD220x12THK	ASTM A36	8
13	LUG PL - 495x278x50THK	GL-E36	4
14	LUG PL - 85x70x25THK	ASTM A36	4
15	FLANGE PL - 800x650x50THK	GL-E36	8
16	GUSSET PL - 277x147x12THK	ASTM A36	20
17	FOOT PL - 400x400x12THK	ASTM A36	4



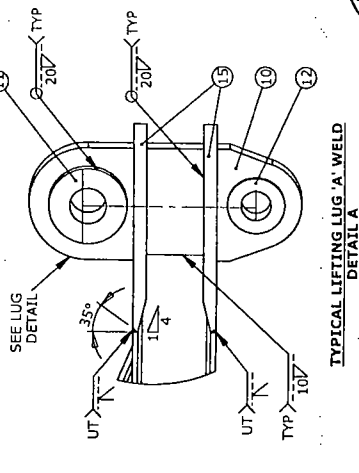
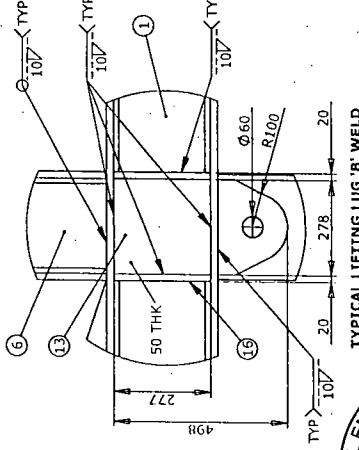
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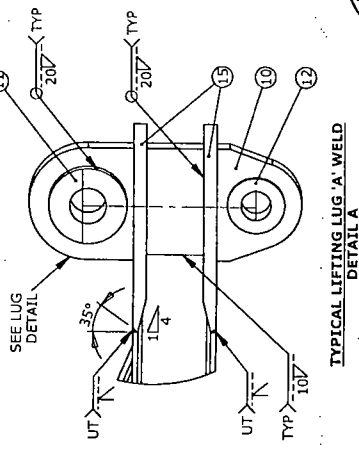
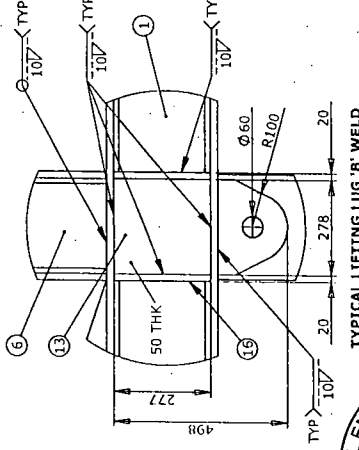
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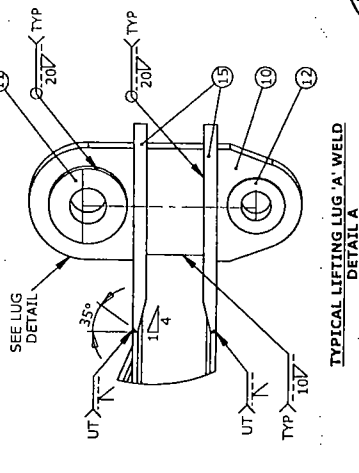
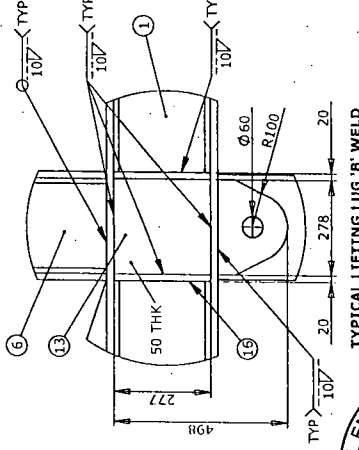
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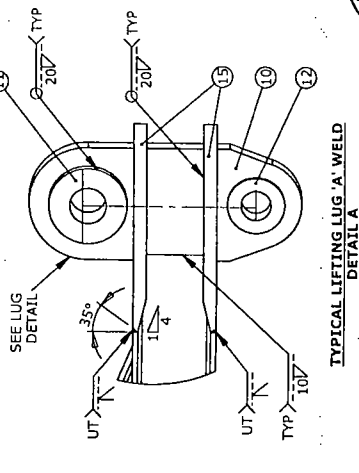
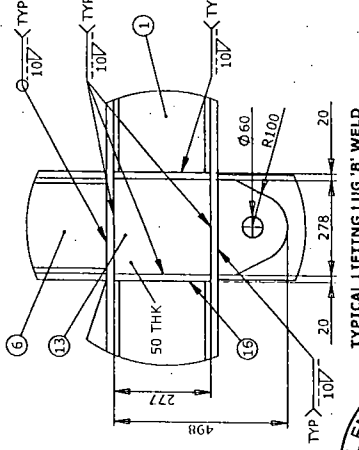
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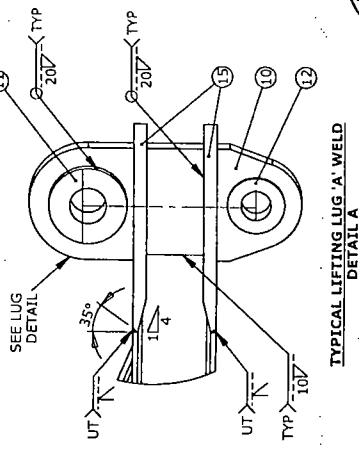
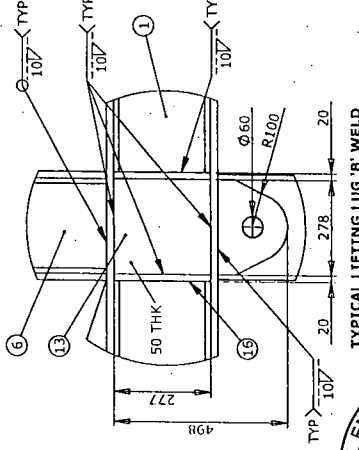
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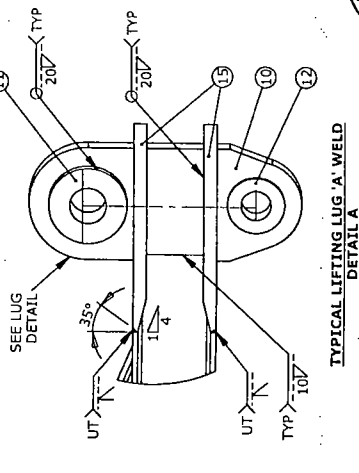
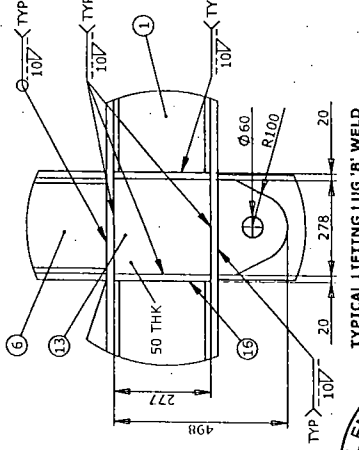
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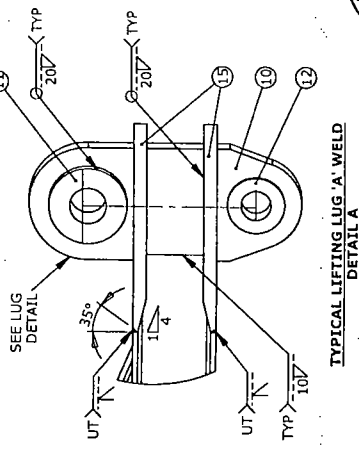
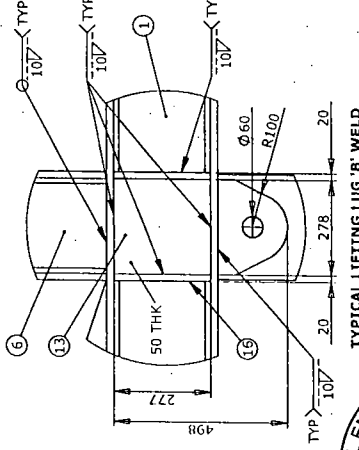
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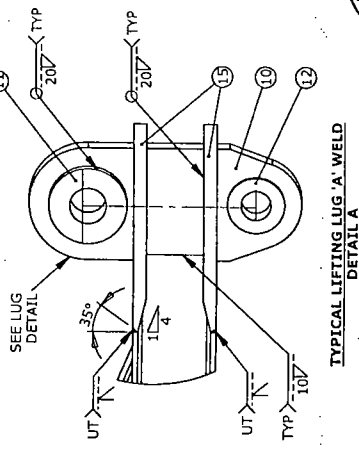
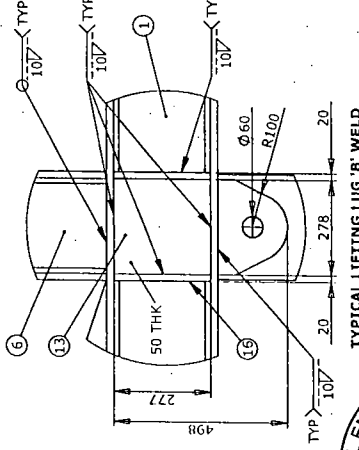
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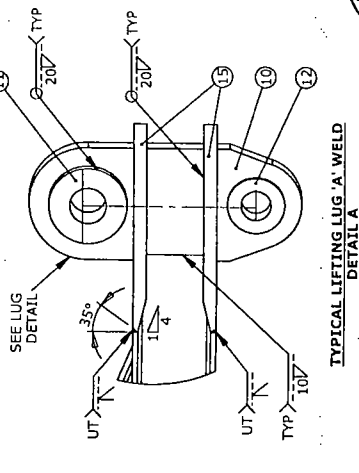
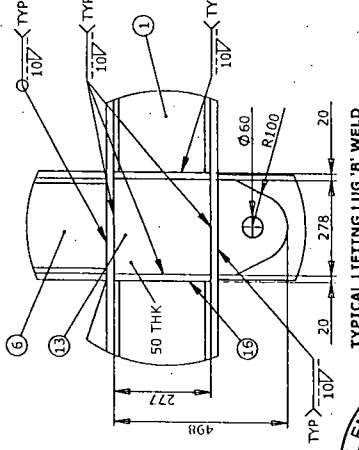
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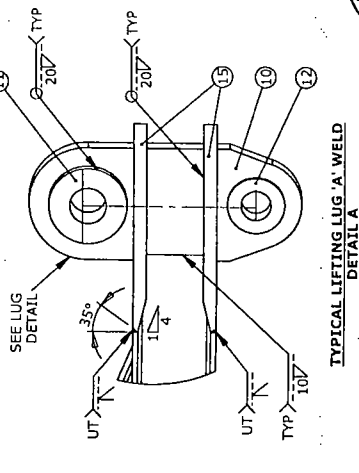
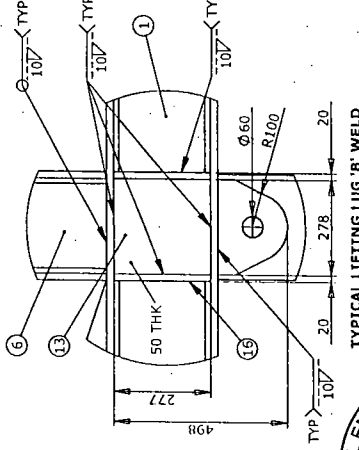
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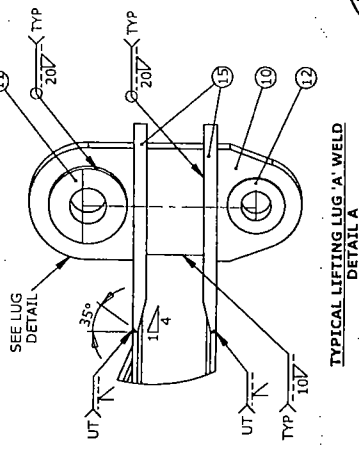
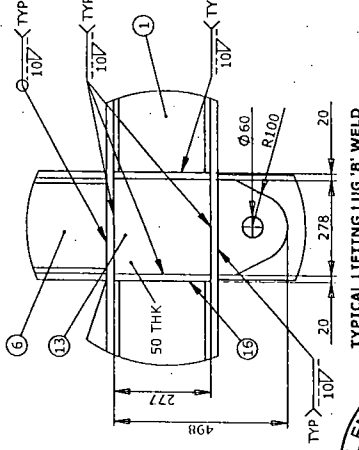
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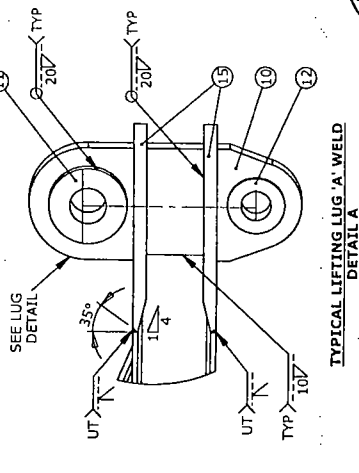
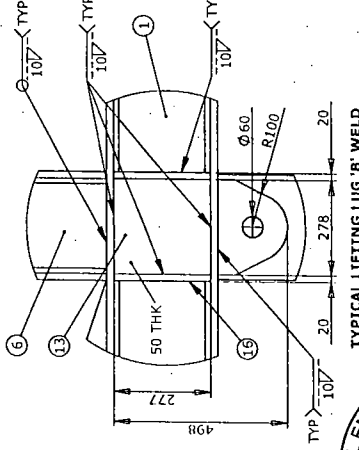
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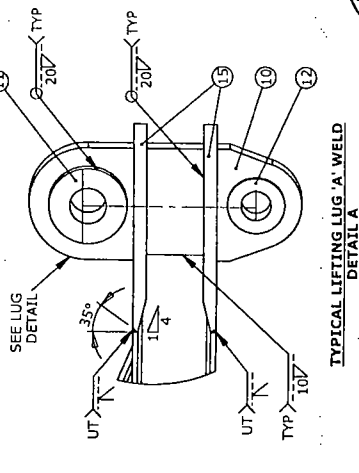
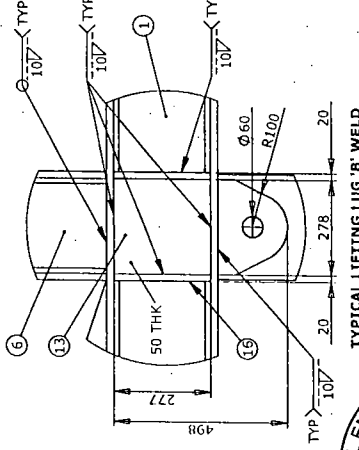
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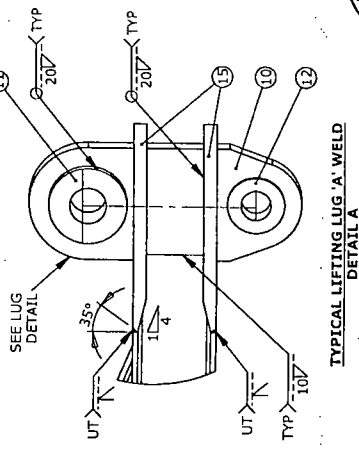
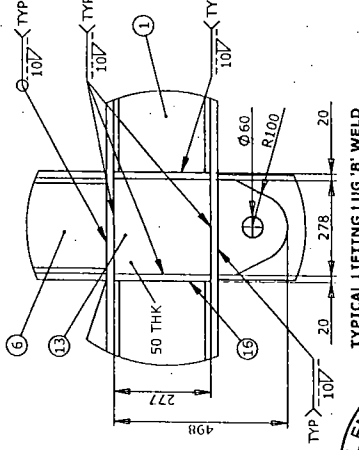
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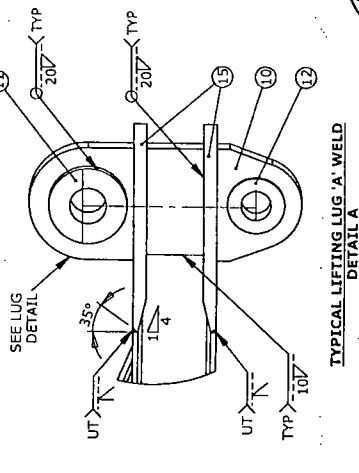
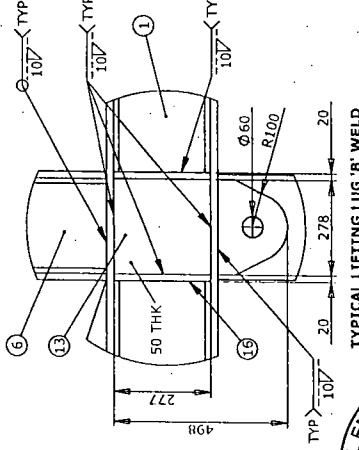
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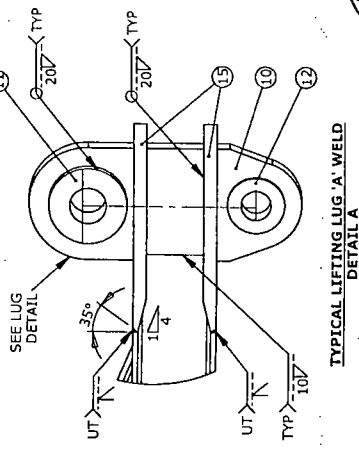
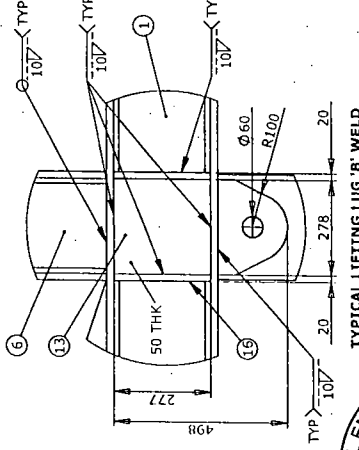
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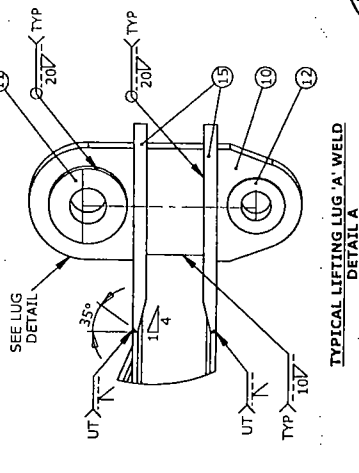
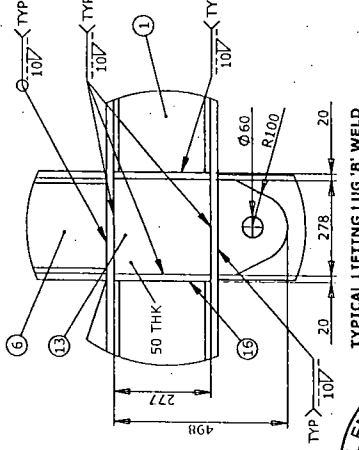
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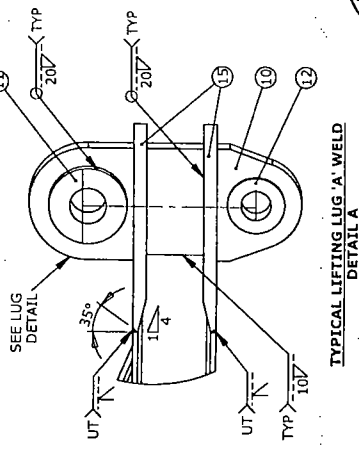
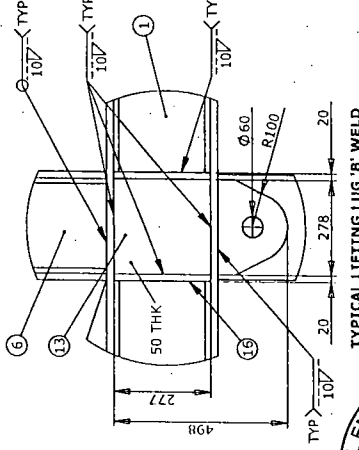
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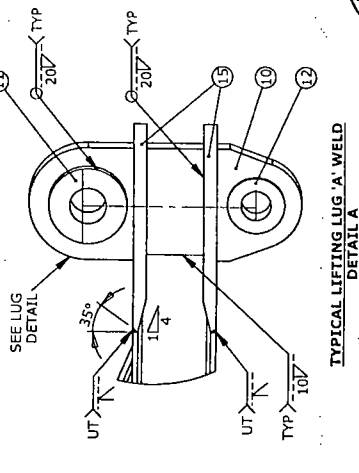
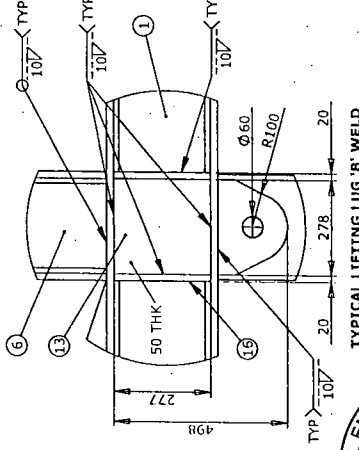
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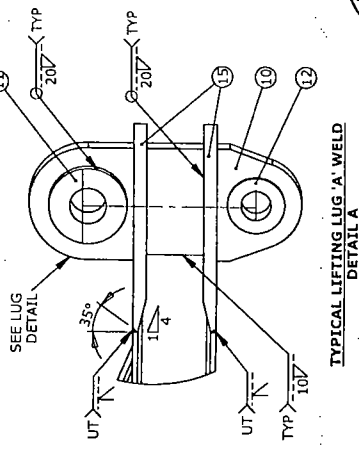
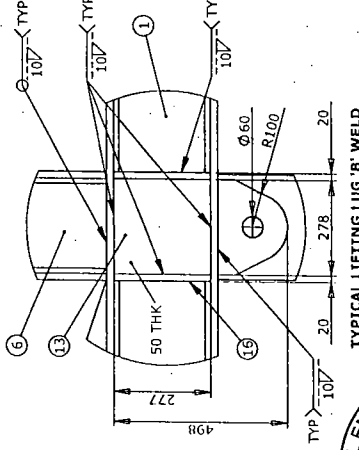
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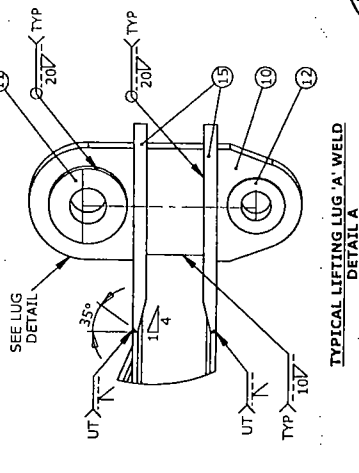
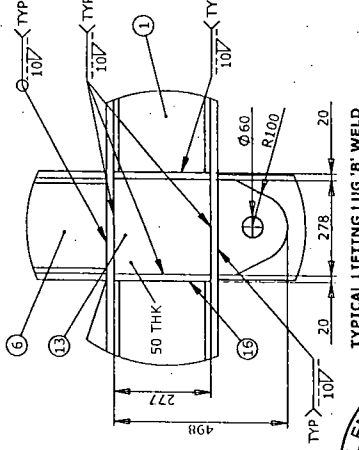
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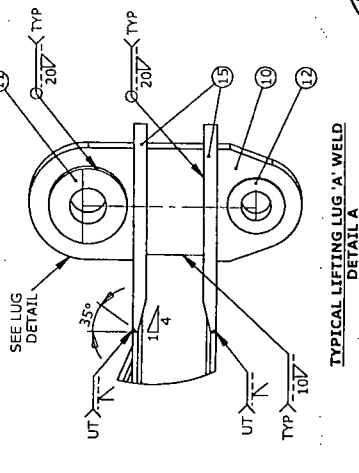
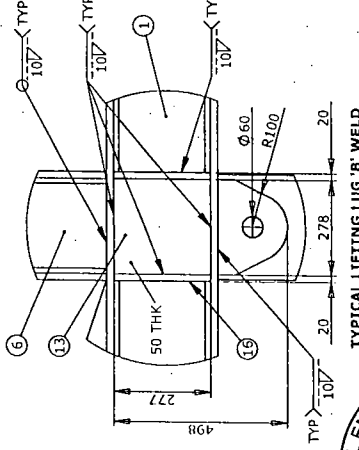
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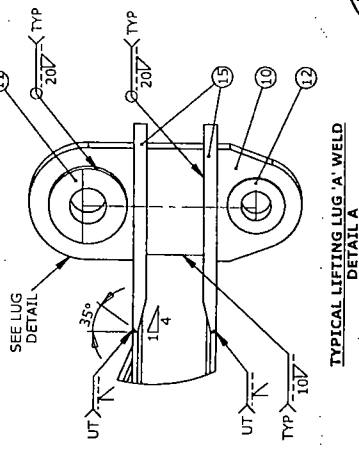
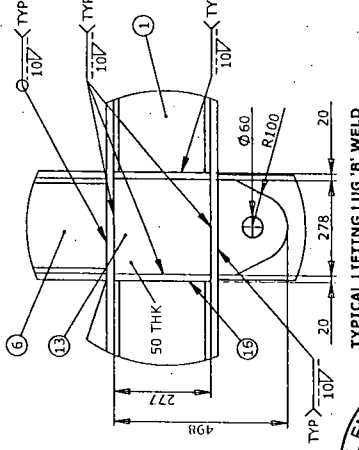
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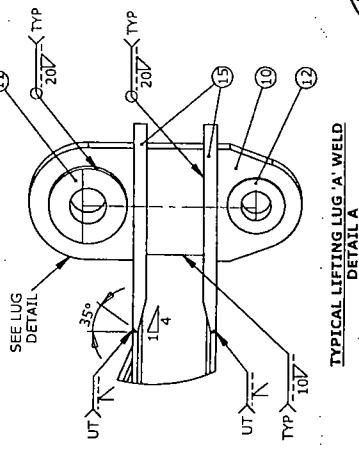
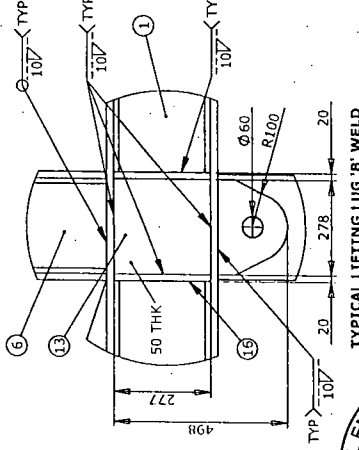
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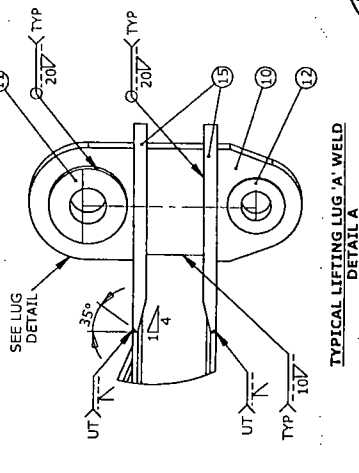
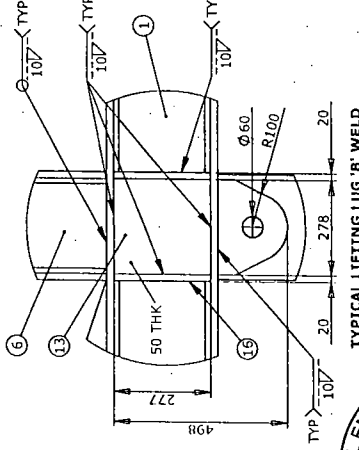
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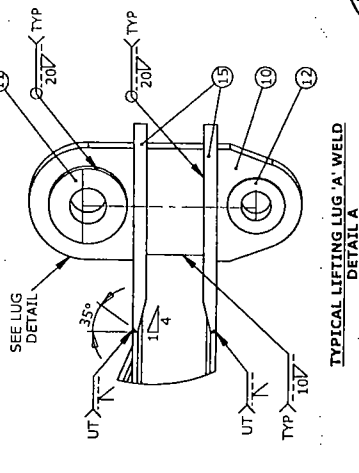
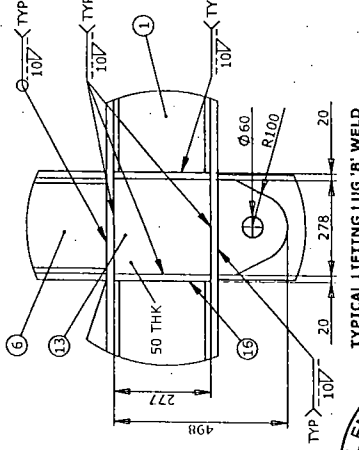
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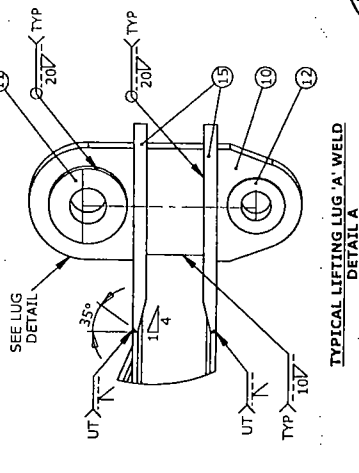
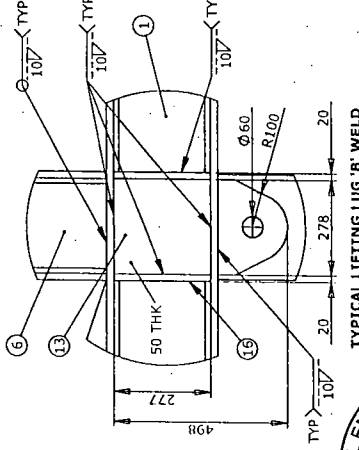
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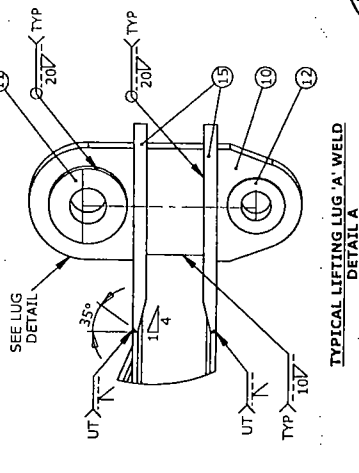
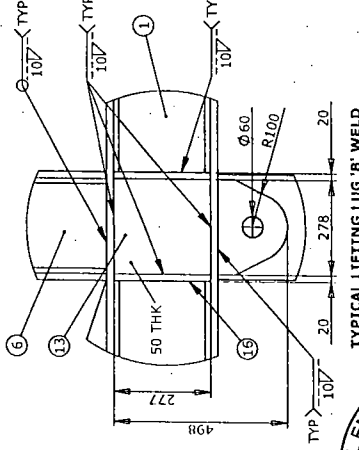
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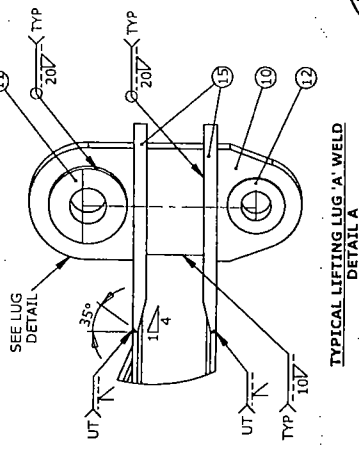
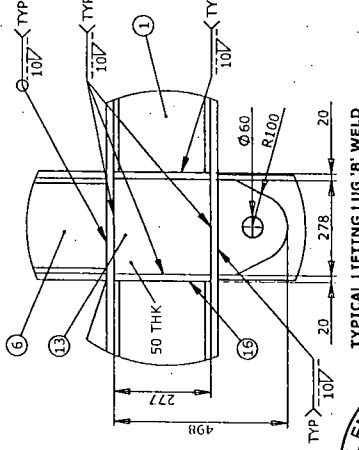
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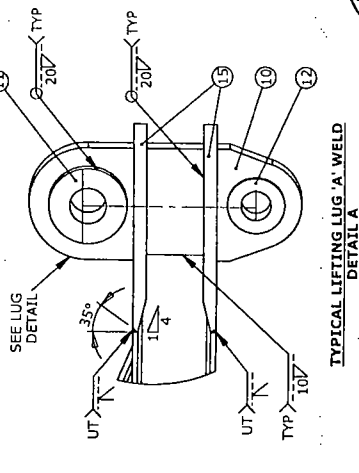
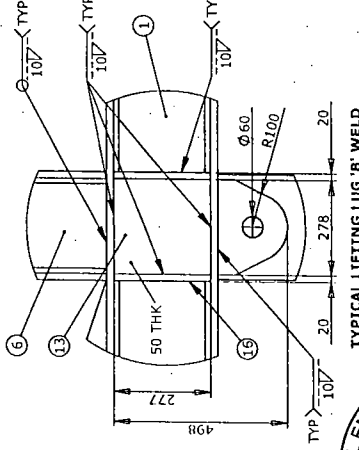
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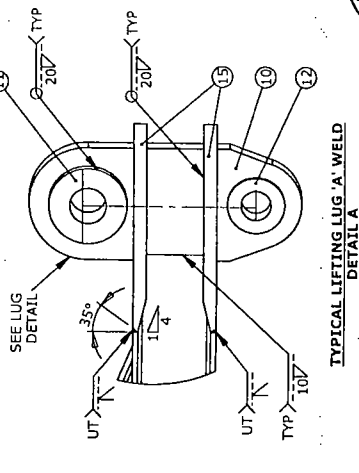
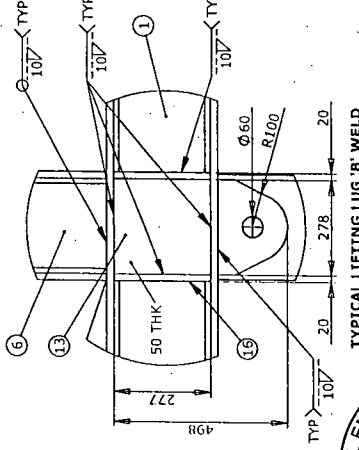
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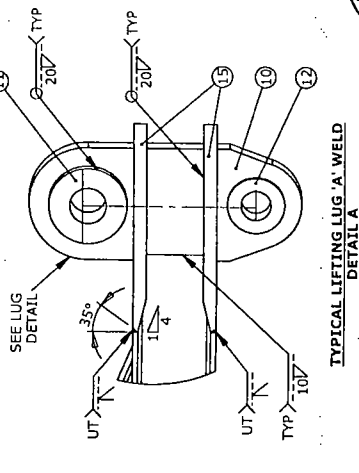
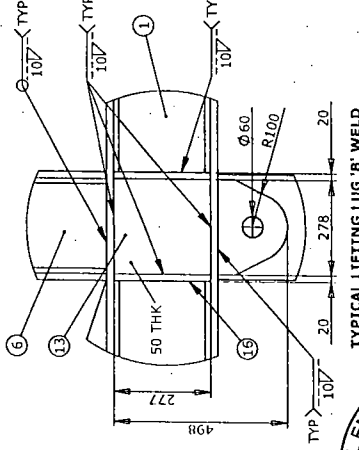
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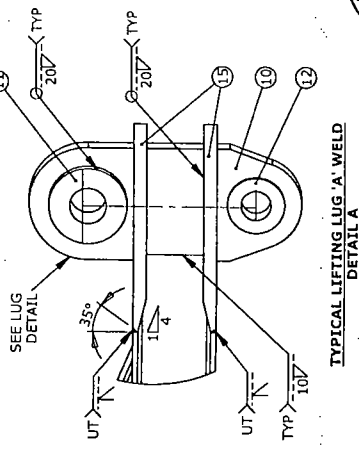
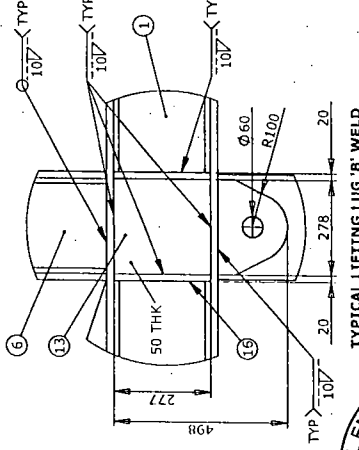
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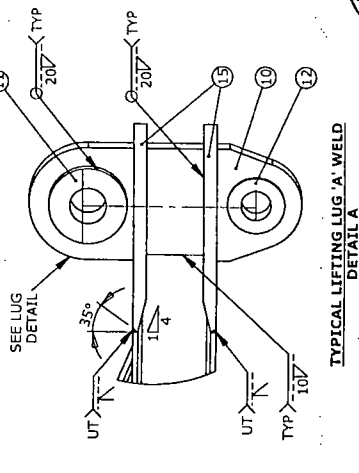
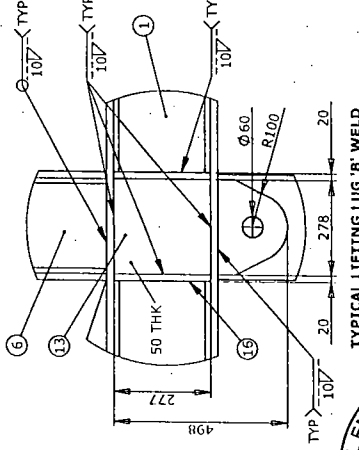
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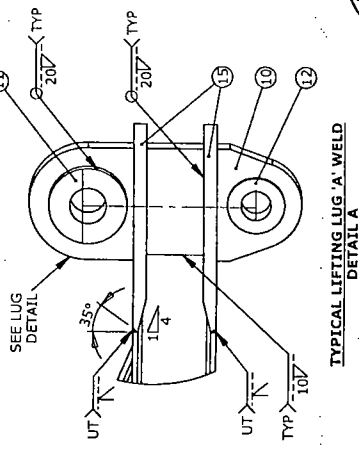
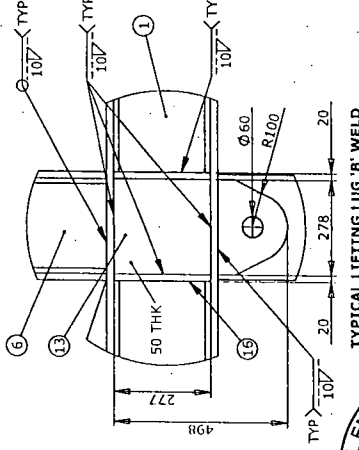
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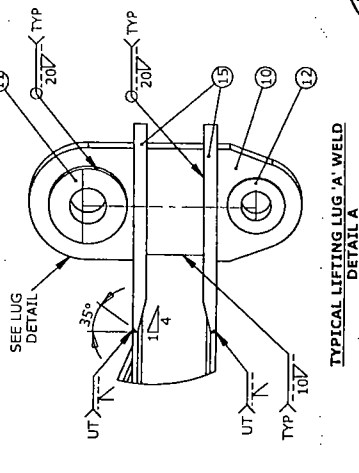
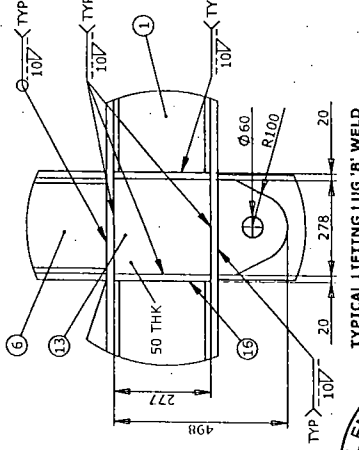
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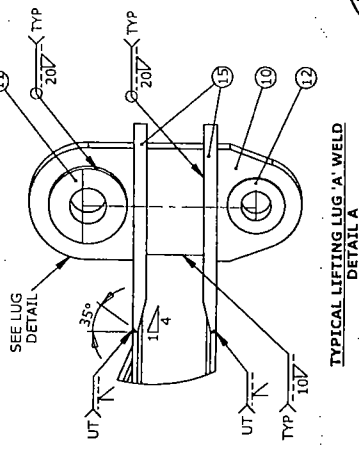
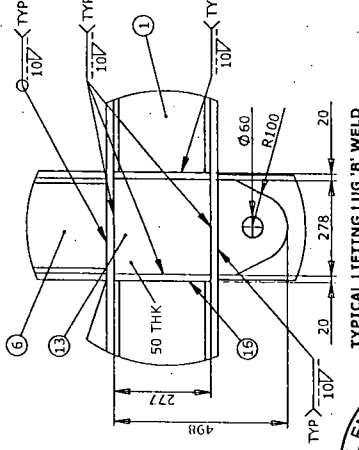
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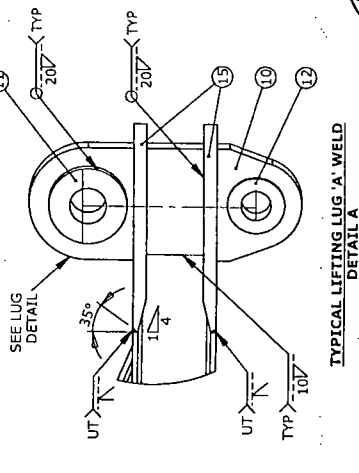
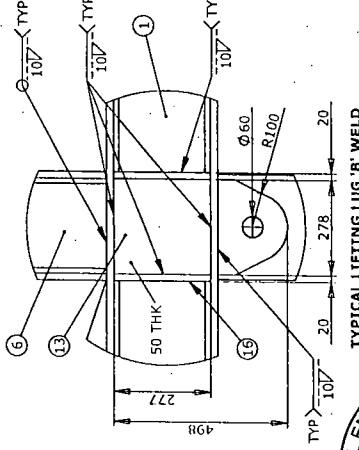
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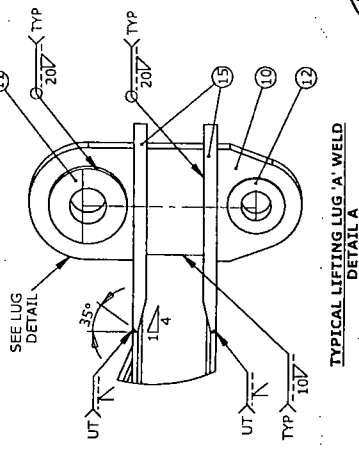
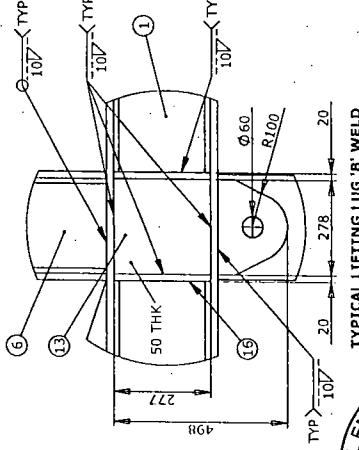
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