

MEMORIA DESCRIPTIVA TÉCNICA

OBRA: REFUERZO ESTRUCTURAL CASONA FERROVIARIA EN CALLE SUIPACHA

1 - Características De Los Materiales

1.1 - Hormigón.

Sólo para el caso de las fundaciones (cilindros de fundación), se utilizará un hormigón con resistencia mínima de 210 Kg/cm^2 ($21 \text{ MPa} = 21 \text{ N/mm}^2$), que se corresponda a tipo H-21. Se debe utilizar el Cemento Portland Normal (CPN), calidad según las normas IRAM 1503. Tamaño máximo del Agregado Grueso debe ser como máximo de 37.5mm para pozos de fundación.

1.2 – Acero para las estructuras de Hormigón Armado

Se deben utilizar Barras de Acero Conformadas de Dureza Natural (ADN) según norma IRAM-IAS U 500-528, superficie Nervurada y características para tipo III DN, de acuerdo a norma CIRSOC 201.

Tensión de fluencia $\beta_s = 4.2 \text{ ton /cm}^2$ (420 MPa).

Resistencia a la tracción $\beta_z = 5.0 \text{ ton /cm}^2$ (500 MPa).

Alargamiento de rotura característico min. $\delta_{10} \geq 12 \%$.-

Diámetro min. mandril de doblado: Ø6mm hasta Ø25mm: 4 ds

En ningún caso se debe utilizar la barra torsionada en frío.

1.3 – Acero para la Estructura Metálica

Los valores característicos, tolerancias, análisis y métodos de ensayo de los materiales necesarios requeridos para los trabajos a que se refiere esta sección, así como las exigencias constructivas se ajustaran a las normas IRAM respectivas.

Todo el acero empleado deberá ser de calidad soldable garantizada, según el reglamento CIRSOC 304. Asimismo las soldaduras se ejecutarán según los lineamientos del CIRSOC 304.

Tornillos y bulones de anclaje serán de calidad ASTM A325M o Clase ISO 8.8.

2 - Acciones Permanentes

b) Cubierta de chapa inclinada:

$$\begin{array}{rcl} \text{Peso de cubierta de chapa} & & 010 \text{ kg/m}^2 \\ \text{Peso Aislaciones y cielorraso} & & 070 \text{ kg/m}^2 \\ \hline g = & & 080 \text{ kg/m}^2 \end{array}$$

Sobrecarga L_r para la viga principal:

$$L_r = 0.96 R_1 R_2 \quad 0.58 < L_r < 0.96$$

$$A_t = 15.7 \text{ m} \times 5.9 \text{ m} = 92.6 \text{ m}^2$$

$$R_1 = 0.6 \quad \text{para } A_t \geq 56 \text{ m}^2$$

$$R_2 = 0.89 \quad \text{para } F = 0.12 \times 52\% = 6.24$$

$$L_r = 0.96 \times 0.60 \times 0.89 = 0.51 \text{ KN/ m}^2 = 51 \text{ kg/m}^2$$

Sobrecarga L_r para la correa:

$$L_r = 0.96 R_1 R_2 \quad 0.58 < L_r < 0.96$$

$$A_t = 1.00 \text{ m} \times 5.83 \text{ m} = 5.83 \text{ m}^2$$

$$\begin{aligned} R1 &= 1.0 \quad \text{para } A_t \leq 19 \text{ m}^2 \\ R2 &= 0.89, \text{ por lo tanto} \\ Lr &= 0.96 \times 1.0 \times 0.89 = 0.85 \text{ KN/ m}^2 = 85 \text{ kg/m}^2 \end{aligned}$$

3 - Acción del Viento s/Cirsoc 102 (2005)

Para edificio regular, cerrado y de baja altura.

3.1. Velocidad básica del viento:

$$V = 39 \text{ m/s}$$

3.2. Factor de direccionalidad del viento k_d :

$$K_d = 0.85$$

3.3. Factor de importancia I:

$$I = 1.00 \quad \text{Categoría II}$$

3.4. Categoría de exposición:

Exposición B (Área suburbana con numerosas obstrucciones entre sí)

3.5. Coeficiente de exposición para la presión dinámica K_h y K_z :

De la tabla 5 para una altura s/nivel de terreno = 10.0 m

$$K_h = K_z = 0.72$$

3.6. Factor topográfico k_{zt} :

$$K_{zt} = 1.0$$

3.7. Cálculo de la presión dinámica:

Para edificio cerrado: $q_z = 0.613 K_z \cdot K_{zt} \cdot K_d \cdot V^2 \cdot I \text{ (N/m}^2\text{)}$

$$q_z = 0.613 \times 0.72 \times 1.0 \times 0.85 \times (39 \text{ m/s})^2 \times 1.15 = 570.6 \text{ N/m}^2 = 57.06 \text{ kg/m}^2$$

3.8. Coeficientes de presión:

Coeficiente de presión interna:

$$GC_{pi} = \pm 0.18 \quad (\text{Para edificio cerrado})$$

En la cubierta:

Coeficiente de presión externa GC_{pf} ,

Viento perpendicular a la cara mayor:

$$\text{A barlovento: } GC_{pf} = +0.10$$

$$\text{A sotavento: } GC_{pf} = -0.50$$

Viento perpendicular a la cara menor:

$$GC_{pf} = +0.10$$

3.9. Presiones de diseño:

Para edificio de baja altura

$$P = q_h [(GC_{pf} - GC_{pi})] \text{ (N/m}^2\text{)}$$

En la cubierta:

Presión para Viento perpendicular a la cara mayor:

$$\text{A barlovento: } P1 = 57.06 \text{ kg/m}^2 \times (0.10 + 0.18) = +16.0 \text{ kg/m}^2$$

$$\text{A sotavento: } P2 = 57.06 \text{ kg/m}^2 \times (-0.50 - 0.18) = -38.8 \text{ kg/m}^2$$

Presión para Viento perpendicular a la cara menor:

$$P3 = 57.06 \text{ kg/m}^2 \times (0.10 + 0.18) = 16.0 \text{ kg/m}^2$$

En las paredes:

Viento sobre la cara menor:

$$P1 = 57.06 \text{ kg/m}^2 \times (0.10 + 0.18) = 16.0 \text{ kg/m}^2$$

Viento sobre la cara mayor:

$$P1 = 57.06 \text{ kg/m}^2 \times (0.10 + 0.18) = 16.0 \text{ kg/m}^2$$

4- Acción de la Nieve Cirsoc 104 (2005)

$$p_f = 30 \text{ kg/m}^2 \text{ (Carga de nieve sobre una superficie plana)}$$

4.1- Carga de Cálculo:

Para $C_t=1.1$

$$p_s = C_s \times p_f$$

$C_s = 0.7$ (factor de pendiente para cubierta fría)

$$p_s = C_s \times p_f = 0.7 \times 30 \text{ kg/m}^2$$

$p_s = 21.0 \text{ kg/m}^2$ (Carga de nieve sobre la cubierta plana y con pendiente)

5 - Evaluación Del Efecto Sísmico. S/ Inpres Cirsoc 103 (2013)

Descripción general:

Zonificación Sísmica: Zona sísmica 4 (Peligrosidad muy elevada)

Clasificación de las construcciones según Destino y funciones:

Edificios gubernamentales de dependencias nacionales y provinciales (Grupo A).

Factor de Riesgo $\gamma_d=1.3$.

$R= 3.0$ (Estructura de Acero Convencional)

Para los análisis siguientes, se adopta el tipo espectral 2 SD.

Esfuerzo de Corte en la base:

$$V_0 = C \times W \quad \text{siendo:}$$

V_0 : Esfuerzo de corte en la base de la construcción (fuerza sísmica horizontal).

C : coeficiente sísmico de diseño.

W : peso de la construcción.

Periodo Fundamental aproximado

$$T_a = C_r (H) \times \quad C_r = 0,0724 \quad (\text{de tabla 6.2})$$

$$T_a = 0,40 \quad x = 0,8 \quad (\text{de tabla 6.2})$$

$$H = 8,5\text{m}$$

El periodo no excederá:

$$T < C_u \times T_a = 0,56\text{seg.}$$

$$C_u = 1,4 (\text{tabla 6.1})$$

Por lo tanto el periodo a utilizar es:

$$T = 0,40\text{seg.}$$

$$C = 2.5 \times C_a \times \square r / R$$

Para $T < T_2=0,71$

$$C = S_a \times \square r / R$$

Para $T > T_2$

$$C > 0.8 \times a_s \times N_v / R$$

Para zonas sísmicas 3 y 4.

$R=3,0$ (Factor de reducción para estructura de acero Convencional)

Como el periodo es $<T_2$, entonces utilizamos la expresión

$$C = 2.5 \times C_a \times \square r / R$$

$$\text{Para } T < T_2 = 0,71$$

$$C = 0,433$$

$$C_a = 0,4$$

$$C > 0,112$$

$$g_r = 1,3$$

$$V_0 = C \cdot W$$

Carga Gravitatoria total W :

Se considera la totalidad de la carga permanente y el 50% de la carga de nieve y la sobrecarga de uso.

Como carga permanente consideramos el peso de la cubierta existente, que quedará a modo de cielorraso, y el peso de los muros de mampostería existentes, que funcionarán como cerramientos.

W1= 50 t (Peso a nivel cubierta)

W2= 290 t (Peso incidencia muros)

W= 340 t Superficie mayor: 355m² $q_u = 0.95 \text{ t/m}^2$

Corte Basal:

$V_o = C \cdot W$

$V_o = 0.43 \cdot 340 \text{ t} = 146 \text{ t}$ (distribuimos esta carga en los nudos del modelo estructural)

6 – Diseño de la Estructura Metálica

La estructura se modeló tridimensionalmente utilizando un programa de cálculo y diseño estructural. Para los elementos metálicos se utiliza el reglamento CIRSOC 301-2005 que toma como base la especificación AISC-LRFD (Load & Resistance Factor Design Specification for Structural Steel Buildings del American Institute of Steel Construction, Inc). Método de diseño también llamado método por estados límites. Este método genera una mejor aproximación para el proyecto de una estructura de acero.

Se adjuntan impresiones de la geometría general del modelo, de las cargas aplicadas y de los esfuerzos debidos a dichas cargas.

Combinaciones de Acciones para la verificación de la Estructura Metálica según Cirsoc 301-2005:

1.4 D

1.2 D + 1.6 L + 0.5 S

1.2 D + 1.6 S + f1 L $f1 = 0.5$

1.2 D + 1.6 S + 0.8 W

1.2 D + 1.6 W + f1 L + 0.5 S $f1 = 0.5$

1.2 D + 1.0 E + f1 L + 1.0 S

0.9 D + 1.6 W

0.9 D + 1.0 E

Siendo:

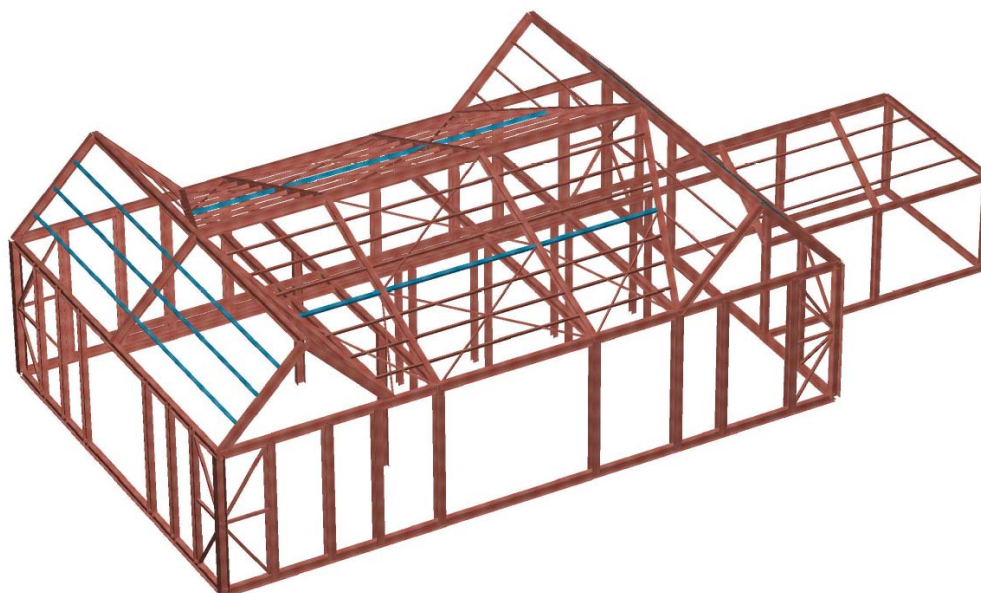
D: Peso propio tanto de la estructura como de elementos no estructurales.

L: Sobrecargas de uso o cargas útiles.

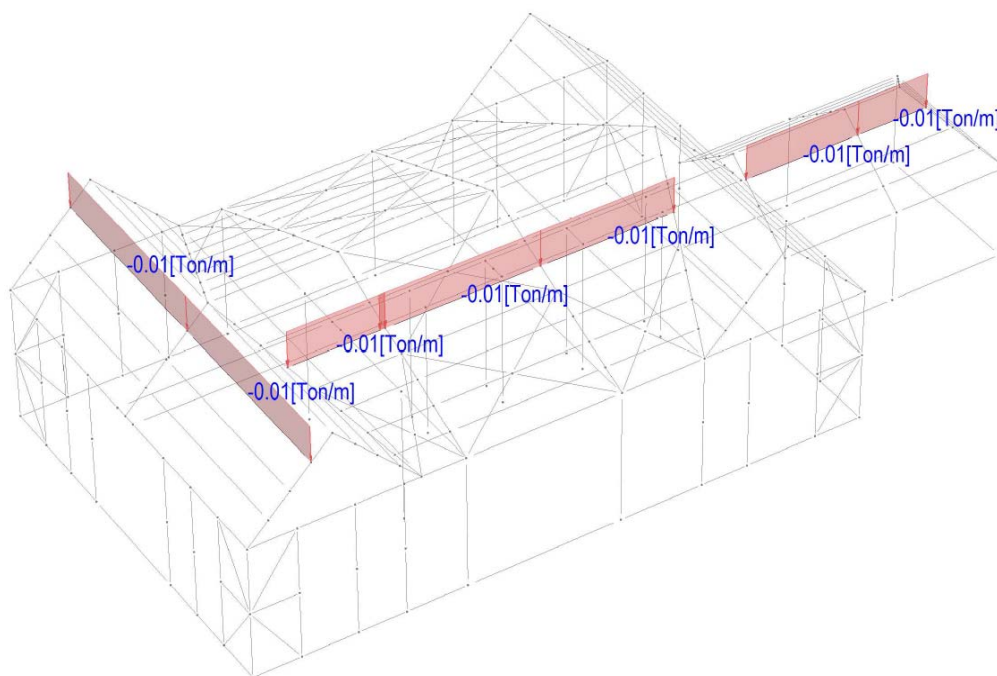
S: Acción de la Nieve.

W: Acción del viento.

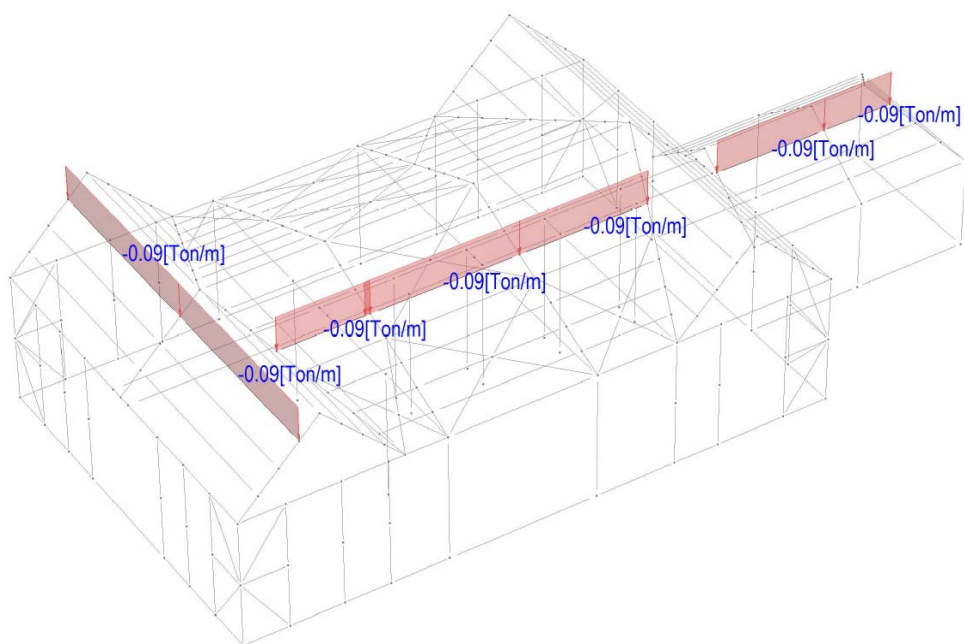
E: Acción sísmica



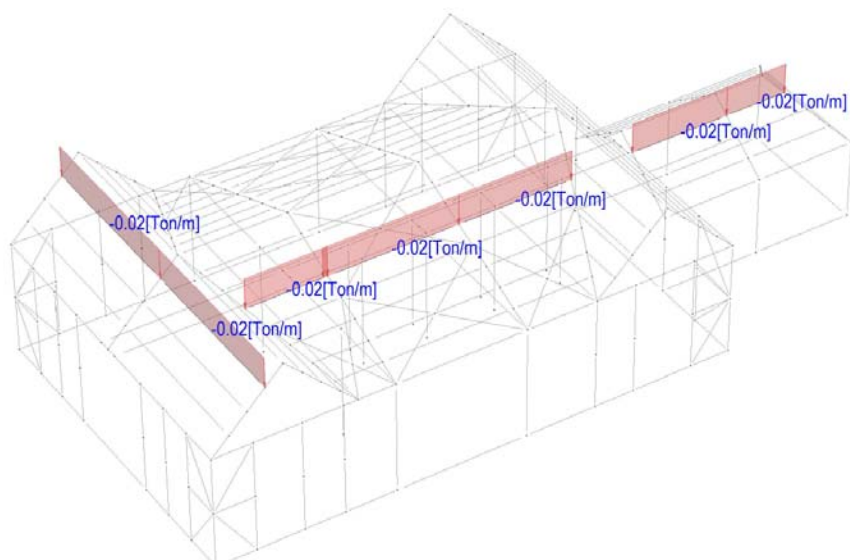
Vistas 3D del modelo matemático adoptado.



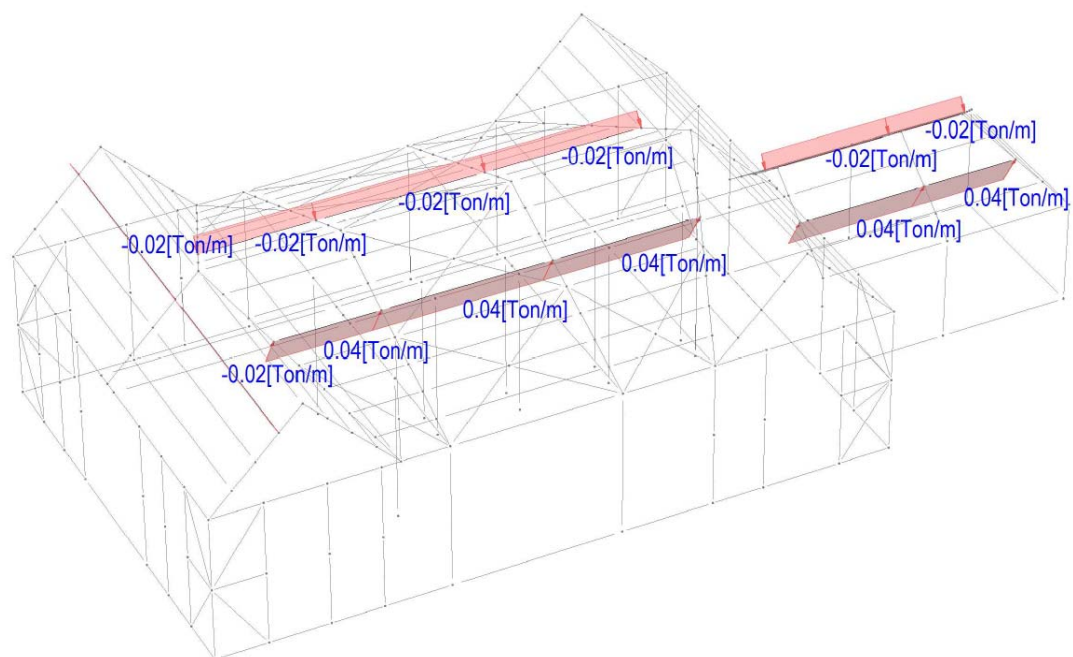
Cargas de peso propio sobre correas (esquematizado en algunas correas)



Cargas de sobrecarga sobre correas (esquematzado en algunas correas)

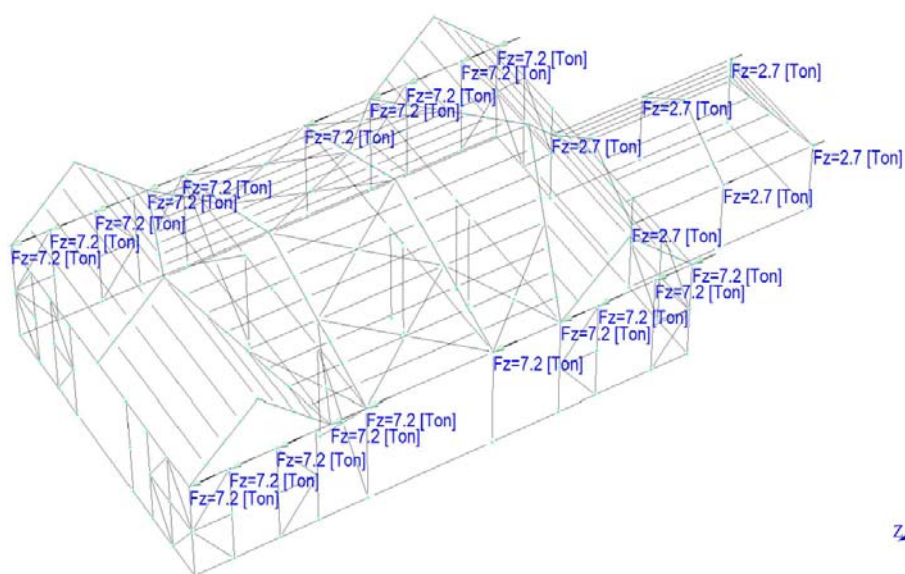


Cargas de nieve sobre correas (esquematzado en algunas correas)



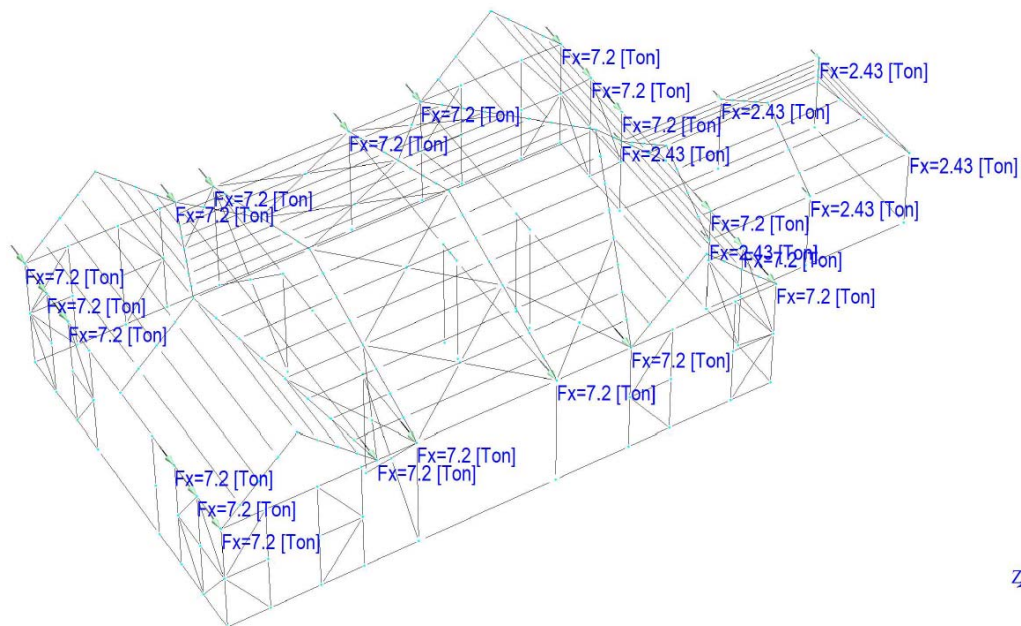
Y

Cargas de viento sobre correas (esquemmatizado en algunas correas)



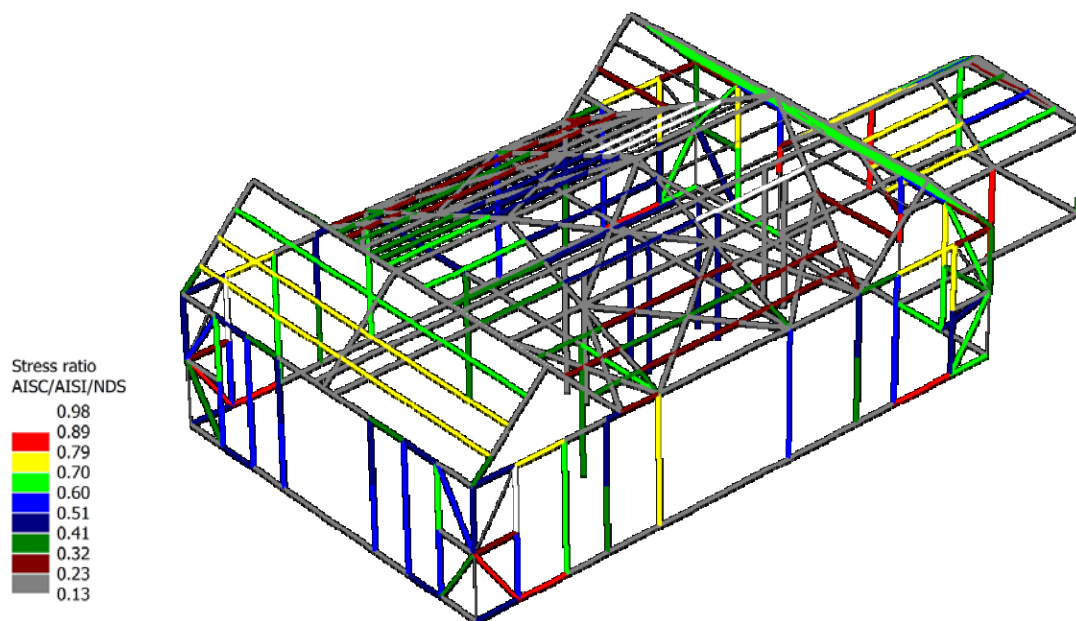
Z

Cargas de Sismo s/ z-z



Cargas de Sismo s/ x-x

VERIFICACION ELEMENTOS ESTRUCTURA METALICA



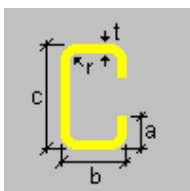
VERIFICACION CORREAS DE CUBIERTA

CORREAS cmet1:

Member : 461 (cm)
Design status : OK

PROPERTIES

Section : PC 160x60x25x2.5mm



Lip (a) 2.50 [cm]
Flange width (b) 6.00 [cm]
Depth (c) 16.00 [cm]
Inside bend radius (r) 0.25 [cm]
Thickness (t) 0.25 [cm]

Section properties	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	7.82	
Moment of Inertia (local axes) (I)	[cm ⁴]	302.22	40.78
Moment of Inertia (principal axes) (I')	[cm ⁴]	302.22	40.78
Bending constant for moments (principal axis) (J')	[cm]	0.00	8.57
Radius of gyration (local axes) (r)	[cm]	6.22	2.28
Radius of gyration (principal axes) (r')	[cm]	6.22	2.28
Saint-Venant torsion constant (J)	[cm ⁴]	0.17	
Warping constant of the cross-section (Cw)	[cm ⁶]	2497.82	
Distance from centroid to shear center (principal axis) (xo, yo)	[cm]		1.01
0.00			
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	37.78	10.17
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		37.78
20.50			
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]		37.78
10.17			
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]		37.78
20.50			
Plastic section modulus (local axis) (Z)	[cm ³]	44.69	16.08
Plastic section modulus (principal axis) (Z')	[cm ³]	44.69	16.08
Polar radius of gyration (ro)	[cm]	8.29	
Area for shear (Aw)	[cm ²]	2.88	5.13
Torsional modulus (1/C)	--	1.50	

Material : Acero F22

Description	Unit	Value
Yield stress (Fy):	[Ton/cm ²]	2.20
Tensile strength (Fu):	[Ton/cm ²]	3.75
Elasticity Modulus (E):	[Ton/cm ²]	2000.00
Shear modulus for steel (G):	[Ton/cm ²]	769.23

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Lateral-torsional buckling modification factor (Cb)	--	0.00	0.00
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Unbraced compression length (Lx, Ly)	[m]	3.63	3.63
Length for torsion and lateral-torsional buckling	[m]	3.63	
Lateral bracing	--	No	No
End moment coefficient in interaction formula (Cm)	--	0.00	0.00
Additional hypotheses			
Bearing length	[cm]	0.00	
Fastened to support		No	
Continuous lateral torsional restraint		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Maximum geometric slenderness (L/r)	--	0.00	(Com. C4F)	
Geometric slenderness (KL/r)	--	0.00		
Deflection in compression and/or bending	--	0.00		

DESIGN CHECKS

DESIGN FOR FLEXURE



Bending about major axis, M33

Ratio	: 0.50	Ctrl Eq.	: C4 at 0.00%
Capacity	: 0.70 [Ton*m]	Reference	: (Sec. C3)
Demand	: -0.35 [Ton*m]		

Intermediate results	Unit	Value	Reference
Nominal flexural strength (Mnx)	[Ton*m]	0.78	(Sec. C3)
Nominal flexural strength with Fy (Mnxo)	[Ton*m]	0.83	(Eq. C3.1.1-1)

Elastic section modulus of effective section at F_y (Sex)	[cm ³]	37.93	(Sec.
C3.1.1)			
Lateral torsional buckling nominal flexural strength (Mnc)	[Ton*m]	0.78	(Sec.
C3.1.2)			
Elastic buckling stress for bending (F_e)	[Ton/cm ²]	3.92	(Sec.
C3.1.2.1)			
Critical buckling stress (F_c)	[Ton/cm ²]	2.06	(Sec.
C3.1.2.1)			
Elastic section modulus of effective section at F_c (Scx)	[cm ³]	37.93	(Sec.
C3.1.2.1)			

Bending about minor axis, M22

Ratio	: 0.45	Ctrl Eq.	: C5 at 0.00%
Capacity	: 0.20 [Ton*m]	Reference	: (Sec. C3)
Demand	: 0.09 [Ton*m]		

Intermediate results	Unit	Value	Reference
<u>Nominal flexural strength (Mny)</u>	[Ton*m]	0.22	(Sec. C3)
Nominal flexural strength with F_y (Mnyo)	[Ton*m]	0.22	(Eq. C3.1.1-
1)			
Elastic section modulus of effective section at F_y (Sey)	[cm ³]	10.22	(Sec.
C3.1.1)			
Lateral torsional buckling nominal flexural strength (Mnc)	[Ton*m]	0.22	(Sec.
C3.1.2)			
Elastic buckling stress for bending (F_e)	[Ton/cm ²]	186.72	(Sec.
C3.1.2.1)			
Critical buckling stress (F_c)	[Ton/cm ²]	2.20	(Sec.
C3.1.2.1)			
Elastic section modulus of effective section at F_c (Scy)	[cm ³]	10.22	(Sec.
C3.1.2.1)			

DESIGN FOR SHEAR



Shear parallel to major axis, V2

Ratio	: 0.08	Ctrl Eq.	: C4 at 0.00%
Capacity	: 4.70 [Ton]	Reference	: (Sec. C3.2)
Demand	: -0.35 [Ton]		

Intermediate results	Unit	Value	Reference
<u>Nominal shear strength (Vn)</u>	[Ton]	4.95	(Sec. C3.2)
Nominal shear stress (F_v)	[Ton/cm ²]	1.32	(Eq. C3.2.1)

Shear parallel to major axis, V3

Ratio	: 0.05
-------	--------

Capacity : 3.14 [Ton]
Demand : -0.15 [Ton]

Ctrl Eq. : C5 at 0.00%
Reference : (Sec. C3.2)

Intermediate results	Unit	Value	Reference
Nominal shear strength (Vn)	[Ton]	3.30	(Sec. C3.2)
Nominal shear stress (Fv)	[Ton/cm2]	1.32	(Eq. C3.2.1)

DESIGN FOR TENSION



Tension

Ratio : 0.00
Capacity : 15.53 [Ton]
Demand : 0.07 [Ton]

Ctrl Eq. : C4 at 0.00%
Reference : (Eq. C2-1)

Intermediate results	Unit	Value	Reference
Nominal tension strength (Tn)	[Ton]	17.25	(Sec. C2)

DESIGN FOR COMPRESSION



Compression

Ratio : 0.05
Capacity : -4.57 [Ton]
Demand : -0.21 [Ton]

Ctrl Eq. : C18 at 0.00%
Reference : (Sec. C4)

Intermediate results	Unit	Value	Reference
Nominal compression strength (Pn)	[Ton]	-5.38	(Eq. C4.1)
Axial elastic buckling stress (Fe)	[Ton/cm2]	0.78	(Sec. C4.2)
Effective net area at stress at stress Fy (Ae)	[cm2]	7.84	(Sec. B)
Nominal axial strength with Fy (Pno)	[Ton]	-15.23	(Sec. C4)
Nominal buckling stress (Fn)	[Ton/cm2]	0.69	(Sec. C4)
Effective net area at stress at stress Fn (Ae)	[cm2]	7.84	(Sec. B)

DESIGN FOR TORSION



Torsion

Ratio : 0.00
Capacity : 0.01 [Ton*m]
Demand : 0.00 [Ton*m]

Ctrl Eq. : C4 at 0.00%
Reference : (AISC, Sec. H)

Intermediate results	Unit	Value	Reference
----------------------	------	-------	-----------

Nominal torsion strength [Ton*m] 0.01

DESIGN FOR CRIPPLING



Web crippling strength

Ratio : 0.00
Capacity : 1.58 [Ton]
Demand : 0.00 [Ton]

Ctrl Eq. : C1 at 0.00%
Reference : (Sec. C3.4)

Intermediate results	Unit	Value	Reference
Nominal crippling strength (P _n)	[Ton]	1.76	(Eq. C3.4.1-
1) Crippling strength factor (φ _w)	--	0.90	(Tables
C3.4.1) Coefficient from Tables	--	13.00	(Sec. C3.4)
Inside bend radius coefficient (CR)	--	0.23	(Sec. C3.4)
Bearing length coefficient (CN)	--	0.14	(Sec. C3.4)
Web slenderness coefficient (Ch)	--	0.01	(Sec. C3.4)
Limit R/t	--	5.00	(Sec. C3.4)

INTERACTION



Combined bending and web crippling ratio

Ratio : 0.31

Ctrl Eq. : C4 at 0.00%
Reference : C3.5.2-1

*The equation has been modified for a maximum ratio equal to 1.0

Combined bending and shear ratio (x-x)

Ratio : 0.45

Ctrl Eq. : C4 at 0.00%
Reference : C3.3.2-1

Combined bending and shear ratio (y-y)

Ratio : 0.45

Ctrl Eq. : C5 at 0.00%
Reference : C3.3.2-1

Combined flexure and tension ratio

Ratio : 0.95

Ctrl Eq. : C4 at 0.00%
Reference : C5.1.2-2

Intermediate results	Unit	Value	Reference
Nominal flexural strength with gross properties (Mnxt)	[Ton*m]	0.83	(Sec. C5.1)
Nominal flexural strength with gross properties (Mnyt)	[Ton*m]	0.45	(Sec. C5.1)

Combined flexure and compression ratio

Ratio : 0.95

Ctrl Eq. Reference C4 at 0.00%
C5.2.2-2

Intermediate results	Unit	Value	Reference
Elastic buckling strength (PE _x)	[Ton]	45.43	(Sec. C5.2.1)
Elastic buckling strength (PE _y)	[Ton]	6.13	(Sec. C5.2.1)
Magnification factor (\square_x)	--	1.00	(Sec. C5.2.1)
Magnification factor (\square_y)	--	1.00	(Sec. C5.2.1)

CRITICAL STRENGTH RATIO



Ratio : 0.95

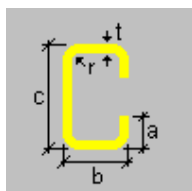
Ctrl Eq. : C4 at 0.00% Reference : C3.3.2-1

CORREAS cmet2:

Member : 428 (cm sector chico)
Design status : OK

PROPERTIES

Section : PC 120x50x20x2.5



Lip (a)	2.00	[cm]
Flange width (b)	5.00	[cm]
Depth (c)	12.00	[cm]
Inside bend radius (r)	0.25	[cm]
Thickness (t)	0.25	[cm]

Section properties	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	6.07	
Moment of Inertia (local axes) (I)	[cm ⁴]	132.66	21.57
Moment of Inertia (principal axes) (I')	[cm ⁴]	132.66	21.57
Bending constant for moments (principal axis) (J')	[cm]	0.00	6.69
Radius of gyration (local axes) (r)	[cm]	4.67	1.88
Radius of gyration (principal axes) (r')	[cm]	4.67	1.88
Saint-Venant torsion constant (J)	[cm ⁴]	0.13	
Warping constant of the cross-section (Cw)	[cm ⁶]	761.61	
Distance from centroid to shear center (principal axis) (x _o , y _o)		[cm]	0.78
0.00			
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	22.11	6.57
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		22.11
12.55			
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]		22.11
6.57			
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]		22.11
12.55			
Plastic section modulus (local axis) (Z)	[cm ³]	26.16	10.33
Plastic section modulus (principal axis) (Z')	[cm ³]	26.16	10.33
Polar radius of gyration (r _o)	[cm]	6.59	
Area for shear (A _w)	[cm ²]	2.38	3.88
Torsional modulus (1/C)	--	1.92	

Material : Acero F22

Description	Unit	Value
Yield stress (F _y):	[Ton/cm ²]	2.20
Tensile strength (F _u):	[Ton/cm ²]	3.75
Elasticity Modulus (E):	[Ton/cm ²]	2000.00
Shear modulus for steel (G):	[Ton/cm ²]	769.23

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Lateral-torsional buckling modification factor (C _b)	--	0.00	0.00
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Unbraced compression length (L _x , L _y)	[m]	3.15	3.15
Length for torsion and lateral-torsional buckling	[m]	3.15	
Lateral bracing	--	No	No
End moment coefficient in interaction formula (C _m)	--	0.00	0.00

Additional hypotheses

Bearing length	[cm]	0.00
Fastened to support		No
Continuous lateral torsional restraint		No

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Maximum geometric slenderness (L/r)	--	0.00	(Com. C4F)	
Geometric slenderness (KL/r)	--	0.00		
Deflection in compression and/or bending	--	0.00		

DESIGN CHECKS

DESIGN FOR FLEXURE



Bending about major axis, M33

Ratio	: 0.33	Ctrl Eq.	: C5 at 0.00%
Capacity	: 0.38 [Ton*m]	Reference	: (Sec. C3)
Demand	: -0.13 [Ton*m]		

Intermediate results	Unit	Value	Reference
<u>Nominal flexural strength (Mnx)</u>	[Ton*m]	0.43	(Sec. C3)
Nominal flexural strength with Fy (Mnxo)	[Ton*m]	0.49	(Eq. C3.1.1-1)
Elastic section modulus of effective section at Fy (Sex)	[cm ³]	22.23	(Sec. C3.1.1)
Lateral torsional buckling nominal flexural strength (Mnc)	[Ton*m]	0.43	(Sec. C3.1.2)
Elastic buckling stress for bending (Fe)	[Ton/cm ²]	2.86	(Sec. C3.1.2.1)
Critical buckling stress (Fc)	[Ton/cm ²]	1.92	(Sec. C3.1.2.1)
Elastic section modulus of effective section at Fc (Scx)	[cm ³]	22.23	(Sec. C3.1.2.1)

Bending about minor axis, M22

Ratio	: 0.04	Ctrl Eq.	: C8 at 100.00%
Capacity	: 0.13 [Ton*m]	Reference	: (Sec. C3)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
<u>Nominal flexural strength (Mny)</u>	[Ton*m]	0.15	(Sec. C3)

1) Nominal flexural strength with F_y (M_{nyo})	[Ton*m]	0.15	(Eq. C3.1.1-1)
C3.1.1) Elastic section modulus of effective section at F_y (S_{ey})	[cm ³]	6.62	(Sec. C3.1.1)
C3.1.2) Lateral torsional buckling nominal flexural strength (M_{nc})	[Ton*m]	0.15	(Sec. C3.1.2)
C3.1.2.1) Elastic buckling stress for bending (F_e)	[Ton/cm ²]	118.55	(Sec. C3.1.2.1)
C3.1.2.1) Critical buckling stress (F_c)	[Ton/cm ²]	2.20	(Sec. C3.1.2.1)
C3.1.2.1) Elastic section modulus of effective section at F_c (S_{cy})	[cm ³]	6.62	(Sec. C3.1.2.1)

DESIGN FOR SHEAR



Shear parallel to major axis, V2

Ratio	: 0.08	Ctrl Eq.	: C5 at 0.00%
Capacity	: 3.45 [Ton]	Reference	: (Sec. C3.2)
Demand	: -0.26 [Ton]		

Intermediate results	Unit	Value	Reference
Nominal shear strength (V_n)	[Ton]	3.63	(Sec. C3.2)
Nominal shear stress (F_v)	[Ton/cm ²]	1.32	(Eq. C3.2.1)

Shear parallel to major axis, V3

Ratio	: 0.00	Ctrl Eq.	: C14 at 0.00%
Capacity	: 2.51 [Ton]	Reference	: (Sec. C3.2)
Demand	: 0.00 [Ton]		

Intermediate results	Unit	Value	Reference
Nominal shear strength (V_n)	[Ton]	2.64	(Sec. C3.2)
Nominal shear stress (F_v)	[Ton/cm ²]	1.32	(Eq. C3.2.1)

DESIGN FOR TENSION



Tension

Ratio	: 0.00	Ctrl Eq.	: C16 at 0.00%
Capacity	: 12.06 [Ton]	Reference	: (Eq. C2-1)
Demand	: 0.05 [Ton]		

Intermediate results	Unit	Value	Reference
Nominal tension strength (T_n)	[Ton]	13.40	(Sec. C2)

DESIGN FOR COMPRESSION



Compression

Ratio	: 0.17	Ctrl Eq.	: C4 at 0.00%
Capacity	: -3.22 [Ton]	Reference	: (Sec. C4)
Demand	: -0.55 [Ton]		

Intermediate results	Unit	Value	Reference
Nominal compression strength (Pn)	[Ton]	-3.79	(Eq. C4.1)
Axial elastic buckling stress (Fe)	[Ton/cm2]	0.71	(Sec. C4.2)
Effective net area at stress at stress Fy (Ae)	[cm2]	6.09	(Sec. B)
Nominal axial strength with Fy (Pno)	[Ton]	-12.98	(Sec. C4)
Nominal buckling stress (Fn)	[Ton/cm2]	0.62	(Sec. C4)
Effective net area at stress at stress Fn (Ae)	[cm2]	6.09	(Sec. B)

DESIGN FOR TORSION



Torsion

Ratio	: 0.00	Ctrl Eq.	: C13 at 0.00%
Capacity	: 0.01 [Ton*m]	Reference	: (AISC, Sec. H)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
Nominal torsion strength	[Ton*m]	0.01	

DESIGN FOR CRIPPLING



Web crippling strength

Ratio	: 0.00	Ctrl Eq.	: C1 at 0.00%
Capacity	: 1.60 [Ton]	Reference	: (Sec. C3.4)
Demand	: 0.00 [Ton]		

Intermediate results	Unit	Value	Reference
Nominal crippling strength (Pn)	[Ton]	1.78	(Eq. C3.4.1-1)
Crippling strength factor (ϕ_w)	--	0.90	(Tables C3.4.1)
Coefficient from Tables	--	13.00	(Sec. C3.4)
Inside bend radius coefficient (CR)	--	0.23	(Sec. C3.4)
Bearing length coefficient (CN)	--	0.14	(Sec. C3.4)
Web slenderness coefficient (Ch)	--	0.01	(Sec. C3.4)

Limit R/t	--	5.00	(Sec. C3.4)
-----------	----	------	-------------

INTERACTION ✓

Combined bending and web crippling ratio

Ratio : 0.19

Ctrl Eq. Reference	C5 at 0.00% C3.5.2-1
-----------------------	-------------------------

*The equation has been modified for a maximum ratio equal to 1.0

Combined bending and shear ratio (x-x)

Ratio : 0.28

Ctrl Eq. Reference	C5 at 0.00% C3.3.2-1
-----------------------	-------------------------

Combined bending and shear ratio (y-y)

Ratio : 0.04

Ctrl Eq. Reference	C8 at 100.00% C3.3.2-1
-----------------------	---------------------------

Combined flexure and tension ratio

Ratio : 0.34

Ctrl Eq. Reference	C5 at 0.00% C5.1.2-2
-----------------------	-------------------------

Intermediate results

Unit	Value	Reference
Nominal flexural strength with gross properties (Mnxt)	[Ton*m]	0.49 (Sec. C5.1)
Nominal flexural strength with gross properties (Mnyt)	[Ton*m]	0.28 (Sec. C5.1)

Combined flexure and compression ratio

Ratio : 0.46

Ctrl Eq. Reference	C4 at 0.00% C5.2.2-1
-----------------------	-------------------------

Intermediate results

Unit	Value	Reference
Elastic buckling strength (PE _x)	[Ton]	26.53 (Sec. C5.2.1)
Elastic buckling strength (PE _y)	[Ton]	4.32 (Sec. C5.2.1)
Magnification factor (□ _x)	--	0.98 (Sec. C5.2.1)

Magnification factor ($\square y$) -- 0.87 (Sec. C5.2.1)

CRITICAL STRENGTH RATIO



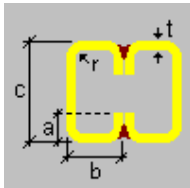
Ratio : 0.46
Ctrl Eq. : C4 at 0.00% Reference : C5.2.2-1

CORREAS cmet3:

Member : 353 (cm doble)
Design status : OK

PROPERTIES

Section : 2PC 160x60x25x3.2



Lip (a) 2.50 [cm]
Flange width (b) 6.00 [cm]
Depth (c) 16.00 [cm]
Inside bend radius (r) 0.00 [cm]
Thickness (t) 0.32 [cm]

Section properties

Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	20.30 [cm ²]	
Moment of Inertia (local axes) (I)	787.17 [cm ⁴]	427.42 [cm ⁴]
Moment of Inertia (principal axes) (I')	787.17 [cm ⁴]	427.42 [cm ⁴]
Bending constant for moments (principal axis) (J')	0.00 [cm]	0.00 [cm]
Radius of gyration (local axes) (r)	6.23 [cm]	4.59 [cm]
Radius of gyration (principal axes) (r')	6.23 [cm]	4.59 [cm]
Saint-Venant torsion constant (J)	772.38 [cm ⁴]	
Warping constant of the cross-section (Cw)	261.98 [cm ⁶]	
Distance from centroid to shear center (principal axis) (x _o , y _o)	[cm]	0.00
Top elastic section modulus of the section (local axis) (S top)	98.40 [cm ³]	71.24 [cm ³]
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]	98.40 [cm ³]
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]	98.40 [cm ³]

Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]	98.40
71.24		
Plastic section modulus (local axis) (Z)	[cm ³]	116.32
Plastic section modulus (principal axis) (Z')	[cm ³]	116.32
Polar radius of gyration (ro)	[cm]	7.73
Area for shear (Aw)	[cm ²]	7.27
Torsional modulus (1/C)	--	0.01

Material : Acero F22

Description	Unit	Value
Yield stress (Fy):	[Ton/cm ²]	2.20
Tensile strength (Fu):	[Ton/cm ²]	3.75
Elasticity Modulus (E):	[Ton/cm ²]	2000.00
Shear modulus for steel (G):	[Ton/cm ²]	769.23

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Lateral-torsional buckling modification factor (Cb)	--	0.00	0.00
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Unbraced compression length (Lx, Ly)	[m]	7.65	7.65
Length for torsion and lateral-torsional buckling	[m]	7.65	
Lateral bracing	--	No	No
End moment coefficient in interaction formula (Cm)	--	0.00	0.00
Additional hypotheses			
Bearing length	[cm]	0.00	
Fastened to support		No	
Continuous lateral torsional restraint		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Maximum geometric slenderness (L/r)	--	0.00	(Com. C4F)	
Geometric slenderness (KL/r)	--	0.00		
Deflection in compression and/or bending	--	0.00		

DESIGN CHECKS

DESIGN FOR FLEXURE



Bending about major axis, M33

Ratio : 0.55

Capacity : 2.03 [Ton*m]
Demand : -1.11 [Ton*m]

Ctrl Eq. : C5 at 100.00%
Reference : (Sec. C3)

Intermediate results	Unit	Value	Reference
<u>Nominal flexural strength (Mnx)</u>	[Ton*m]	2.14	(Sec. C3)
Nominal flexural strength with Fy (Mnxo)	[Ton*m]	2.14	(Eq. C3.1.1-1)
1) Elastic section modulus of effective section at Fy (Sex)	[cm3]	97.06	(Sec. C3.1.1)
Lateral torsional buckling nominal flexural strength (Mnc)	[Ton*m]	2.14	(Sec. C3.1.2)
Elastic buckling stress for bending (Fe)	[Ton/cm2]	59.94	(Sec. C3.1.2.1)
Critical buckling stress (Fc)	[Ton/cm2]	2.20	(Sec. C3.1.2.1)
Elastic section modulus of effective section at Fc (Scx)	[cm3]	97.06	(Sec. C3.1.2.1)

Bending about minor axis, M22

Ratio : 0.39
Capacity : 1.37 [Ton*m]
Demand : -0.54 [Ton*m]

Ctrl Eq. : C4 at 0.00%
Reference : (Sec. C3)

Intermediate results	Unit	Value	Reference
<u>Nominal flexural strength (Mny)</u>	[Ton*m]	1.53	(Sec. C3)
Nominal flexural strength with Fy (Mnyo)	[Ton*m]	1.53	(Eq. C3.1.1-1)
1) Elastic section modulus of effective section at Fy (Sey)	[cm3]	69.43	(Sec. C3.1.1)
Lateral torsional buckling nominal flexural strength (Mnc)	[Ton*m]	2.14	(Sec. C3.1.2)
Elastic buckling stress for bending (Fe)	[Ton/cm2]	148.56	(Sec. C3.1.2.1)
Critical buckling stress (Fc)	[Ton/cm2]	2.20	(Sec. C3.1.2.1)
Elastic section modulus of effective section at Fc (Scy)	[cm3]	97.05	(Sec. C3.1.2.1)

DESIGN FOR SHEAR



Shear parallel to major axis, V2

Ratio : 0.06
Capacity : 12.33 [Ton]
Demand : 0.75 [Ton]

Ctrl Eq. : C5 at 100.00%
Reference : (Sec. C3.2)

Intermediate results	Unit	Value	Reference
Nominal shear strength (Vn)	[Ton]	12.98	(Sec. C3.2)
Nominal shear stress (Fv)	[Ton/cm2]	1.32	(Eq. C3.2.1)

Shear parallel to major axis, V3

Ratio	: 0.04	Ctrl Eq.	: C4 at 0.00%
Capacity	: 8.60 [Ton]	Reference	: (Sec. C3.2)
Demand	: 0.36 [Ton]		

Intermediate results	Unit	Value	Reference
Nominal shear strength (Vn)	[Ton]	9.06	(Sec. C3.2)
Nominal shear stress (Fv)	[Ton/cm2]	1.32	(Eq. C3.2.1)

DESIGN FOR TENSION



Tension

Ratio	: 0.00	Ctrl Eq.	: C13 at 0.00%
Capacity	: 39.86 [Ton]	Reference	: (Eq. C2-1)
Demand	: 0.13 [Ton]		

Intermediate results	Unit	Value	Reference
Nominal tension strength (Tn)	[Ton]	44.28	(Sec. C2)

DESIGN FOR COMPRESSION



Compression

Ratio	: 0.01	Ctrl Eq.	: C14 at 0.00%
Capacity	: -10.67 [Ton]	Reference	: (Sec. C4)
Demand	: -0.09 [Ton]		

Intermediate results	Unit	Value	Reference
Nominal compression strength (Pn)	[Ton]	-12.56	(Eq. C4.1)
Axial elastic buckling stress (Fe)	[Ton/cm2]	0.71	(Sec. C4.2)
Effective net area at stress at stress Fy (Ae)	[cm2]	20.13	(Sec. B)
Nominal axial strength with Fy (Pno)	[Ton]	-41.70	(Sec. C4)
Nominal buckling stress (Fn)	[Ton/cm2]	0.62	(Sec. C4)
Effective net area at stress at stress Fn (Ae)	[cm2]	20.13	(Sec. B)

DESIGN FOR TORSION



Torsion

Ratio	: 0.00	Ctrl Eq.	: C16 at 0.00%
Capacity	: 1.43 [Ton*m]	Reference	: (AISC, Sec. H)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
Nominal torsion strength	[Ton*m]	1.50	

DESIGN FOR CRIPPLING (N/A)

INTERACTION ✓

Combined bending and web crippling ratio

Ratio	: 0.00	Ctrl Eq.	C1 at 0.00%
		Reference	

*The equation has been modified for a maximum ratio equal to 1.0

Combined bending and shear ratio (x-x)

Ratio	: 0.55	Ctrl Eq.	C5 at 100.00%
		Reference	C3.3.2-1

Combined bending and shear ratio (y-y)

Ratio	: 0.39	Ctrl Eq.	C4 at 0.00%
		Reference	C3.3.2-1

Combined flexure and tension ratio

Ratio	: 0.81	Ctrl Eq.	C5 at 100.00%
		Reference	C5.1.2-2

Intermediate results	Unit	Value	Reference
Nominal flexural strength with gross properties (Mnxt)	[Ton*m]	2.14	(Sec. C5.1)
Nominal flexural strength with gross properties (Mnyt)	[Ton*m]	1.56	(Sec. C5.1)

Combined flexure and compression ratio

Ratio	: 0.81
-------	--------

Ctrl Eq. Reference
C5 at 100.00%
C5.2.2-2

Intermediate results	Unit	Value	Reference
Elastic buckling strength (PEx) C5.2.1)	[Ton]	26.19	(Sec.
Elastic buckling strength (PEy) C5.2.1)	[Ton]	14.32	(Sec.
Magnification factor (\square x) C5.2.1)	--	1.00	(Sec.
Magnification factor (\square y) C5.2.1)	--	1.00	(Sec.

CRITICAL STRENGTH RATIO

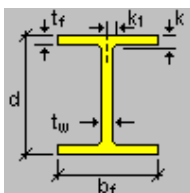


Ratio : 0.81
Ctrl Eq. : C5 at 100.00% Reference : C5.2.2-2

VIGAS VM1:

Member : 42 (VArriostr hor)
Design status : OK

PROPERTIES Section : W 12X40



Width (bf) 20.35 [cm]
Depth (d) 30.23 [cm]
Distance k (k) 2.59 [cm]
Distance k1 (k1) 2.22 [cm]
Flange thickness (tf) 1.31 [cm]
Web thickness (tw) 0.75 [cm]

Section properties	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm2]	75.48	
Moment of Inertia (local axes) (I)	[cm4]	12778.30	1835.58
Moment of Inertia (principal axes) (I')	[cm4]	12778.30	1835.58
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	13.01	4.93

Radius of gyration (principal axes) (r')	[cm]	13.01	4.93
Saint-Venant torsion constant (J)	[cm ⁴]	37.71	
Warping constant of the cross-section (C_w)	[cm ⁶]	386691.60	
Distance from centroid to shear center (principal axis) (x_o, y_o)	[cm]		0.00
0.00			
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	843.93	180.26
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		843.93
180.26			
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]		843.93
180.26			
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]		843.93
180.26			
Plastic section modulus (local axis) (Z)	[cm ³]	934.06	275.30
Plastic section modulus (principal axis) (Z')	[cm ³]	934.06	275.30
Polar radius of gyration (r_o)	[cm]	13.91	
Area for shear (A_w)	[cm ²]	53.23	22.65
Torsional modulus (1/C)	--	0.04	

Material : A36

Properties	Unit	Value
Yield stress (F_y):	[Ton/cm ²]	2.53
Tensile strength (F_u):	[Ton/cm ²]	4.08
Elasticity Modulus (E):	[Ton/cm ²]	2038.89
Shear modulus for steel (G):	[Ton/cm ²]	809.08

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Top unbraced length between lateral supports (L _{bTop})	[m]	2.10	
Bottom unbraced length between lateral supports (L _{bBot})	[m]	2.10	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	2.10	
Unbraced compression length (L _x , L _y)	[m]	2.10	2.10
Length for torsion and lateral-torsional buckling	[m]	2.10	
Additional hypotheses			
Continuous lateral torsional restraint		No	
Tension field action		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Tension				
Maximum geometric slenderness (L/r)	--	42.59		(Sec. D1)

Compression

Geometric critical slenderness (KL/r) -- 42.59 (Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$) ✓

Bending about major axis, M33

Ratio : 0.62
Capacity : 21.28 [Ton*m]
Demand : -13.18 [Ton*m]

Ctrl Eq. : C7 at 0.00%
Reference : (Sec. F)

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	23.64	(Sec. F)
Lateral-torsional buckling (LTB Mn)	--	N/A	(Sec. F)
Limiting unbraced length for yielding (Lp)	[m]	2.46	(Sec. F)
Limiting unbraced length for inelastic LTB (Lr)	[m]	8.25	(Sec. F)
Web local buckling (WLB Mn)	--	N/A	(Sec. F)
Local buckling (LB Mn)	--	N/A	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (ϕ)	--	7.78	(Sec. B4)
Limiting slenderness parameter for compact flange (ϕ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ_r)	--	28.38	(Sec. B4)
Tension flange yielding (TFY Mn)	--	N/A	(Sec. F)

Bending about minor axis, M22

Ratio : 0.12
Capacity : 6.27 [Ton*m]
Demand : -0.74 [Ton*m]

Ctrl Eq. : C9 at 0.00%
Reference : (Sec. F)

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	6.97	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (ϕ)	--	7.78	(Sec. B4)
Limiting slenderness parameter for compact flange (ϕ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ_r)	--	28.38	(Sec. B4)

DESIGN FOR SHEAR ✓

Shear parallel to major axis, V3 ($\phi = 0.90$)

Ratio : 0.00

Capacity	: 72.75 [Ton]	Ctrl Eq.	: C9 at 0.00%
Demand	: 0.26 [Ton]	Reference	: (Sec. G)

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	1.20	(Sec. G2)

Shear parallel to major axis, V2 ($\phi = 1.00$)

Ratio	: 0.33	Ctrl Eq.	: C7 at 0.00%
Capacity	: 34.39 [Ton]	Reference	: (Sec. G)
Demand	: -11.51 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\phi = 0.90$) ✓

Tension

Ratio	: 0.06	Ctrl Eq.	: C7 at 0.00%
Capacity	: 171.95 [Ton]	Reference	: (Sec. D)
Demand	: 10.72 [Ton]		

DESIGN FOR COMPRESSION ($\phi = 0.90$) ✓

Compression

Ratio	: 0.03	Ctrl Eq.	: C6 at 0.00%
Capacity	: 156.29 [Ton]	Reference	: (Sec. E)
Demand	: -4.54 [Ton]		

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (ϕ_w)	--	33.42	(Sec. B4)
Limiting slenderness parameter for non-compact web (ϕ_{rw})	--	42.29	(Sec. B4)
Slenderness parameter for flange (ϕ_f)	--	7.78	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ_{rf})	--	15.89	(Sec. B4)
Elastic flexural stress (Fex)	[Ton/cm ²]	77.25	(Eq. E4-9)
Elastic flexural stress (Fey)	[Ton/cm ²]	11.10	(Ec. E4-10)
Elastic torsional buckling stress (Fex)	[Ton/cm ²]	14.16	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (Fe)	[Ton/cm ²]	14.16	(Sec. E4)
Critical flexural buckling stress (Fcr)	[Ton/cm ²]	2.30	(Sec. E)
Critical flexural-torsional buckling stress (FcrTor)	[Ton/cm ²]	2.35	(Sec. E4)

Stress reduction factor in unstiffened elements (Qs)	--	1.00	(Sec.E7)
Effective section reduction factor in stiffened elements (Qa) (Sec.E7)		--	1.00
Effective area at a uniform stress (Aeff)	[cm2]	75.48	(Sec.E7)

DESIGN FOR TORSION ($\phi = 0.90$) ✓

Torsion

Ratio	: 0.00	Ctrl Eq.	: C8 at 0.00%
Capacity	: 0.36 [Ton*m]	Reference	: (Sec. H3)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
Critical stress (Fcr)	[Ton/cm2]	1.52	(Sec. H)

INTERACTION ✓

Combined axial and flexure interaction value

Ratio	: 0.65		
Ctrl Eq.	: C7 at 0.00%	Reference	: (H1-1b)

Combined shear and torsion interaction value

Ratio	: 0.33		
Ctrl Eq.	: C7 at 0.00%	Reference	: (Ec. 4.9) DG 9

CRITICAL STRENGTH RATIO ✓

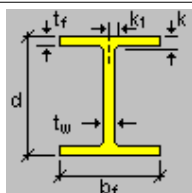
Ratio	: 0.65		
Ctrl Eq.	: C7 at 0.00%	Reference	: (H1-1b)

VIGAS VM2:

Member	: 196 (VArriostr hor 2)
Design status	: OK

PROPERTIES

Section : W 8X31



Width (bf)	20.32	[cm]
Depth (d)	20.32	[cm]
Distance k (k)	2.11	[cm]
Distance k1 (k1)	1.90	[cm]
Flange thickness (tf)	1.10	[cm]
Web thickness (tw)	0.72	[cm]

Section properties	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	58.81	
Moment of Inertia (local axes) (I)	[cm ⁴]	4577.23	1545.62
Moment of Inertia (principal axes) (I')	[cm ⁴]	4577.23	1545.62
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	8.82	5.13
Radius of gyration (principal axes) (r')	[cm]	8.82	5.13
Saint-Venant torsion constant (J)	[cm ⁴]	20.70	
Warping constant of the cross-section (Cw)	[cm ⁶]	142611.20	
Distance from centroid to shear center (principal axis) (xo, yo)	[cm]		0.00
0.00			
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	450.52	152.13
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		450.52
152.13			
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]		450.52
152.13			
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]		450.52
152.13			
Plastic section modulus (local axis) (Z)	[cm ³]	498.22	228.10
Plastic section modulus (principal axis) (Z')	[cm ³]	498.22	228.10
Polar radius of gyration (ro)	[cm]	10.20	
Area for shear (Aw)	[cm ²]	44.90	13.91
Torsional modulus (1/C)	--	0.05	

Material : A36

Properties	Unit	Value
Yield stress (Fy):	[Ton/cm ²]	2.53
Tensile strength (Fu):	[Ton/cm ²]	4.08
Elasticity Modulus (E):	[Ton/cm ²]	2038.89
Shear modulus for steel (G):	[Ton/cm ²]	809.08

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Top unbraced length between lateral supports (LbTop)	[m]	4.60	

Bottom unbraced length between lateral supports (LbBop)	[m]	4.60	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	4.60	
Unbraced compression length (Lx, Ly)	[m]	4.60	4.60
Length for torsion and lateral-torsional buckling	[m]	4.60	

Additional hypotheses

Continuous lateral torsional restraint	No
Tension field action	No

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Tension				
Maximum geometric slenderness (L/r)	--	89.73		(Sec. D1)
Compression				
Geometric critical slenderness (KL/r)	--	89.73		(Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$)

Bending about major axis, M33

Ratio	: 0.25		
Capacity	: 11.35 [Ton*m]	Ctrl Eq.	: C6 at 100.00%
Demand	: -2.89 [Ton*m]	Reference	: (Sec. F)

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	12.61	(Sec. F)
<u>Lateral-torsional buckling (LTB Mn)</u>	[Ton*m]	12.61	(Sec. F)
Limiting unbraced length for yielding (Lp)	[m]	2.56	(Sec. F)
Limiting unbraced length for inelastic LTB (Lr)	[m]	9.71	(Sec. F)
Modification factor for lateral-torsional buckling (Cb)	--	2.30	(Sec. F1)
Lateral-torsional factor (c)	--	1.00	(Sec. F2.2)
Calculated stress for nominal flexural strength (FL)	[Ton/cm2]	1.77	(Sec. F4.2)
Radius of gyration of the flange (rt)	[cm]	5.84	(Sec. F4.2)
Effective radius of gyration (rts)	[cm]	5.74	(Sec. F2.2)
Web area ratio (aw)	--	0.58	(Sec. F4.2)
Web plastification factor (Rpc)	--	1.11	(Sec. F4.1)
Critical stress (Fcr)	[Ton/cm2]	10.68	(Sec. F)
Slenderness parameter for web (λ)	--	22.25	(Sec. B4)
Limiting slenderness parameter for compact (λ_p)	--	106.72	(Sec. B4)
Limiting slenderness parameter for non-compact web (λ_r)	--	161.78	(Sec. B4)
<u>Web local buckling (WLB Mn)</u>	--	N/A	(Sec. F)

Local buckling (LB Mn)	--	N/A	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	9.20	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	--	28.38 (Sec. B4)
Tension flange yielding (TFY Mn)	--	N/A	(Sec. F)

Bending about minor axis, M22

Ratio	: 0.08	Ctrl Eq.	: C7 at 100.00%
Capacity	: 5.20 [Ton*m]	Reference	: (Sec. F)
Demand	: -0.41 [Ton*m]		

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	5.77	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	9.20	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	--	28.38 (Sec. B4)

DESIGN FOR SHEAR



Shear parallel to major axis, V3 ($\phi = 0.90$)

Ratio	: 0.00	Ctrl Eq.	: C7 at 0.00%
Capacity	: 61.37 [Ton]	Reference	: (Sec. G)
Demand	: -0.15 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	1.20	(Sec. G2)

Shear parallel to major axis, V2 ($\phi = 1.00$)

Ratio	: 0.06	Ctrl Eq.	: C7 at 0.00%
Capacity	: 21.12 [Ton]	Reference	: (Sec. G)
Demand	: -1.22 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\lambda = 0.90$) ✓

Tension

Ratio	: 0.00	Ctrl Eq.	: C7 at 0.00%
Capacity	: 133.97 [Ton]	Reference	: (Sec. D)
Demand	: 0.63 [Ton]		

DESIGN FOR COMPRESSION ($\lambda = 0.90$) ✓

Compression

Ratio	: 0.00	Ctrl Eq.	: C1 at 0.00%
Capacity	: 87.68 [Ton]	Reference	: (Sec. E)
Demand	: 0.19 [Ton]		

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (λ_w)	--	22.25	(Sec. B4)
Limiting slenderness parameter for non-compact web (λ_{rw})	--	42.29	(Sec. B4)
Slenderness parameter for flange (λ_f)	--	9.20	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_{rf})	--	15.89	(Sec. B4)
Elastic flexural stress (F_{ex})	[Ton/cm ²]	7.40	(Eq. E4-9)
Elastic flexural stress (F_{ey})	[Ton/cm ²]	2.50	(Ec. E4-10)
Elastic torsional buckling stress (F_{ez})	[Ton/cm ²]	4.95	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (F_e)	[Ton/cm ²]	4.95	(Sec. E4)
Critical flexural buckling stress (F_{cr})	[Ton/cm ²]	1.66	(Sec. E)
Critical flexural-torsional buckling stress (F_{crTor})	[Ton/cm ²]	2.04	(Sec. E4)
Stress reduction factor in unstiffened elements (Q_s)	--	1.00	(Sec. E7)
Effective section reduction factor in stiffened elements (Q_a)	--	1.00	(Sec. E7)
Effective area at a uniform stress (A_{eff})	[cm ²]	58.81	(Sec. E7)

DESIGN FOR TORSION ($\lambda = 0.90$) ✓

Torsion

Ratio	: 0.00	Ctrl Eq.	: C9 at 0.00%
Capacity	: 0.26 [Ton*m]	Reference	: (Sec. H3)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
Critical stress (F_{cr})	[Ton/cm ²]	1.52	(Sec. H)

INTERACTION ✓

Combined axial and flexure interaction value

Ratio : 0.32
Ctrl Eq. : C7 at 100.00% Reference : (H1-1b)

Combined shear and torsion interaction value

Ratio : 0.06
Ctrl Eq. : C7 at 0.00% Reference : (Ec. 4.9) DG 9

CRITICAL STRENGTH RATIO



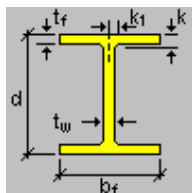
Ratio : 0.32
Ctrl Eq. : C7 at 100.00% Reference : (H1-1b)

VIGAS VM3:

Member : 547 (VArriostr hor ref)
Design status : OK

PROPERTIES

Section : W 12X40



Width (bf) 20.35 [cm]
Depth (d) 30.23 [cm]
Distance k (k) 2.59 [cm]
Distance k1 (k1) 2.22 [cm]
Flange thickness (tf) 1.31 [cm]
Web thickness (tw) 0.75 [cm]

Section properties

	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	75.48	
Moment of Inertia (local axes) (I)	[cm ⁴]	12778.30	1835.58
Moment of Inertia (principal axes) (I')	[cm ⁴]	12778.30	1835.58
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	13.01	4.93
Radius of gyration (principal axes) (r')	[cm]	13.01	4.93
Saint-Venant torsion constant (J)	[cm ⁴]	37.71	
Warping constant of the cross-section (Cw)	[cm ⁶]	386691.60	
Distance from centroid to shear center (principal axis) (xo, yo)	[cm]		0.00
0.00			

Top elastic section modulus of the section (local axis) (S top) [cm ³]	843.93	180.26
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]	843.93
180.26		
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]	843.93
180.26		
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]	843.93
180.26		
Plastic section modulus (local axis) (Z)	[cm ³]	934.06
Plastic section modulus (principal axis) (Z')	[cm ³]	934.06
Polar radius of gyration (ro)	[cm]	13.91
Area for shear (Aw)	[cm ²]	53.23
Torsional modulus (1/C)	--	0.04
		22.65

Material : A36

Properties	Unit	Value
Yield stress (Fy):	[Ton/cm ²]	2.53
Tensile strength (Fu):	[Ton/cm ²]	4.08
Elasticity Modulus (E):	[Ton/cm ²]	2038.89
Shear modulus for steel (G):	[Ton/cm ²]	809.08

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Top unbraced length between lateral supports (LbTop)	[m]	3.90	
Bottom unbraced length between lateral supports (LbBop)	[m]	3.90	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	3.90	
Unbraced compression length (Lx, Ly)	[m]	3.90	3.90
Length for torsion and lateral-torsional buckling	[m]	3.90	
Additional hypotheses			
Continuous lateral torsional restraint		No	
Tension field action		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Tension				
Maximum geometric slenderness (L/r)	--	79.09		(Sec. D1)
Compression				
Geometric critical slenderness (KL/r)	--	79.09		(Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$) ✓

Bending about major axis, M33

Ratio	: 0.21	Ctrl Eq.	: C9 at 100.00%
Capacity	: 21.28 [Ton*m]	Reference	: (Sec. F)
Demand	: 4.37 [Ton*m]		

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	23.64	(Sec. F)
<u>Lateral-torsional buckling (LTB Mn)</u>	[Ton*m]	23.64	(Sec. F)
Limiting unbraced length for yielding (Lp)	[m]	2.46	(Sec. F)
Limiting unbraced length for inelastic LTB (Lr)	[m]	8.25	(Sec. F)
Modification factor for lateral-torsional buckling (Cb)	--	1.97	(Sec. F1)
Lateral-torsional factor (c)	--	1.00	(Sec. F2.2)
Calculated stress for nominal flexural strength (FL)	[Ton/cm2]	1.77	(Sec. F4.2)
Radius of gyration of the flange (rt)	[cm]	5.73	(Sec. F4.2)
Effective radius of gyration (rts)	[cm]	5.62	(Sec. F2.2)
Web area ratio (aw)	--	0.78	(Sec. F4.2)
Web plastification factor (Rpc)	--	1.11	(Sec. F4.1)
Critical stress (Fcr)	[Ton/cm2]	10.36	(Sec. F)
Slenderness parameter for web (ϕ)	--	33.42	(Sec. B4)
Limiting slenderness parameter for compact (ϕ p)	--	106.72	(Sec. B4)
Limiting slenderness parameter for non-compact web (ϕ r)	--	161.78	(Sec. B4)
<u>Web local buckling (WLB Mn)</u>	--	N/A	(Sec. F)
<u>Local buckling (LB Mn)</u>	--	N/A	(Sec. F)
<u>Flange local buckling (FLB Mn)</u>	--	N/A	(Sec. F)
Slenderness parameter for flange (ϕ)	--	7.78	(Sec. B4)
Limiting slenderness parameter for compact flange (ϕ p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ r)	--	--	28.38 (Sec. B4)
<u>Tension flange yielding (TFY Mn)</u>	--	N/A	(Sec. F)

Bending about minor axis, M22

Ratio	: 0.22	Ctrl Eq.	: C7 at 100.00%
Capacity	: 6.27 [Ton*m]	Reference	: (Sec. F)
Demand	: -1.40 [Ton*m]		

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	6.97	(Sec. F)
<u>Flange local buckling (FLB Mn)</u>	--	N/A	(Sec. F)
Slenderness parameter for flange (ϕ)	--	7.78	(Sec. B4)
Limiting slenderness parameter for compact flange (ϕ p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ r)	--	--	28.38 (Sec. B4)

DESIGN FOR SHEAR



Shear parallel to major axis, V3 ($\phi = 0.90$)

Ratio	: 0.01	Ctrl Eq.	: C7 at 0.00%
Capacity	: 72.75 [Ton]	Reference	: (Sec. G)
Demand	: -0.50 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	1.20	(Sec. G2)

Shear parallel to major axis, V2 ($\phi = 1.00$)

Ratio	: 0.05	Ctrl Eq.	: C9 at 0.00%
Capacity	: 34.39 [Ton]	Reference	: (Sec. G)
Demand	: -1.58 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\phi = 0.90$)



Tension

Ratio	: 0.06	Ctrl Eq.	: C8 at 0.00%
Capacity	: 171.95 [Ton]	Reference	: (Sec. D)
Demand	: 9.86 [Ton]		

DESIGN FOR COMPRESSION ($\phi = 0.90$)



Compression

Ratio	: 0.07	Ctrl Eq.	: C9 at 0.00%
Capacity	: 123.71 [Ton]	Reference	: (Sec. E)
Demand	: -8.91 [Ton]		

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (ϕ_w)	--	33.42	(Sec. B4)
Limiting slenderness parameter for non-compact web (ϕ_{rw})	--	42.29	(Sec. B4)
Slenderness parameter for flange (ϕ_f)	--	7.78	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ_{rf})	--	15.89	(Sec. B4)

Elastic flexural stress (Fex)	[Ton/cm2]	22.40	(Eq. E4-9)
Elastic flexural stress (Fey)	[Ton/cm2]	3.22	(Ec. E4-10)
Elastic torsional buckling stress (Fez)	[Ton/cm2]	5.59	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (Fe)	[Ton/cm2]	5.59	(Sec.E4)
Critical flexural buckling stress (Fcr)	[Ton/cm2]	1.82	(Sec.E)
Critical flexural-torsional buckling stress (FcrTor)	[Ton/cm2]	2.09	(Sec.E4)
Stress reduction factor in unstiffened elements (Qs)	--	1.00	(Sec.E7)
Effective section reduction factor in stiffened elements (Qa) (Sec.E7)	--	1.00	
Effective area at a uniform stress (Aeff)	[cm2]	75.48	(Sec.E7)

DESIGN FOR TORSION ($\phi = 0.90$) ✓

Torsion

Ratio	: 0.01	Ctrl Eq.	: C7 at 0.00%
Capacity	: 0.36 [Ton*m]	Reference	: (Sec. H3)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
Critical stress (Fcr)	[Ton/cm2]	1.52	(Sec. H)

INTERACTION ✓

Combined axial and flexure interaction value

Ratio	: 0.30	Reference	: (H1-1b)
Ctrl Eq.	: C7 at 100.00%		

Combined shear and torsion interaction value

Ratio	: 0.05	Reference	: (Ec. 4.9) DG 9
Ctrl Eq.	: C9 at 0.00%		

CRITICAL STRENGTH RATIO ✓

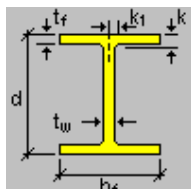
Ratio	: 0.30	Reference	: (H1-1b)
Ctrl Eq.	: C7 at 100.00%		

VIGAS VM4:

Member	: 256 (V Cub)
Design status	: OK

PROPERTIES

Section : W 12X40



Width (bf)	20.35	[cm]
Depth (d)	30.23	[cm]
Distance k (k)	2.59	[cm]
Distance k1 (k1)	2.22	[cm]
Flange thickness (tf)	1.31	[cm]
Web thickness (tw)	0.75	[cm]

Section properties

	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	75.48	
Moment of Inertia (local axes) (I)	[cm ⁴]	12778.30	1835.58
Moment of Inertia (principal axes) (I')	[cm ⁴]	12778.30	1835.58
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	13.01	4.93
Radius of gyration (principal axes) (r')	[cm]	13.01	4.93
Saint-Venant torsion constant (J)	[cm ⁴]	37.71	
Warping constant of the cross-section (Cw)	[cm ⁶]	386691.60	
Distance from centroid to shear center (principal axis) (xo, yo)	[cm]		0.00
0.00			
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	843.93	180.26
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		843.93
180.26			
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]		843.93
180.26			
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]		843.93
180.26			
Plastic section modulus (local axis) (Z)	[cm ³]	934.06	275.30
Plastic section modulus (principal axis) (Z')	[cm ³]	934.06	275.30
Polar radius of gyration (ro)	[cm]	13.91	
Area for shear (Aw)	[cm ²]	53.23	22.65
Torsional modulus (1/C)	--	0.04	

Material : A36

Properties	Unit	Value
Yield stress (Fy):	[Ton/cm ²]	2.53
Tensile strength (Fu):	[Ton/cm ²]	4.08
Elasticity Modulus (E):	[Ton/cm ²]	2038.89
Shear modulus for steel (G):	[Ton/cm ²]	809.08

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Top unbraced length between lateral supports (LbTop)	[m]	1.04	
Bottom unbraced length between lateral supports (LbBop)	[m]	1.04	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	1.04	
Unbraced compression length (Lx, Ly)	[m]	1.04	1.04
Length for torsion and lateral-torsional buckling	[m]	1.04	
Additional hypotheses			
Continuous lateral torsional restraint		No	
Tension field action		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Tension				
Maximum geometric slenderness (L/r)	--	21.02		(Sec. D1)
Compression				
Geometric critical slenderness (KL/r)	--	21.02		(Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$) ✓

Bending about major axis, M33

Ratio	: 0.29		
Capacity	: 21.28 [Ton*m]	Ctrl Eq.	: C8 at 100.00%
Demand	: -6.26 [Ton*m]	Reference	: (Sec. F)

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	23.64	(Sec. F)
<u>Lateral-torsional buckling (LTB Mn)</u>	--	N/A	(Sec. F)
Limiting unbraced length for yielding (Lp)	[m]	2.46	(Sec. F)
Limiting unbraced length for inelastic LTB (Lr)	[m]	8.25	(Sec. F)
<u>Web local buckling (WLB Mn)</u>	--	N/A	(Sec. F)
<u>Local buckling (LB Mn)</u>	--	N/A	(Sec. F)
<u>Flange local buckling (FLB Mn)</u>	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	7.78	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	28.38	(Sec. B4)

Tension flange yielding (TFY Mn) -- N/A (Sec. F)

Bending about minor axis, M22

Ratio : 0.15
Capacity : 6.27 [Ton*m]
Demand : -0.94 [Ton*m]

Ctrl Eq. : C8 at 100.00%
Reference : (Sec. F)

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	6.97	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	7.78	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	28.38	(Sec. B4)

B4)

DESIGN FOR SHEAR



Shear parallel to major axis, V3 ($\lambda = 0.90$)

Ratio : 0.02
Capacity : 72.75 [Ton]
Demand : -1.19 [Ton]

Ctrl Eq. : C8 at 0.00%
Reference : (Sec. G)

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	1.20	(Sec. G2)

Shear parallel to major axis, V2 ($\lambda = 1.00$)

Ratio : 0.10
Capacity : 34.39 [Ton]
Demand : 3.33 [Ton]

Ctrl Eq. : C4 at 100.00%
Reference : (Sec. G)

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\lambda = 0.90$)



Tension

Ratio : 0.00
Capacity : 171.95 [Ton]

Ctrl Eq. : C1 at 0.00%

Demand : -3.54 [Ton]

Reference : (Sec. D)

DESIGN FOR COMPRESSION ($\phi = 0.90$) ✓

Compression

Ratio : 0.08

Capacity : 167.99 [Ton]

Demand : -13.21 [Ton]

Ctrl Eq. : C9 at 100.00%

Reference : (Sec. E)

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (λ_w)	--	33.42	(Sec. B4)
Limiting slenderness parameter for non-compact web (λ_{rw})	--	42.29	(Sec. B4)
Slenderness parameter for flange (λ_f)	--	7.78	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_{rf})	--	15.89	(Sec. B4)
Elastic flexural stress (F_{ex})	[Ton/cm ²]	317.06	(Eq. E4-9)
Elastic flexural stress (F_{ey})	[Ton/cm ²]	45.55	(Eq. E4-10)
Elastic torsional buckling stress (F_{ez})	[Ton/cm ²]	51.65	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (F_e)	[Ton/cm ²]	51.65	(Sec. E4)
Critical flexural buckling stress (F_{cr})	[Ton/cm ²]	2.47	(Sec. E)
Critical flexural-torsional buckling stress (F_{crTor})	[Ton/cm ²]	2.48	(Sec. E4)
Stress reduction factor in unstiffened elements (Q_s)	--	1.00	(Sec. E7)
Effective section reduction factor in stiffened elements (Q_a)	--	1.00	(Sec. E7)
Effective area at a uniform stress (A_{eff})	[cm ²]	75.48	(Sec. E7)

DESIGN FOR TORSION ($\phi = 0.90$) ✓

Torsion

Ratio : 0.02

Capacity : 0.36 [Ton*m]

Demand : -0.01 [Ton*m]

Ctrl Eq. : C7 at 0.00%

Reference : (Sec. H3)

Intermediate results	Unit	Value	Reference
Critical stress (F_{cr})	[Ton/cm ²]	1.52	(Sec. H)

INTERACTION ✓

Combined axial and flexure interaction value

Ratio : 0.47

Ctrl Eq. : C8 at 100.00%

Reference : (H1-1b)

Combined shear and torsion interaction value

Ratio : 0.12
Ctrl Eq. : C8 at 100.00% Reference : (Ec. 4.9) DG 9

CRITICAL STRENGTH RATIO



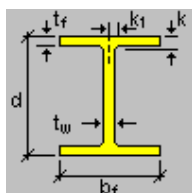
Ratio : 0.47
Ctrl Eq. : C8 at 100.00% Reference : (H1-1b)

VIGAS VM5:

Member : 382 (V Cub 2)
Design status : OK

PROPERTIES

Section : W 8X31



Width (bf) 20.32 [cm]
Depth (d) 20.32 [cm]
Distance k (k) 2.11 [cm]
Distance k1 (k1) 1.90 [cm]
Flange thickness (tf) 1.10 [cm]
Web thickness (tw) 0.72 [cm]

Section properties

	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	58.81	
Moment of Inertia (local axes) (I)	[cm ⁴]	4577.23	1545.62
Moment of Inertia (principal axes) (I')	[cm ⁴]	4577.23	1545.62
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	8.82	5.13
Radius of gyration (principal axes) (r')	[cm]	8.82	5.13
Saint-Venant torsion constant (J)	[cm ⁴]	20.70	
Warping constant of the cross-section (Cw)	[cm ⁶]	142611.20	
Distance from centroid to shear center (principal axis) (xo, yo)	[cm]		0.00
0.00			
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	450.52	152.13
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		450.52
152.13			
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]		450.52
152.13			

Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]	450.52
152.13		
Plastic section modulus (local axis) (Z)	[cm ³]	498.22
Plastic section modulus (principal axis) (Z')	[cm ³]	498.22
Polar radius of gyration (ro)	[cm]	10.20
Area for shear (Aw)	[cm ²]	44.90
Torsional modulus (1/C)	--	0.05

Material : A36

Properties	Unit	Value
Yield stress (Fy):	[Ton/cm ²]	2.53
Tensile strength (Fu):	[Ton/cm ²]	4.08
Elasticity Modulus (E):	[Ton/cm ²]	2038.89
Shear modulus for steel (G):	[Ton/cm ²]	809.08

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Top unbraced length between lateral supports (LbTop)	[m]	0.98	
Bottom unbraced length between lateral supports (LbBop)	[m]	0.98	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	0.98	
Unbraced compression length (Lx, Ly)	[m]	0.98	0.98
Length for torsion and lateral-torsional buckling	[m]	0.98	
Additional hypotheses			
Continuous lateral torsional restraint		No	
Tension field action		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Tension				
Maximum geometric slenderness (L/r)	--	19.17		(Sec. D1)
Compression				
Geometric critical slenderness (KL/r)	--	19.17		(Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$) ✓

Bending about major axis, M33

Ratio : 0.33
Capacity : 11.35 [Ton*m]
Demand : -3.74 [Ton*m]

Ctrl Eq. : C8 at 100.00%
Reference : (Sec. F)

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	12.61	(Sec. F)
Lateral-torsional buckling (LTB Mn)	--	N/A	(Sec. F)
Limiting unbraced length for yielding (Lp)	[m]	2.56	(Sec. F)
Limiting unbraced length for inelastic LTB (Lr)	[m]	9.71	(Sec. F)
Web local buckling (WLB Mn)	--	N/A	(Sec. F)
Local buckling (LB Mn)	--	N/A	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	9.20	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	28.38	(Sec. B4)
Tension flange yielding (TFY Mn)	--	N/A	(Sec. F)

Bending about minor axis, M22

Ratio : 0.08
Capacity : 5.20 [Ton*m]
Demand : -0.44 [Ton*m]

Ctrl Eq. : C7 at 100.00%
Reference : (Sec. F)

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	5.77	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	9.20	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	28.38	(Sec. B4)

DESIGN FOR SHEAR



Shear parallel to major axis, V3 ($\phi = 0.90$)

Ratio : 0.00
Capacity : 61.37 [Ton]
Demand : -0.24 [Ton]

Ctrl Eq. : C4 at 0.00%
Reference : (Sec. G)

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	1.20	(Sec. G2)

Shear parallel to major axis, V2 ($\phi = 1.00$)

Ratio	: 0.08	Ctrl Eq.	: C8 at 100.00%
Capacity	:21.12 [Ton]	Reference	: (Sec. G)
Demand	: 1.78 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\phi = 0.90$) ✓

Tension

Ratio	: 0.00	Ctrl Eq.	: C1 at 0.00%
Capacity	:133.97 [Ton]	Reference	: (Sec. D)
Demand	:-0.57 [Ton]		

DESIGN FOR COMPRESSION ($\phi = 0.90$) ✓

Compression

Ratio	: 0.02	Ctrl Eq.	: C4 at 100.00%
Capacity	:131.23 [Ton]	Reference	: (Sec. E)
Demand	:-2.18 [Ton]		

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (ϕ_w)	--	22.25	(Sec. B4)
Limiting slenderness parameter for non-compact web (ϕ_{rw})	--	42.29	(Sec. B4)
Slenderness parameter for flange (ϕ_f)	--	9.20	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ_{rf})	--	15.89	(Sec. B4)
Elastic flexural stress (Fex)	[Ton/cm ²]	162.24	(Eq. E4-9)
Elastic flexural stress (Fey)	[Ton/cm ²]	54.78	(Ec. E4-10)
Elastic torsional buckling stress (Fez)	[Ton/cm ²]	51.29	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (Fe)	[Ton/cm ²]	51.29	(Sec.E4)
Critical flexural buckling stress (Fcr)	[Ton/cm ²]	2.48	(Sec.E)
Critical flexural-torsional buckling stress (FcrTor)	[Ton/cm ²]	2.48	(Sec.E4)
Stress reduction factor in unstiffened elements (Qs)	--	1.00	(Sec.E7)
Effective section reduction factor in stiffened elements (Qa)	--	1.00	(Sec.E7)
Effective area at a uniform stress (Aeff)	[cm ²]	58.81	(Sec.E7)

DESIGN FOR TORSION ($\phi = 0.90$) ✓

Torsion

Ratio : 0.03
Capacity : 0.26 [Ton*m]
Demand : -0.01 [Ton*m]

Ctrl Eq. : C7 at 0.00%
Reference : (Sec. H3)

Intermediate results	Unit	Value	Reference
Critical stress (Fcr)	[Ton/cm ²]	1.52	(Sec. H)

INTERACTION



Combined axial and flexure interaction value

Ratio : 0.37
Ctrl Eq. : C8 at 100.00% Reference : (H1-1b)

Combined shear and torsion interaction value

Ratio : 0.11
Ctrl Eq. : C8 at 100.00% Reference : (Ec. 4.9) DG 9

CRITICAL STRENGTH RATIO



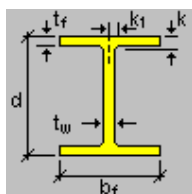
Ratio : 0.37
Ctrl Eq. : C8 at 100.00% Reference : (H1-1b)

COLUMNAS CM1:

Member : 12 (COLS)
Design status : OK

PROPERTIES

Section : W 12X72



Width (bf) : 30.48 [cm]
Depth (d) : 31.24 [cm]
Distance k (k) : 3.23 [cm]
Distance k1 (k1) : 2.70 [cm]

Flange thickness (tf)	1.70 [cm]
Web thickness (tw)	1.09 [cm]

Section properties	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	136.13	
Moment of Inertia (local axes) (I)	[cm ⁴]	24849.01	8116.51
Moment of Inertia (principal axes) (I')	[cm ⁴]	24849.01	8116.51
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	13.51	7.72
Radius of gyration (principal axes) (r')	[cm]	13.51	7.72
Saint-Venant torsion constant (J)	[cm ⁴]	121.96	
Warping constant of the cross-section (Cw)	[cm ⁶]	1756224.00	
Distance from centroid to shear center (principal axis) (xo, yo)		[cm]	0.00
0.00			
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	1596.10	530.94
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		1596.10
530.94			
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]		1596.10
530.94			
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]		1596.10
530.94			
Plastic section modulus (local axis) (Z)	[cm ³]	1769.80	806.24
Plastic section modulus (principal axis) (Z')	[cm ³]	1769.80	806.24
Polar radius of gyration (ro)	[cm]	15.56	
Area for shear (Aw)	[cm ²]	103.74	34.13
Torsional modulus (1/C)	--	0.02	

Material : A36

Properties	Unit	Value
Yield stress (Fy):	[Ton/cm ²]	2.53
Tensile strength (Fu):	[Ton/cm ²]	4.08
Elasticity Modulus (E):	[Ton/cm ²]	2038.89
Shear modulus for steel (G):	[Ton/cm ²]	809.08

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Top unbraced length between lateral supports (LbTop)	[m]	2.65	
Bottom unbraced length between lateral supports (LbBop)	[m]	2.65	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	2.65	
Unbraced compression length (Lx, Ly)	[m]	2.65	2.65
Length for torsion and lateral-torsional buckling	[m]	2.65	
Additional hypotheses			
Continuous lateral torsional restraint		No	
Tension field action		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Tension				
Maximum geometric slenderness (L/r)	--	34.32		(Sec. D1)
Compression				
Geometric critical slenderness (KL/r)	--	34.32		(Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$) ✓

Bending about major axis, M33

Ratio	: 0.93		
Capacity	: 40.31 [Ton*m]	Ctrl Eq.	: C6 at 0.00%
Demand	: -37.41 [Ton*m]	Reference	: (Sec. F)

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	44.79	(Sec. F)
<u>Lateral-torsional buckling (LTB Mn)</u>	--	N/A	(Sec. F)
Limiting unbraced length for yielding (Lp)	[m]	3.86	(Sec. F)
Limiting unbraced length for inelastic LTB (Lr)	[m]	15.06	(Sec. F)
<u>Web local buckling (WLB Mn)</u>	--	N/A	(Sec. F)
<u>Local buckling (LB Mn)</u>	--	N/A	(Sec. F)
<u>Flange local buckling (FLB Mn)</u>	--	N/A	(Sec. F)
Slenderness parameter for flange (ϕ)	--	8.96	(Sec. B4)
Limiting slenderness parameter for compact flange (ϕ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ_r)	--	--	28.38 (Sec. B4)
<u>Tension flange yielding (TFY Mn)</u>	--	N/A	(Sec. F)

Bending about minor axis, M22

Ratio	: 0.36		
Capacity	: 18.37 [Ton*m]	Ctrl Eq.	: C8 at 0.00%
Demand	: 6.65 [Ton*m]	Reference	: (Sec. F)

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	20.41	(Sec. F)
<u>Flange local buckling (FLB Mn)</u>	--	N/A	(Sec. F)
Slenderness parameter for flange (ϕ)	--	8.96	(Sec. B4)
Limiting slenderness parameter for compact flange (ϕ_p)	--	10.79	(Sec. B4)

Limiting slenderness parameter for non-compact flange (λ_r)	--	28.38 (Sec. B4)
---	----	-----------------

DESIGN FOR SHEAR ✓

Shear parallel to major axis, V3 ($\phi = 0.90$)

Ratio	: 0.02	Ctrl Eq.	: C8 at 0.00%
Capacity	:141.79 [Ton]	Reference	: (Sec. G)
Demand	: -3.51 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	1.20	(Sec. G2)

Shear parallel to major axis, V2 ($\phi = 1.00$)

Ratio	: 0.35	Ctrl Eq.	: C6 at 0.00%
Capacity	:51.83 [Ton]	Reference	: (Sec. G)
Demand	: -18.35 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\phi = 0.90$) ✓

Tension

Ratio	: 0.10	Ctrl Eq.	: C6 at 100.00%
Capacity	:310.09 [Ton]	Reference	: (Sec. D)
Demand	:30.50 [Ton]		

DESIGN FOR COMPRESSION ($\phi = 0.90$) ✓

Compression

Ratio	: 0.12	Ctrl Eq.	: C7 at 0.00%
Capacity	:291.45 [Ton]	Reference	: (Sec. E)
Demand	: -35.55 [Ton]		

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (λ_w)	--	22.70	(Sec. B4)
Limiting slenderness parameter for non-compact web (λ_{rw})	--	42.29	(Sec. B4)

Slenderness parameter for flange (λ_f)	--	8.96	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_{rf})	--	15.89	(Sec. B4)
Elastic flexural stress (F_{ex})	[Ton/cm ²]	52.31	(Eq. E4-9)
Elastic flexural stress (F_{ey})	[Ton/cm ²]	17.09	(Ec. E4-10)
Elastic torsional buckling stress (F_{ez})	[Ton/cm ²]	18.26	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (F_e)	[Ton/cm ²]	18.26	(Sec. E4)
Critical flexural buckling stress (F_{cr})	[Ton/cm ²]	2.38	(Sec. E)
Critical flexural-torsional buckling stress (F_{crTor})	[Ton/cm ²]	2.39	(Sec. E4)
Stress reduction factor in unstiffened elements (Q_s)	--	1.00	(Sec. E7)
Effective section reduction factor in stiffened elements (Q_a)	--	1.00	(Sec. E7)
Effective area at a uniform stress (A_{eff})	[cm ²]	136.13	(Sec. E7)

DESIGN FOR TORSION ($\phi = 0.90$) ✓

Torsion

Ratio	: 0.00	Ctrl Eq.	: C7 at 0.00%
Capacity	: 0.91 [Ton*m]	Reference	: (Sec. H3)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
Critical stress (F_{cr})	[Ton/cm ²]	1.52	(Sec. H)

INTERACTION ✓

Combined axial and flexure interaction value

Ratio	: 0.98	Reference	: (H1-1b)
Ctrl Eq.	: C6 at 0.00%		

Combined shear and torsion interaction value

Ratio	: 0.36	Reference	: (Ec. 4.9) DG 9
Ctrl Eq.	: C6 at 0.00%		

CRITICAL STRENGTH RATIO ✓

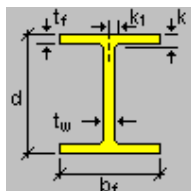
Ratio	: 0.98	Reference	: (H1-1b)
Ctrl Eq.	: C6 at 0.00%		

COLUMNAS CM2:

Member : 592 (col int)
Design status : OK

PROPERTIES

Section : W 12X40



Width (bf)	20.35	[cm]
Depth (d)	30.23	[cm]
Distance k (k)	2.59	[cm]
Distance k1 (k1)	2.22	[cm]
Flange thickness (tf)	1.31	[cm]
Web thickness (tw)	0.75	[cm]

Section properties

	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	75.48	
Moment of Inertia (local axes) (I)	[cm ⁴]	12778.30	1835.58
Moment of Inertia (principal axes) (I')	[cm ⁴]	12778.30	1835.58
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	13.01	4.93
Radius of gyration (principal axes) (r')	[cm]	13.01	4.93
Saint-Venant torsion constant (J)	[cm ⁴]	37.71	
Warping constant of the cross-section (Cw)	[cm ⁶]	386691.60	
Distance from centroid to shear center (principal axis) (xo, yo)	[cm]		0.00
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	843.93	180.26
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		843.93
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]		843.93
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]		843.93
Plastic section modulus (local axis) (Z)	[cm ³]	934.06	275.30
Plastic section modulus (principal axis) (Z')	[cm ³]	934.06	275.30
Polar radius of gyration (ro)	[cm]	13.91	
Area for shear (Aw)	[cm ²]	53.23	22.65
Torsional modulus (1/C)	--	0.04	

Material : A36

Properties	Unit	Value
Yield stress (Fy):	[Ton/cm ²]	2.53
Tensile strength (Fu):	[Ton/cm ²]	4.08
Elasticity Modulus (E):	[Ton/cm ²]	2038.89
Shear modulus for steel (G):	[Ton/cm ²]	809.08

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Top unbraced length between lateral supports (LbTop)	[m]	5.30	
Bottom unbraced length between lateral supports (LbBop)	[m]	5.30	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	5.30	
Unbraced compression length (Lx, Ly)	[m]	5.30	5.30
Length for torsion and lateral-torsional buckling	[m]	5.30	
Additional hypotheses			
Continuous lateral torsional restraint		No	
Tension field action		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Tension				
Maximum geometric slenderness (L/r)	--	107.48		(Sec. D1)
Compression				
Geometric critical slenderness (KL/r)	--	107.48		(Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$) ✓

Bending about major axis, M33

Ratio	: 0.40		
Capacity	: 21.28 [Ton*m]	Ctrl Eq.	: C9 at 0.00%
Demand	: 8.51 [Ton*m]	Reference	: (Sec. F)

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	23.64	(Sec. F)
<u>Lateral-torsional buckling (LTB Mn)</u>	[Ton*m]	23.64	(Sec. F)
Limiting unbraced length for yielding (Lp)	[m]	2.46	(Sec. F)
Limiting unbraced length for inelastic LTB (Lr)	[m]	8.25	(Sec. F)
Modification factor for lateral-torsional buckling (Cb)	--	2.25	(Sec. F1)
Lateral-torsional factor (c)	--	1.00	(Sec. F2.2)
Calculated stress for nominal flexural strength (FL)	[Ton/cm2]	1.77	(Sec. F4.2)
Radius of gyration of the flange (rt)	[cm]	5.73	(Sec. F4.2)
Effective radius of gyration (rts)	[cm]	5.62	(Sec. F2.2)

Web area ratio (aw)	--	0.78	(Sec. F4.2)
Web plastification factor (Rpc)	--	1.11	(Sec. F4.1)
Critical stress (Fcr)	[Ton/cm2]	7.49	(Sec. F)
Slenderness parameter for web (λ)	--	33.42	(Sec. B4)
Limiting slenderness parameter for compact (λ_p)	--	106.72	(Sec. B4)
Limiting slenderness parameter for non-compact web (λ_r)	--	161.78	(Sec. B4)
Web local buckling (WLB Mn)	--	N/A	(Sec. F)
Local buckling (LB Mn)	--	N/A	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	7.78	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	28.38	(Sec. B4)
Tension flange yielding (TFY Mn)	--	N/A	(Sec. F)

Bending about minor axis, M22

Ratio	: 0.10	Ctrl Eq.	: C6 at 0.00%
Capacity	: 6.27 [Ton*m]	Reference	: (Sec. F)
Demand	: -0.62 [Ton*m]		

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	6.97	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	7.78	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	28.38	(Sec. B4)

DESIGN FOR SHEAR



Shear parallel to major axis, V3 ($\phi = 0.90$)

Ratio	: 0.00	Ctrl Eq.	: C6 at 0.00%
Capacity	: 72.75 [Ton]	Reference	: (Sec. G)
Demand	: 0.12 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	1.20	(Sec. G2)

Shear parallel to major axis, V2 ($\phi = 1.00$)

Ratio	: 0.09	Ctrl Eq.	: C9 at 0.00%
Capacity	: 34.39 [Ton]	Reference	: (Sec. G)
Demand	: 3.00 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\phi = 0.90$) ✓

Tension

Ratio	: 0.04	Ctrl Eq.	: C9 at 100.00%
Capacity	: 171.95 [Ton]	Reference	: (Sec. D)
Demand	: 7.07 [Ton]		

DESIGN FOR COMPRESSION ($\phi = 0.90$) ✓

Compression

Ratio	: 0.09	Ctrl Eq.	: C8 at 0.00%
Capacity	: 93.60 [Ton]	Reference	: (Sec. E)
Demand	: -8.37 [Ton]		

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (λ_w)	--	33.42	(Sec. B4)
Limiting slenderness parameter for non-compact web (λ_{rw})	--	42.29	(Sec. B4)
Slenderness parameter for flange (λ_f)	--	7.78	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_{rf})	--	15.89	(Sec. B4)
Elastic flexural stress (Fex)	[Ton/cm ²]	12.13	(Eq. E4-9)
Elastic flexural stress (Fey)	[Ton/cm ²]	1.74	(Ec. E4-10)
Elastic torsional buckling stress (Fex)	[Ton/cm ²]	3.98	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (Fe)	[Ton/cm ²]	3.98	(Sec.E4)
Critical flexural buckling stress (Fcr)	[Ton/cm ²]	1.38	(Sec.E)
Critical flexural-torsional buckling stress (FcrTor)	[Ton/cm ²]	1.94	(Sec.E4)
Stress reduction factor in unstiffened elements (Qs)	--	1.00	(Sec.E7)
Effective section reduction factor in stiffened elements (Qa)	--	1.00	(Sec.E7)
Effective area at a uniform stress (Aeff)	[cm ²]	75.48	(Sec.E7)

DESIGN FOR TORSION ($\phi = 0.90$) ✓

Torsion

Ratio	: 0.00	Ctrl Eq.	: C8 at 0.00%
Capacity	: 0.36 [Ton*m]	Reference	: (Sec. H3)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
----------------------	------	-------	-----------

Critical stress (Fcr)	[Ton/cm ²]	1.52	(Sec. H)
-----------------------	------------------------	------	----------

INTERACTION



Combined axial and flexure interaction value

Ratio	:	0.44	
Ctrl Eq.	:	C8 at 0.00%	Reference : (H1-1b)

Combined shear and torsion interaction value

Ratio	:	0.09	
Ctrl Eq.	:	C9 at 0.00%	Reference : (Ec. 4.9) DG 9

CRITICAL STRENGTH RATIO



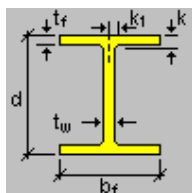
Ratio	:	0.44	
Ctrl Eq.	:	C8 at 0.00%	Reference : (H1-1b)

COLUMNAS CM3:

Member	:	199 (COLS 2)
Design status	:	OK

PROPERTIES

Section : W 12X40



Width (bf)	20.35	[cm]
Depth (d)	30.23	[cm]
Distance k (k)	2.59	[cm]
Distance k1 (k1)	2.22	[cm]
Flange thickness (tf)	1.31	[cm]
Web thickness (tw)	0.75	[cm]

Section properties

Full unreduced cross-sectional area (A)

Unit	Major axis	Minor axis
[cm ²]	75.48	

Moment of Inertia (local axes) (I)	[cm4]	12778.30	1835.58
Moment of Inertia (principal axes) (I')	[cm4]	12778.30	1835.58
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	13.01	4.93
Radius of gyration (principal axes) (r')	[cm]	13.01	4.93
Saint-Venant torsion constant (J)	[cm4]	37.71	
Warping constant of the cross-section (Cw)	[cm6]	386691.60	
Distance from centroid to shear center (principal axis) (xo, yo)	[cm]		0.00
0.00			
Top elastic section modulus of the section (local axis) (S top)	[cm3]	843.93	180.26
Bottom elastic section modulus of the section (local axis) (S bot)	[cm3]		843.93
180.26			
Top elastic section modulus of the section (principal axis) (S' top)	[cm3]		843.93
180.26			
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm3]		843.93
180.26			
Plastic section modulus (local axis) (Z)	[cm3]	934.06	275.30
Plastic section modulus (principal axis) (Z')	[cm3]	934.06	275.30
Polar radius of gyration (ro)	[cm]	13.91	
Area for shear (Aw)	[cm2]	53.23	22.65
Torsional modulus (1/C)	--	0.04	

Material : A36

Properties	Unit	Value
Yield stress (Fy):	[Ton/cm2]	2.53
Tensile strength (Fu):	[Ton/cm2]	4.08
Elasticity Modulus (E):	[Ton/cm2]	2038.89
Shear modulus for steel (G):	[Ton/cm2]	809.08

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Top unbraced length between lateral supports (LbTop)	[m]	3.75	
Bottom unbraced length between lateral supports (LbBop)	[m]	3.75	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	3.75	
Unbraced compression length (Lx, Ly)	[m]	3.75	3.75
Length for torsion and lateral-torsional buckling	[m]	3.75	
Additional hypotheses			
Continuous lateral torsional restraint		No	
Tension field action		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
--------------	------	-------	---------	-----------

Tension

Maximum geometric slenderness (L/r) -- 76.05 (Sec. D1)

Compression

Geometric critical slenderness (KL/r) -- 76.05 (Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$) ✓

Bending about major axis, M33

Ratio	: 0.39	Ctrl Eq.	: C9 at 0.00%
Capacity	: 21.28 [Ton*m]	Reference	: (Sec. F)
Demand	: 8.38 [Ton*m]		

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	23.64	(Sec. F)
<u>Lateral-torsional buckling (LTB Mn)</u>	[Ton*m]	23.64	(Sec. F)
Limiting unbraced length for yielding (Lp)	[m]	2.46	(Sec. F)
Limiting unbraced length for inelastic LTB (Lr)	[m]	8.25	(Sec. F)
Modification factor for lateral-torsional buckling (Cb)	--	2.16	(Sec. F1)
Lateral-torsional factor (c)	--	1.00	(Sec. F2.2)
Calculated stress for nominal flexural strength (FL)	[Ton/cm ²]	1.77	(Sec. F4.2)
Radius of gyration of the flange (rt)	[cm]	5.73	(Sec. F4.2)
Effective radius of gyration (rts)	[cm]	5.62	(Sec. F2.2)
Web area ratio (aw)	--	0.78	(Sec. F4.2)
Web plastification factor (Rpc)	--	1.11	(Sec. F4.1)
Critical stress (Fcr)	[Ton/cm ²]	12.12	(Sec. F)
Slenderness parameter for web (ϕ)	--	33.42	(Sec. B4)
Limiting slenderness parameter for compact (ϕ_p)	--	106.72	(Sec. B4)
Limiting slenderness parameter for non-compact web (ϕ_r)	--	161.78	(Sec. B4)
<u>Web local buckling (WLB Mn)</u>	--	N/A	(Sec. F)
<u>Local buckling (LB Mn)</u>	--	N/A	(Sec. F)
<u>Flange local buckling (FLB Mn)</u>	--	N/A	(Sec. F)
Slenderness parameter for flange (ϕ)	--	7.78	(Sec. B4)
Limiting slenderness parameter for compact flange (ϕ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ_r)	--	28.38	(Sec. B4)
<u>Tension flange yielding (TFY Mn)</u>	--	N/A	(Sec. F)

Bending about minor axis, M22

Ratio	: 0.81	Ctrl Eq.	: C7 at 0.00%
Capacity	: 6.27 [Ton*m]	Reference	: (Sec. F)
Demand	: 5.09 [Ton*m]		

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	6.97	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	7.78	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	10.79	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	--	28.38 (Sec. B4)

DESIGN FOR SHEAR



Shear parallel to major axis, V3 ($\phi = 0.90$)

Ratio	: 0.04	Ctrl Eq.	: C7 at 0.00%
Capacity	: 72.75 [Ton]	Reference	: (Sec. G)
Demand	: -2.64 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	1.20	(Sec. G2)

Shear parallel to major axis, V2 ($\phi = 1.00$)

Ratio	: 0.09	Ctrl Eq.	: C9 at 0.00%
Capacity	: 34.39 [Ton]	Reference	: (Sec. G)
Demand	: 3.23 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\phi = 0.90$)



Tension

Ratio	: 0.00	Ctrl Eq.	: C1 at 0.00%
Capacity	: 171.95 [Ton]	Reference	: (Sec. D)
Demand	: -1.31 [Ton]		

DESIGN FOR COMPRESSION ($\phi = 0.90$)



Compression

Ratio	: 0.03	Ctrl Eq.	: C9 at 0.00%
Capacity	: 126.82 [Ton]	Reference	: (Sec. E)
Demand	: -3.38 [Ton]		

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (λ_w)	--	33.42	(Sec. B4)
Limiting slenderness parameter for non-compact web (λ_{rw})	--	42.29	(Sec. B4)
Slenderness parameter for flange (λ_f)	--	7.78	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_{rf})	--	15.89	(Sec. B4)
Elastic flexural stress (F_{ex})	[Ton/cm ²]	24.22	(Eq. E4-9)
Elastic flexural stress (F_{ey})	[Ton/cm ²]	3.48	(Ec. E4-10)
Elastic torsional buckling stress (F_{ez})	[Ton/cm ²]	5.87	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (F_e)	[Ton/cm ²]	5.87	(Sec. E4)
Critical flexural buckling stress (F_{cr})	[Ton/cm ²]	1.87	(Sec. E)
Critical flexural-torsional buckling stress (F_{crTor})	[Ton/cm ²]	2.11	(Sec. E4)
Stress reduction factor in unstiffened elements (Q_s)	--	1.00	(Sec. E7)
Effective section reduction factor in stiffened elements (Q_a)	--	1.00	(Sec. E7)
Effective area at a uniform stress (A_{eff})	[cm ²]	75.48	(Sec. E7)

DESIGN FOR TORSION ($\phi = 0.90$) ✓

Torsion

Ratio	: 0.00	Ctrl Eq.	: C9 at 0.00%
Capacity	: 0.36 [Ton*m]	Reference	: (Sec. H3)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
Critical stress (F_{cr})	[Ton/cm ²]	1.52	(Sec. H)

INTERACTION ✓

Combined axial and flexure interaction value

Ratio	: 0.89	Reference	: (H1-1b)
Ctrl Eq.	: C7 at 0.00%		

Combined shear and torsion interaction value

Ratio	: 0.10	Reference	: (Ec. 4.9) DG 9
Ctrl Eq.	: C9 at 0.00%		

CRITICAL STRENGTH RATIO ✓

Ratio	: 0.89
-------	--------

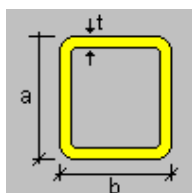
Ctrl Eq. : C7 at 0.00% Reference : (H1-1b)

RIGIDIZACION LATERAL – Diagonales d1:

Member : 90 (Diag Rig)
Design status : OK

PROPERTIES

Section : TUBO 100x100x6.35



Height (a) 10.00 [cm]
Width (b) 10.00 [cm]
Thickness (t) 0.64 [cm]

Section properties

	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	22.80	
Moment of Inertia (local axes) (I)	[cm ⁴]	324.75	324.75
Moment of Inertia (principal axes) (I')	[cm ⁴]	324.75	324.75
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	3.77	3.77
Radius of gyration (principal axes) (r')	[cm]	3.77	3.77
Saint-Venant torsion constant (J)	[cm ⁴]	534.28	
Warping constant of the cross-section (Cw)	[cm ⁶]	2.85	
Distance from centroid to shear center (principal axis) (xo, yo)	[cm]		0.00
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	64.95	64.95
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		64.95
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]		64.95
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]		64.95
Plastic section modulus (local axis) (Z)	[cm ³]	78.73	78.73
Plastic section modulus (principal axis) (Z')	[cm ³]	78.73	78.73
Polar radius of gyration (ro)	[cm]	5.34	
Area for shear (Aw)	[cm ²]	11.89	11.89
Torsional modulus (1/C)	--	0.01	

Material : Acero F22

Properties	Unit	Value
Yield stress (Fy):	[Ton/cm ²]	2.20

Tensile strength (Fu):	[Ton/cm ²]	3.75
Elasticity Modulus (E):	[Ton/cm ²]	2000.00
Shear modulus for steel (G):	[Ton/cm ²]	769.23

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Top unbraced length between lateral supports (LbTop)	[m]	3.20	
Bottom unbraced length between lateral supports (LbBop)	[m]	3.20	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	3.20	
Unbraced compression length (Lx, Ly)	[m]	3.20	3.20
Length for torsion and lateral-torsional buckling	[m]	3.20	
Additional hypotheses			
Continuous lateral torsional restraint		No	
Tension field action		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Tension				
Maximum geometric slenderness (L/r)	--	84.88		(Sec. D1)
Compression				
Geometric critical slenderness (KL/r)	--	84.88		(Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$)

Bending about major axis, M33

Ratio	: 0.01	Ctrl Eq.	: C1 at 50.00%
Capacity	: 1.56 [Ton*m]	Reference	: (Sec. F)
Demand	: 0.02 [Ton*m]		

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	1.73	(Sec. F)
Lateral-torsional buckling (LTB Mn)	--	N/A	(Sec. F)
Web local buckling (WLB Mn)	--	N/A	(Sec. F)
Local buckling (LB Mn)	--	N/A	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)

Slenderness parameter for flange (λ)	--	12.75	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	33.77	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	42.21	(Sec. B4)
Tension flange yielding (TFY Mn)	--	N/A	(Sec. F)

Bending about minor axis, M22

Ratio	: 0.00	Ctrl Eq.	: C9 at 0.00%
Capacity	: 1.56 [Ton*m]	Reference	: (Sec. F)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	1.73	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	12.75	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	33.77	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	42.21	(Sec. B4)

DESIGN FOR SHEAR



Shear parallel to major axis, V3 ($\phi = 0.90$)

Ratio	: 0.00	Ctrl Eq.	: C9 at 0.00%
Capacity	: 14.13 [Ton]	Reference	: (Sec. G)
Demand	: 0.00 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

Shear parallel to major axis, V2 ($\phi = 0.90$)

Ratio	: 0.00	Ctrl Eq.	: C1 at 0.00%
Capacity	: 14.13 [Ton]	Reference	: (Sec. G)
Demand	: -0.02 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\phi = 0.90$)



Tension

Ratio : 0.98
Capacity : 45.14 [Ton]
Demand : 44.03 [Ton]

Ctrl Eq. : C6 at 0.00%
Reference : (Sec. D)

DESIGN FOR COMPRESSION ($\phi = 0.90$) ✓

Compression

Ratio : 0.00
Capacity : 32.26 [Ton]
Demand : -0.03 [Ton]

Ctrl Eq. : C1 at 100.00%
Reference : (Sec. E)

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (λ_w)	--	12.75	(Sec. B4)
Limiting slenderness parameter for non-compact web (λ_{rw})	--	42.21	(Sec. B4)
Slenderness parameter for flange (λ_f)	--	12.75	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_{rf})	--	42.21	(Sec. B4)
Elastic flexural stress (F_{ex})	[Ton/cm ²]	2.74	(Eq. E4-9)
Elastic flexural stress (F_{ey})	[Ton/cm ²]	2.74	(Ec. E4-10)
Elastic torsional buckling stress (F_{ez})	[Ton/cm ²]	632.77	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (F_e)	[Ton/cm ²]	2.74	(Sec. E4)
Critical flexural buckling stress (F_{cr})	[Ton/cm ²]	1.57	(Sec. E)
Critical flexural-torsional buckling stress (F_{crTor})	[Ton/cm ²]	1.57	(Sec. E4)
Stress reduction factor in unstiffened elements (Q_s)	--	1.00	(Sec. E7)
Effective section reduction factor in stiffened elements (Q_a)	--	1.00	(Sec. E7)
Effective area at a uniform stress (A_{eff})	[cm ²]	22.80	(Sec. E7)

DESIGN FOR TORSION ($\phi = 0.90$) ✓

Torsion

Ratio : 0.00
Capacity : 1.31 [Ton*m]
Demand : -0.01 [Ton*m]

Ctrl Eq. : C9 at 0.00%
Reference : (Sec. H3)

Intermediate results	Unit	Value	Reference
Critical stress (F_{cr})	[Ton/cm ²]	1.32	(Sec. H)

INTERACTION ✓

Combined axial and flexure interaction value

Ratio : 0.98

Ctrl Eq. : C6 at 50.00% Reference : (H1-1a)

Combined torsion, flexure, shear and/or axial

Ratio : 0.98
Ctrl Eq. : C6 at 50.00% Reference : (H3-6)

CRITICAL STRENGTH RATIO



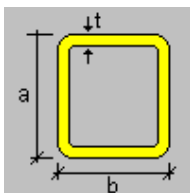
Ratio : 0.98
Ctrl Eq. : C6 at 50.00% Reference : (H3-6)

RIGIDIZACION LATERAL – Montantes m1:

Member : 221 (Mont Rig)
Design status : OK

PROPERTIES

Section : TUBO 100x100x3.2



Height (a) : 10.00 [cm]
Width (b) : 10.00 [cm]
Thickness (t) : 0.32 [cm]

Section properties

	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	12.14	
Moment of Inertia (local axes) (I)	[cm ⁴]	187.45	187.45
Moment of Inertia (principal axes) (I')	[cm ⁴]	187.45	187.45
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	3.93	3.93
Radius of gyration (principal axes) (r')	[cm]	3.93	3.93
Saint-Venant torsion constant (J)	[cm ⁴]	294.97	
Warping constant of the cross-section (Cw)	[cm ⁶]	0.63	
Distance from centroid to shear center (principal axis) (xo, yo)	[cm]		0.00
0.00			
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	37.49	37.49
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		37.49
37.49			

Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]	37.49
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]	37.49
Plastic section modulus (local axis) (Z)	[cm ³]	43.74
Plastic section modulus (principal axis) (Z')	[cm ³]	43.74
Polar radius of gyration (ro)	[cm]	5.56
Area for shear (Aw)	[cm ²]	6.20
Torsional modulus (1/C)	--	0.02

Material : Acero F22

Properties	Unit	Value
Yield stress (Fy):	[Ton/cm ²]	2.20
Tensile strength (Fu):	[Ton/cm ²]	3.75
Elasticity Modulus (E):	[Ton/cm ²]	2000.00
Shear modulus for steel (G):	[Ton/cm ²]	769.23

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Top unbraced length between lateral supports (LbTop)	[m]	2.25	
Bottom unbraced length between lateral supports (LbBop)	[m]	2.25	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	2.25	
Unbraced compression length (Lx, Ly)	[m]	2.25	2.25
Length for torsion and lateral-torsional buckling	[m]	2.25	
Additional hypotheses			
Continuous lateral torsional restraint		No	
Tension field action		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Tension				
Maximum geometric slenderness (L/r)	--	57.26		(Sec. D1)
Compression				
Geometric critical slenderness (KL/r)	--	57.26		(Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$) ✓

Bending about major axis, M33

Ratio	: 0.01	Ctrl Eq.	: C1 at 50.00%
Capacity	: 0.87 [Ton*m]	Reference	: (Sec. F)
Demand	: 0.01 [Ton*m]		

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	0.96	(Sec. F)
<u>Lateral-torsional buckling (LTB Mn)</u>	--	N/A	(Sec. F)
<u>Web local buckling (WLB Mn)</u>	--	N/A	(Sec. F)
<u>Local buckling (LB Mn)</u>	--	N/A	(Sec. F)
<u>Flange local buckling (FLB Mn)</u>	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	28.25	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	33.77	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	--	42.21 (Sec. B4)
<u>Tension flange yielding (TFY Mn)</u>	--	N/A	(Sec. F)

Bending about minor axis, M22

Ratio	: 0.00	Ctrl Eq.	: C7 at 0.00%
Capacity	: 0.87 [Ton*m]	Reference	: (Sec. F)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	0.96	(Sec. F)
<u>Flange local buckling (FLB Mn)</u>	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	28.25	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	33.77	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	--	42.21 (Sec. B4)

DESIGN FOR SHEAR



Shear parallel to major axis, V3 ($\phi = 0.90$)

Ratio	: 0.00	Ctrl Eq.	: C7 at 0.00%
Capacity	: 7.36 [Ton]	Reference	: (Sec. G)
Demand	: 0.00 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

Shear parallel to major axis, V2 ($\phi = 0.90$)

Ratio	: 0.00	Ctrl Eq.	: C1 at 100.00%
Capacity	: 7.36 [Ton]	Reference	: (Sec. G)
Demand	: 0.02 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\phi = 0.90$) ✓

Tension

Ratio	: 0.00	Ctrl Eq.	: C1 at 0.00%
Capacity	: 24.04 [Ton]	Reference	: (Sec. D)
Demand	: -0.57 [Ton]		

DESIGN FOR COMPRESSION ($\phi = 0.90$) ✓

Compression

Ratio	: 0.97	Ctrl Eq.	: C9 at 0.00%
Capacity	: 20.63 [Ton]	Reference	: (Sec. E)
Demand	: -20.01 [Ton]		

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (ϕ_w)	--	28.25	(Sec. B4)
Limiting slenderness parameter for non-compact web (ϕ_{rw})	--	42.21	(Sec. B4)
Slenderness parameter for flange (ϕ_f)	--	28.25	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ_{rf})	--	42.21	(Sec. B4)
Elastic flexural stress (Fex)	[Ton/cm ²]	6.02	(Eq. E4-9)
Elastic flexural stress (Fey)	[Ton/cm ²]	6.02	(Ec. E4-10)
Elastic torsional buckling stress (Fex)	[Ton/cm ²]	605.21	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (Fe)	[Ton/cm ²]	6.02	(Sec. E4)
Critical flexural buckling stress (Fcr)	[Ton/cm ²]	1.89	(Sec. E)
Critical flexural-torsional buckling stress (FcrTor)	[Ton/cm ²]	1.89	(Sec. E4)
Stress reduction factor in unstiffened elements (Qs)	--	1.00	(Sec. E7)
Effective section reduction factor in stiffened elements (Qa)	--	1.00	(Sec. E7)
Effective area at a uniform stress (Aeff)	[cm ²]	12.14	(Sec. E7)

DESIGN FOR TORSION ($\phi = 0.90$) ✓

Torsion

Ratio	: 0.07	Ctrl Eq.	: C7 at 0.00%
Capacity	: 0.71 [Ton*m]	Reference	: (Sec. H3)
Demand	: -0.05 [Ton*m]		

Intermediate results	Unit	Value	Reference
Critical stress (Fcr)	[Ton/cm ²]	1.32	(Sec. H)

INTERACTION



Combined axial and flexure interaction value

Ratio	: 0.98		
Ctrl Eq.	: C9 at 50.00%	Reference	: (H1-1a)

Combined torsion, flexure, shear and/or axial

Ratio	: 0.98		
Ctrl Eq.	: C9 at 50.00%	Reference	: (H3-6)

CRITICAL STRENGTH RATIO



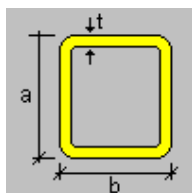
Ratio	: 0.98		
Ctrl Eq.	: C9 at 50.00%	Reference	: (H3-6)

RIGIDIZACION INTERIOR – Diagonales d2:

Member	: 586 (rig pared)
Design status	: OK

PROPERTIES

Section : TUBO 100x100x4



Height (a)	10.00 [cm]
Width (b)	10.00 [cm]
Thickness (t)	0.40 [cm]

Section properties	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	14.97	
Moment of Inertia (local axes) (I)	[cm ⁴]	226.57	226.57
Moment of Inertia (principal axes) (I')	[cm ⁴]	226.57	226.57
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	3.89	3.89
Radius of gyration (principal axes) (r')	[cm]	3.89	3.89
Saint-Venant torsion constant (J)	[cm ⁴]	360.67	
Warping constant of the cross-section (Cw)	[cm ⁶]	1.08	
Distance from centroid to shear center (principal axis) (x _o , y _o)	[cm]		0.00
0.00			
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	45.31	45.31
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		45.31
45.31			
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]		45.31
45.31			
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]		45.31
45.31			
Plastic section modulus (local axis) (Z)	[cm ³]	53.37	53.37
Plastic section modulus (principal axis) (Z')	[cm ³]	53.37	53.37
Polar radius of gyration (r _o)	[cm]	5.50	
Area for shear (A _w)	[cm ²]	7.68	7.68
Torsional modulus (1/C)	--	0.01	

Material : Acero F22

Properties	Unit	Value
Yield stress (F _y):	[Ton/cm ²]	2.20
Tensile strength (F _u):	[Ton/cm ²]	3.75
Elasticity Modulus (E):	[Ton/cm ²]	2000.00
Shear modulus for steel (G):	[Ton/cm ²]	769.23

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Top unbraced length between lateral supports (L _{bTop})	[m]	3.78	
Bottom unbraced length between lateral supports (L _{bBop})	[m]	3.78	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	3.78	
Unbraced compression length (L _x , L _y)	[m]	3.78	3.78
Length for torsion and lateral-torsional buckling	[m]	3.78	
Additional hypotheses			
Continuous lateral torsional restraint		No	
Tension field action		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Tension				
Maximum geometric slenderness (L/r)	--	97.24		(Sec. D1)
Compression				
Geometric critical slenderness (KL/r)	--	97.24		(Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$) ✓

Bending about major axis, M33

Ratio	: 0.02		
Capacity	: 1.06 [Ton*m]	Ctrl Eq.	: C9 at 62.50%
Demand	: 0.03 [Ton*m]	Reference	: (Sec. F)

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	1.17	(Sec. F)
<u>Lateral-torsional buckling (LTB Mn)</u>	--	N/A	(Sec. F)
<u>Web local buckling (WLB Mn)</u>	--	N/A	(Sec. F)
<u>Local buckling (LB Mn)</u>	--	N/A	(Sec. F)
<u>Flange local buckling (FLB Mn)</u>	--	N/A	(Sec. F)
Slenderness parameter for flange (ϕ)	--	22.00	(Sec. B4)
Limiting slenderness parameter for compact flange (ϕ_p)	--	33.77	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ_r)	--	--	42.21 (Sec. B4)
<u>Tension flange yielding (TFY Mn)</u>	--	N/A	(Sec. F)

Bending about minor axis, M22

Ratio	: 0.04		
Capacity	: 1.06 [Ton*m]	Ctrl Eq.	: C6 at 100.00%
Demand	: 0.04 [Ton*m]	Reference	: (Sec. F)

Intermediate results	Unit	Value	Reference
<u>Yielding (Mp)</u>	[Ton*m]	1.17	(Sec. F)
<u>Flange local buckling (FLB Mn)</u>	--	N/A	(Sec. F)
Slenderness parameter for flange (ϕ)	--	22.00	(Sec. B4)
Limiting slenderness parameter for compact flange (ϕ_p)	--	33.77	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ_r)	--	--	42.21 (Sec. B4)

DESIGN FOR SHEAR



Shear parallel to major axis, V3 ($\phi = 0.90$)

Ratio	: 0.00	Ctrl Eq.	: C6 at 0.00%
Capacity	: 9.12 [Ton]	Reference	: (Sec. G)
Demand	: 0.01 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

Shear parallel to major axis, V2 ($\phi = 0.90$)

Ratio	: 0.00	Ctrl Eq.	: C1 at 100.00%
Capacity	: 9.12 [Ton]	Reference	: (Sec. G)
Demand	: 0.03 [Ton]		

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\phi = 0.90$)



Tension

Ratio	: 0.92	Ctrl Eq.	: C9 at 100.00%
Capacity	: 29.64 [Ton]	Reference	: (Sec. D)
Demand	: 27.38 [Ton]		

DESIGN FOR COMPRESSION ($\phi = 0.90$)



Compression

Ratio	: 0.00	Ctrl Eq.	: C8 at 0.00%
Capacity	: 19.07 [Ton]	Reference	: (Sec. E)
Demand	: -0.02 [Ton]		

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (ϕ_w)	--	22.00	(Sec. B4)
Limiting slenderness parameter for non-compact web (ϕ_{rw})	--	42.21	(Sec. B4)
Slenderness parameter for flange (ϕ_f)	--	22.00	(Sec. B4)
Limiting slenderness parameter for non-compact flange (ϕ_{rf})	--	42.21	(Sec. B4)
Elastic flexural stress (Fex)	[Ton/cm ²]	2.09	(Eq. E4-9)

Elastic flexural stress (Fey)	[Ton/cm2]	2.09	(Ec. E4-10)
Elastic torsional buckling stress (Fez)	[Ton/cm2]	612.26	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (Fe)	[Ton/cm2]	2.09	(Sec.E4)
Critical flexural buckling stress (Fcr)	[Ton/cm2]	1.42	(Sec.E)
Critical flexural-torsional buckling stress (FcrTor)	[Ton/cm2]	1.42	(Sec.E4)
Stress reduction factor in unstiffened elements (Qs)	--	1.00	(Sec.E7)
Effective section reduction factor in stiffened elements (Qa)		--	1.00
(Sec.E7)			
Effective area at a uniform stress (Aeff)	[cm2]	14.97	(Sec.E7)

DESIGN FOR TORSION ($\phi = 0.90$) ✓

Torsion

Ratio	: 0.01		
Capacity	: 0.87 [Ton*m]	Ctrl Eq.	: C6 at 0.00%
Demand	: -0.01 [Ton*m]	Reference	: (Sec. H3)

Intermediate results	Unit	Value	Reference
Critical stress (Fcr)	[Ton/cm2]	1.32	(Sec. H)

INTERACTION ✓

Combined axial and flexure interaction value

Ratio	: 0.95		
Ctrl Eq.	: C9 at 62.50%	Reference	: (H1-1a)

Combined torsion, flexure, shear and/or axial

Ratio	: 0.95		
Ctrl Eq.	: C9 at 62.50%	Reference	: (H3-6)

CRITICAL STRENGTH RATIO ✓

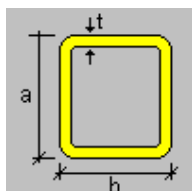
Ratio	: 0.95		
Ctrl Eq.	: C9 at 62.50%	Reference	: (H3-6)

RIGIDIZACION DE CUBIERTA :

Member	: 563 (rig cub)
Design status	: OK

PROPERTIES

Section : TUBO 60x60x2.5



Height (a)	6.00	[cm]
Width (b)	6.00	[cm]
Thickness (t)	0.25	[cm]

Section properties

	Unit	Major axis	Minor axis
Full unreduced cross-sectional area (A)	[cm ²]	5.60	
Moment of Inertia (local axes) (I)	[cm ⁴]	30.37	30.37
Moment of Inertia (principal axes) (I')	[cm ⁴]	30.37	30.37
Bending constant for moments (principal axis) (J')	[cm]	0.00	0.00
Radius of gyration (local axes) (r)	[cm]	2.33	2.33
Radius of gyration (principal axes) (r')	[cm]	2.33	2.33
Saint-Venant torsion constant (J)	[cm ⁴]	48.46	
Warping constant of the cross-section (Cw)	[cm ⁶]	0.06	
Distance from centroid to shear center (principal axis) (xo, yo)	[cm]		0.00
0.00			
Top elastic section modulus of the section (local axis) (S top)	[cm ³]	10.12	10.12
Bottom elastic section modulus of the section (local axis) (S bot)	[cm ³]		10.12
10.12			
Top elastic section modulus of the section (principal axis) (S' top)	[cm ³]		10.12
10.12			
Bottom elastic section modulus of the section (principal axis) (S' bot)	[cm ³]		10.12
10.12			
Plastic section modulus (local axis) (Z)	[cm ³]	11.95	11.95
Plastic section modulus (principal axis) (Z')	[cm ³]	11.95	11.95
Polar radius of gyration (ro)	[cm]	3.29	
Area for shear (Aw)	[cm ²]	2.88	2.88
Torsional modulus (1/C)	--	0.06	

Material : Acero F22

Properties	Unit	Value
Yield stress (Fy):	[Ton/cm ²]	2.20
Tensile strength (Fu):	[Ton/cm ²]	3.75
Elasticity Modulus (E):	[Ton/cm ²]	2000.00
Shear modulus for steel (G):	[Ton/cm ²]	769.23

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
-------------	------	------------	------------

Top unbraced length between lateral supports (LbTop)	[m]	2.96	
Bottom unbraced length between lateral supports (LbBop)	[m]	2.96	
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Length for axial tension (L)	[m]	2.96	
Unbraced compression length (Lx, Ly)	[m]	2.96	2.96
Length for torsion and lateral-torsional buckling	[m]	2.96	

Additional hypotheses

Continuous lateral torsional restraint	No
Tension field action	No

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Tension				
Maximum geometric slenderness (L/r)	--	126.86		(Sec. D1)
Compression				
Geometric critical slenderness (KL/r)	--	126.86		(Sec. E2)

DESIGN CHECKS

DESIGN FOR FLEXURE ($\phi = 0.90$) ✓

Bending about major axis, M33

Ratio	: 0.04		
Capacity	: 0.24 [Ton*m]	Ctrl Eq.	: C9 at 25.00%
Demand	: -0.01 [Ton*m]	Reference	: (Sec. F)

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	0.26	(Sec. F)
Lateral-torsional buckling (LTB Mn)	--	N/A	(Sec. F)
Web local buckling (WLB Mn)	--	N/A	(Sec. F)
Local buckling (LB Mn)	--	N/A	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	21.00	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	33.77	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	--	42.21 (Sec. B4)
Tension flange yielding (TFY Mn)	--	N/A	(Sec. F)

Bending about minor axis, M22

Ratio	: 0.23
-------	--------

Capacity : 0.24 [Ton*m]
Demand : 0.05 [Ton*m]

Ctrl Eq. : C9 at 25.00%
Reference : (Sec. F)

Intermediate results	Unit	Value	Reference
Yielding (Mp)	[Ton*m]	0.26	(Sec. F)
Flange local buckling (FLB Mn)	--	N/A	(Sec. F)
Slenderness parameter for flange (λ)	--	21.00	(Sec. B4)
Limiting slenderness parameter for compact flange (λ_p)	--	33.77	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_r)	--	42.21	(Sec. B4)

DESIGN FOR SHEAR



Shear parallel to major axis, V3 ($\phi = 0.90$)

Ratio : 0.03
Capacity : 3.42 [Ton]
Demand : -0.11 [Ton]

Ctrl Eq. : C9 at 0.00%
Reference : (Sec. G)

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

Shear parallel to major axis, V2 ($\phi = 0.90$)

Ratio : 0.01
Capacity : 3.42 [Ton]
Demand : -0.02 [Ton]

Ctrl Eq. : C9 at 25.00%
Reference : (Sec. G)

Intermediate results	Unit	Value	Reference
Web Shear coefficient (Cv)	--	1.00	
Web plate buckling coefficient (kv)	--	5.00	(Sec. G2)

DESIGN FOR TENSION ($\phi = 0.90$)



Tension

Ratio : 0.66
Capacity : 11.08 [Ton]
Demand : 7.27 [Ton]

Ctrl Eq. : C9 at 22.92%
Reference : (Sec. D)

DESIGN FOR COMPRESSION ($\phi = 0.90$)



Compression

Ratio	: 0.00	Ctrl Eq.	: C8 at 25.00%
Capacity	: 5.23 [Ton]	Reference	: (Sec. E)
Demand	: 0.00 [Ton]		

Intermediate results	Unit	Value	Reference
Slenderness parameter for web (λ_w)	--	21.00	(Sec. B4)
Limiting slenderness parameter for non-compact web (λ_{rw})	--	42.21	(Sec. B4)
Slenderness parameter for flange (λ_f)	--	21.00	(Sec. B4)
Limiting slenderness parameter for non-compact flange (λ_{rf})	--	42.21	(Sec. B4)
Elastic flexural stress (F_{ex})	[Ton/cm ²]	1.23	(Eq. E4-9)
Elastic flexural stress (F_{ey})	[Ton/cm ²]	1.23	(Ec. E4-10)
Elastic torsional buckling stress (F_{ez})	[Ton/cm ²]	613.73	(Eq. E4-11)
Critical elastic flexural-torsional buckling stress (F_e)	[Ton/cm ²]	1.23	(Sec. E4)
Critical flexural buckling stress (F_{cr})	[Ton/cm ²]	1.04	(Sec. E)
Critical flexural-torsional buckling stress (F_{crTor})	[Ton/cm ²]	1.04	(Sec. E4)
Stress reduction factor in unstiffened elements (Q_s)	--	1.00	(Sec. E7)
Effective section reduction factor in stiffened elements (Q_a)	--	1.00	(Sec. E7)
Effective area at a uniform stress (A_{eff})	[cm ²]	5.60	(Sec. E7)

DESIGN FOR TORSION ($\phi = 0.90$) ✓

Torsion

Ratio	: 0.03	Ctrl Eq.	: C4 at 25.00%
Capacity	: 0.20 [Ton*m]	Reference	: (Sec. H3)
Demand	: 0.00 [Ton*m]		

Intermediate results	Unit	Value	Reference
Critical stress (F_{cr})	[Ton/cm ²]	1.32	(Sec. H)

INTERACTION ✓

Combined axial and flexure interaction value

Ratio	: 0.89	Reference	: (H1-1a)
Ctrl Eq.	: C9 at 25.00%		

Combined torsion, flexure, shear and/or axial

Ratio	: 0.88	Reference	: (H3-6)
Ctrl Eq.	: C9 at 25.00%		

CRITICAL STRENGTH RATIO ✓

Ratio : 0.89
Ctrl Eq. : C9 at 25.00% Reference : (H1-1a)