

Projeto de Mezaninos e Escadas

Curso de Projeto e Cálculo de Estruturas metálicas

Tipos usuais de piso para mezaninos

Painel Wall



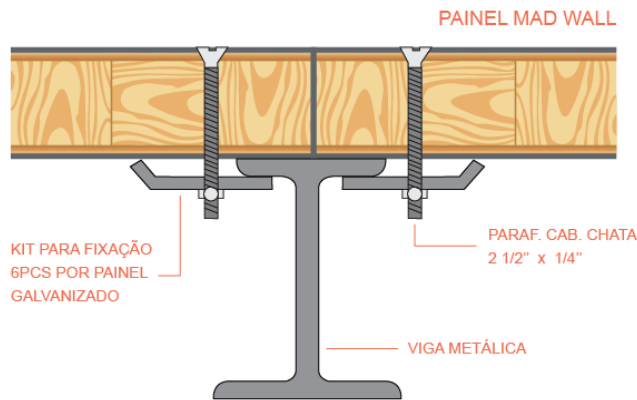
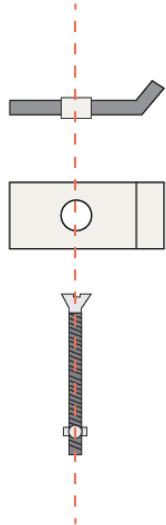
Medida mais comuns: 1200X2500X40mm

Sobrecarga para 300kgf/m² e 500kgf/m²

Tipos usuais de piso para mezaninos

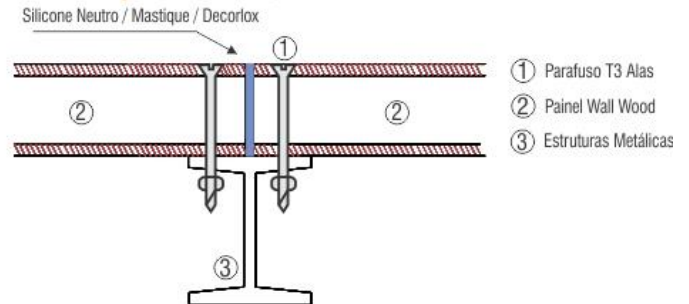
Painel Wall - Fixação

(KIT DE FIXAÇÃO)



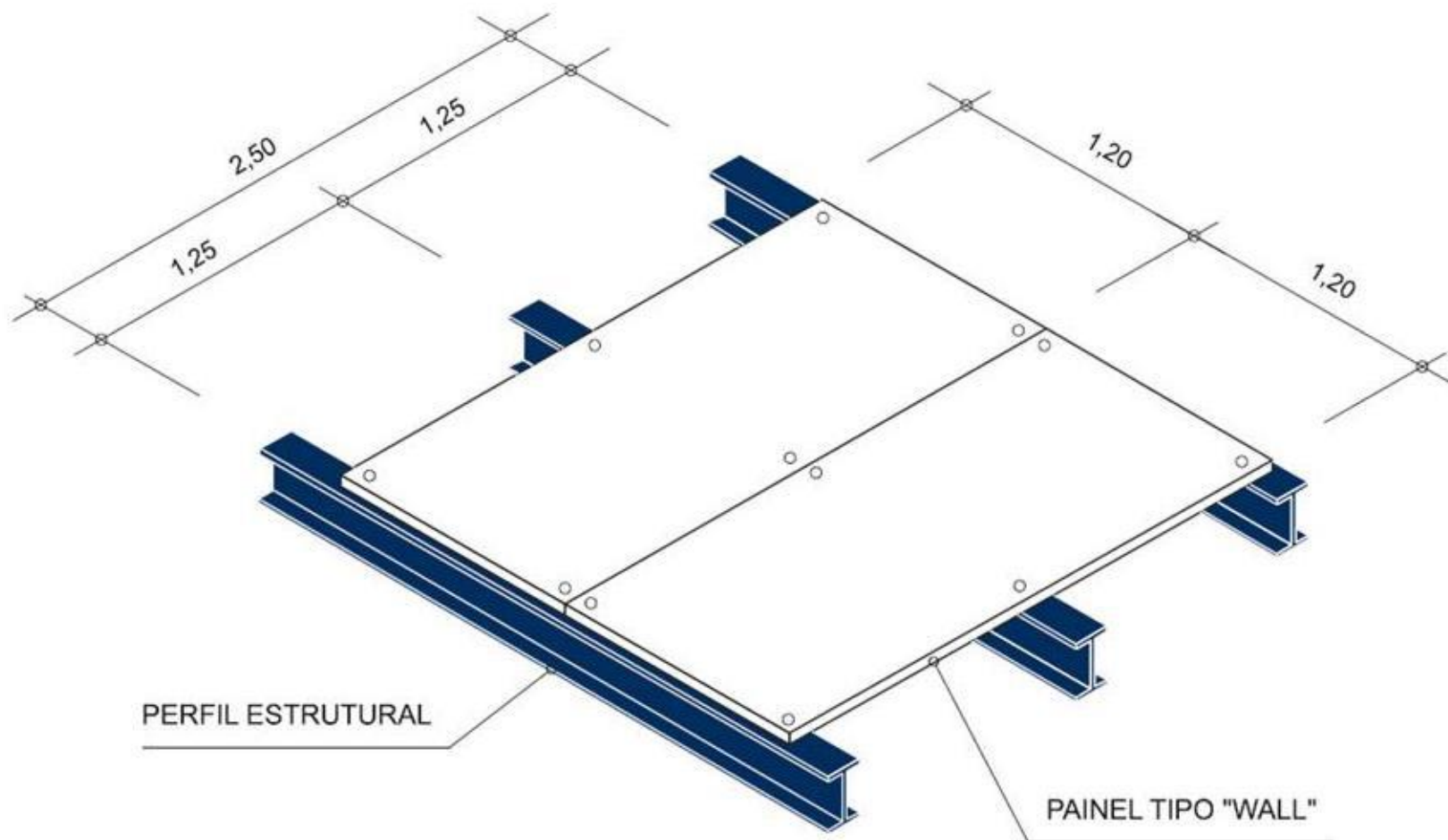
PARAF. CAB. CHATA
2 1/2" x 1/4"

Amostra de Fixação em Perfil Tipo "I"



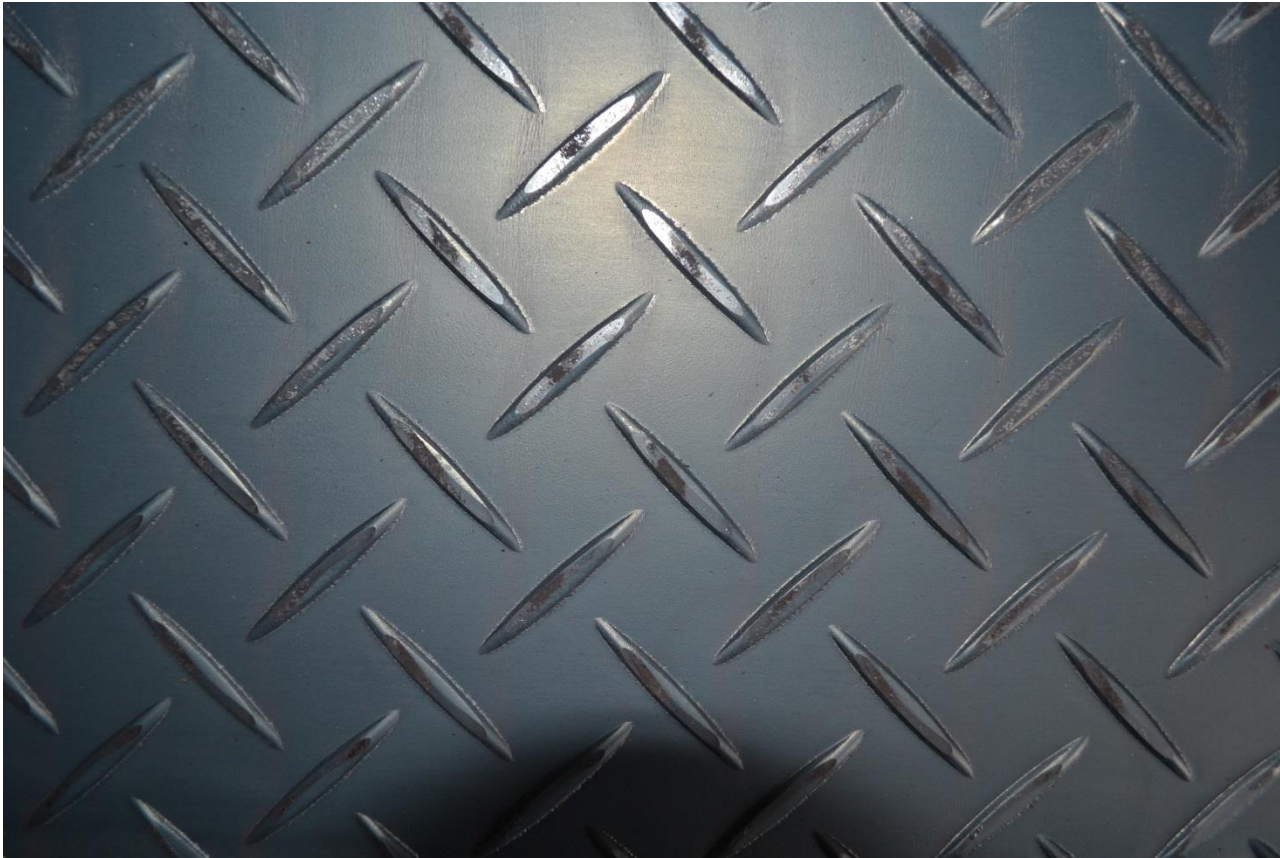
Tipos usuais de piso para mezaninos

Painel Wall - Modulações



Tipos usuais de piso para mezaninos

Chapa xadrez

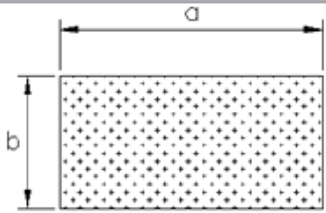


CHAPA XADREZ

Carga admissível em Kg/m² para chapas de piso simplesmente apoiadas nas quatro bordas

$$\frac{A}{L} = \frac{I}{200}$$

Tensão: $\leq 1400 \text{ Kg/cm}^2$



Obs: Subtrair peso próprio da carga admissível dada na tabela

Exemplo: CH 1/4" com vão 1000 x 1000
 $608 - 58 = 550$
 - Sobrecarga Máxima = 550 Kg/m²

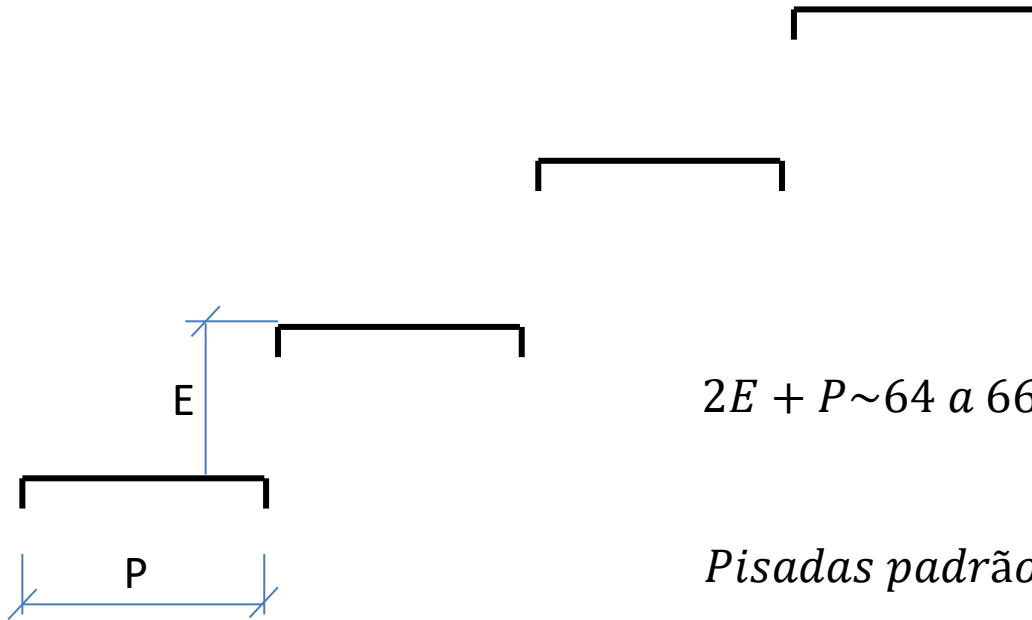
t= 3/16" (42 Kg/m ²)									
	a / b								
b	1	1.2	1.4	1.6	1.8	2	3	4	5
400	3973	2864	2292	1948	1735	1590	1322	1260	1245
600	1182	853	682	580	517	473	393	375	370
800	499	360	288	244	218	200	166	158	156
1000	255	184	147	126	112	101			
1200	148	107							
1400	93								

t= 1/4" (58,33 Kg/m ²)									
	a / b								
b	1	1.2	1.4	1.6	1.8	2	3	4	5
400	9460	6820	5456	4637	4130	3785	3147	3000	2965
600	2814	2030	1623	1380	1230	1126	936	893	882
800	1187	856	685	582	518	475	395	377	372
1000	608	438	350	300	266	240	200		
1200	352	254	203	173	154				
1400	222	160	128						
1600	150	107							

t= 5/16" (67,43 Kg/m ²)									
	a / b								
b	1	1.2	1.4	1.6	1.8	2	3	4	5
400	18497	13332	10665	9065	8075	7400	6150	5665	5796
600	5480	3950	3160	2686	2395	2194	1825	1740	1720
800	2315	1670	1335	1134	1010	926	770	734	726
1000	1185	854	683	580	518	474	394	376	370
1200	686	495	396	336	300	275	228	218	215
1400	432	312	250	212	190	173	144	137	136
1600	290	208	167	142	126				

Projetos de escadas

Regra de Blondel:



$$2E + P \sim 64 \text{ a } 66\text{cm}$$

Pisadas padrão (em geral):

265mm, 280mm, 300mm

Projetos de escadas

Exemplo: Em um desnível de 3m, qual o espelho e a pisada ideais?

Se travarmos a pisada em 28cm, por exemplo teremos:

$$2E + P \sim 66cm$$

$$N = \frac{300}{19} = 15,78 \text{ espelhos} \sim 16 \text{ espelhos}$$

$$2.E + 28 = 66cm$$

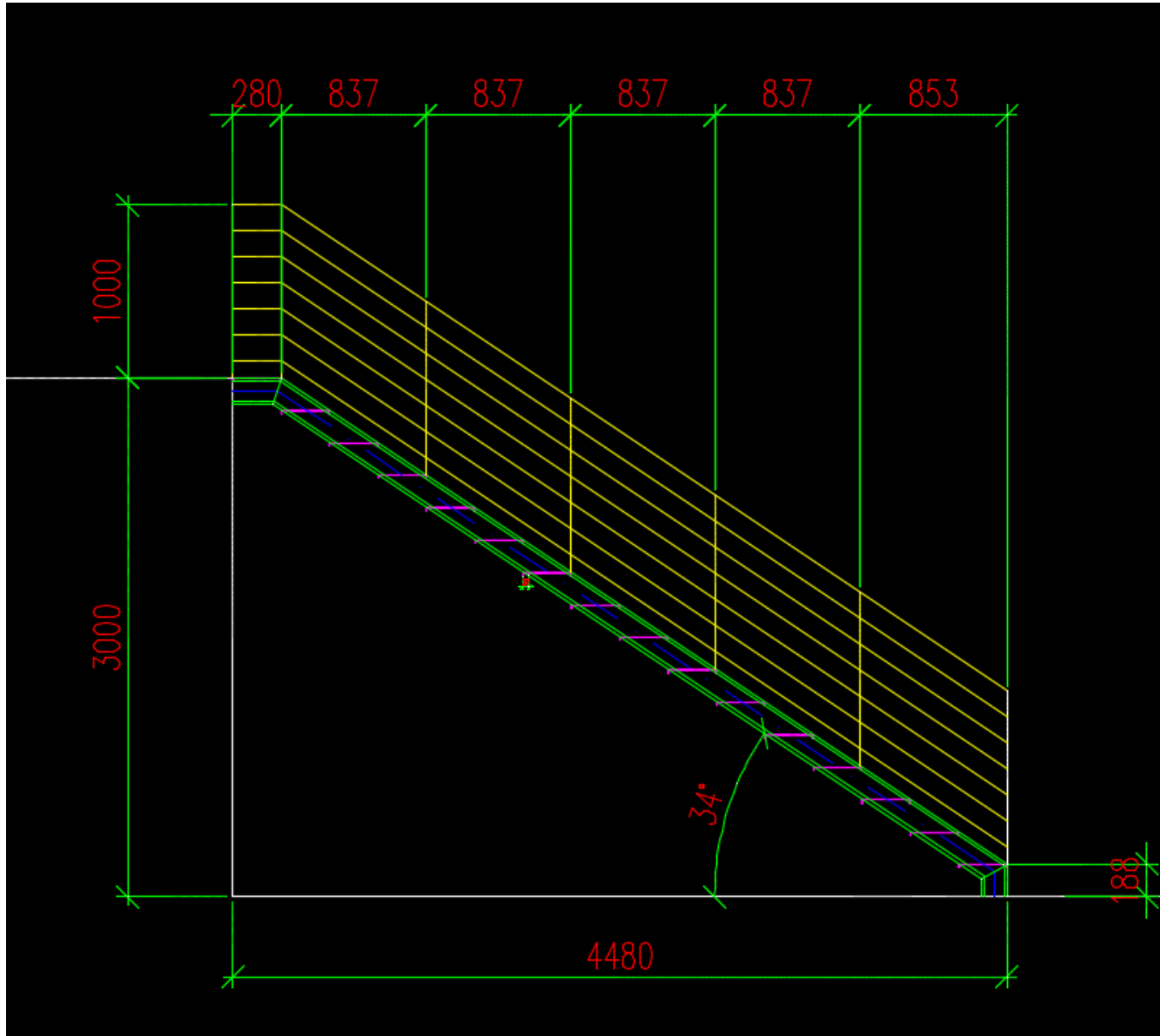
$$E = \frac{300}{16} = 18,75 \text{ cm cada espelho}$$

$$E = \frac{66 - 28}{2}$$

$$2 \cdot 18,75 + 28 = 65,5 \text{ OK}$$

$$E = \frac{66 - 28}{2} = 19cm$$

Projetos de escadas



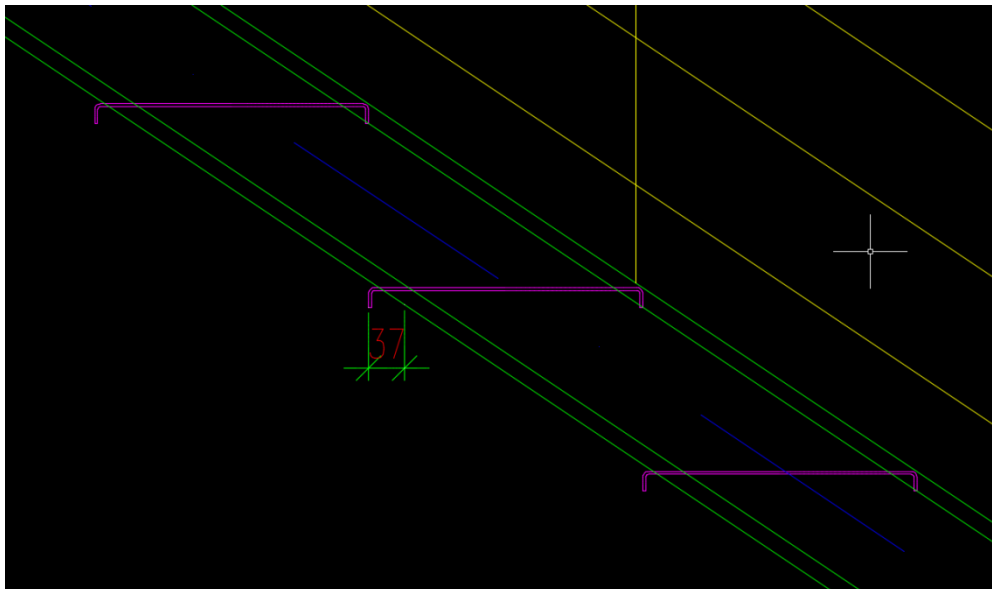
Cálculo da longarina

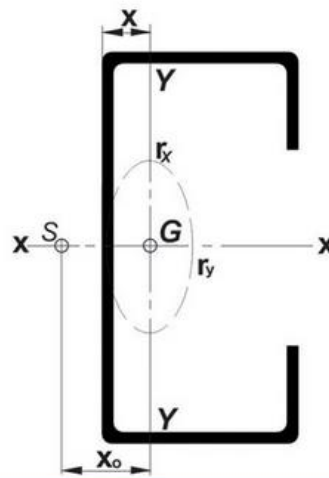
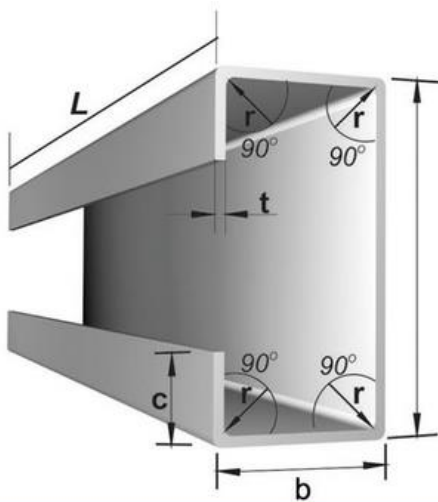
A viga da Escada deve suportar, além do peso próprio, a sobrecarga de 300kgf/m² (NBR6120)

Não há determinação específica para flechas, porém manteremos a limitação de L/350

Determina-se a altura da longarina (Viga da escada depois de desenhar os degraus para que não fique desproporcional)

2.2.1.7 Quando uma escada for constituída por degraus isolados, estes devem ser calculados para suportarem uma carga concentrada de 2,5 kN, aplicada na posição mais desfavorável. Este carregamento não deve ser considerado na composição de cargas das vigas que suportam os degraus, as quais devem ser calculadas para carga indicada na Tabela 2.





PERFIL U ENRIJECIDO

DIMENSÕES				A	M	I _x	W _x	r _x	X	I _y	W _y	r _y	J	C _w	X ₀
a	b	c	t = r	cm ²	kg/m	cm ⁴	cm ³	cm	cm	cm ⁴	cm ³	cm	cm ⁴	cm ⁶	cm
mm	mm	mm	mm	cm ²	kg/m	cm ⁴	cm ³	cm	cm	cm ⁴	cm ³	cm	cm ⁴	cm ⁶	cm
300	85	25	3.75	18.70	14.68	2420.9	161.4	11.38	2.21	163.8	26.1	2.96	0.876	29196.7	-5.54
			3.35	16.78	13.17	2182.7	145.5	11.41	2.21	149.1	23.7	2.98	0.628	26605.5	-5.57
			3.00	15.09	11.84	1970.4	131.4	11.43	2.21	135.7	21.6	3.00	0.453	24241.4	-5.60
			2.65	13.38	10.50	1754.5	117.0	11.45	2.21	121.8	19.4	3.02	0.313	21785.1	-5.63
			2.25	11.41	8.96	1503.2	100.2	11.48	2.21	105.3	16.7	3.04	0.193	18862.6	-5.67
			2.00	10.17	7.98	1343.8	89.6	11.49	2.21	94.7	15.1	3.05	0.136	16972.4	-5.69
250	85	25	3.75	16.82	13.20	1570.4	125.6	9.66	2.44	155.2	25.6	3.04	0.788	19549.4	-5.99
			3.35	15.10	11.86	1417.2	113.4	9.69	2.44	141.3	23.3	3.06	0.565	17833.2	-6.02
			3.00	13.59	10.66	1280.4	102.4	9.71	2.44	128.6	21.2	3.08	0.408	16263.6	-6.05
			2.65	12.05	9.46	1141.0	91.3	9.73	2.44	115.5	19.1	3.09	0.282	14629.0	-6.08
			2.25	10.29	8.07	978.4	78.3	9.75	2.44	99.8	16.5	3.12	0.174	12679.7	-6.12
			2.00	9.17	7.20	875.1	70.0	9.77	2.44	89.8	14.8	3.13	0.122	11416.4	-6.14
200	75	25	3.75	14.20	11.14	858.0	85.8	7.77	2.34	106.6	20.6	2.74	0.665	9015.7	-5.65
			3.35	12.76	10.02	775.8	77.6	7.80	2.34	97.2	18.8	2.76	0.477	8251.1	-5.68
			3.00	11.49	9.02	702.0	70.2	7.82	2.34	88.6	17.2	2.78	0.345	7546.2	-5.72
			2.65	10.20	8.01	626.6	62.7	7.84	2.34	79.7	15.4	2.80	0.239	6806.8	-5.75
200	75	20	2.25	8.49	6.66	524.8	52.5	7.86	2.21	63.2	11.9	2.73	0.143	5081.3	-5.45
			2.00	7.57	5.94	470.0	47.0	7.88	2.21	56.9	10.7	2.74	0.101	4586.0	-5.47
150	60	20	3.75	10.82	8.49	366.4	48.9	5.82	1.93	50.8	12.5	2.17	0.507	2436.0	-4.56
			3.35	9.74	7.66	333.5	44.3	5.84	1.93	46.6	11.6	2.18	0.364	2245.8	-4.60
			3.00	8.79	6.90	301.9	40.3	5.86	1.93	42.7	10.5	2.21	0.264	2066.0	-4.63
			2.65	7.81	6.13	270.3	36.0	5.88	1.93	38.6	9.5	2.22	0.183	1874.8	-4.66
			2.25	6.69	5.25	233.1	31.1	5.90	1.93	33.6	8.3	2.24	0.113	1641.3	-4.70
			2.00	5.97	4.69	209.2	27.9	5.92	1.93	30.4	7.5	2.26	0.080	1487.0	-4.72
127	50	17	1.50	4.52	3.55	159.9	21.3	5.95	1.93	23.5	5.8	2.28	0.034	1158.2	-4.77
			3.35	8.10	6.36	195.1	30.7	4.91	1.60	26.2	7.7	1.80	0.303	899.4	-3.78
			3.00	7.32	5.74	177.6	28.0	4.93	1.60	24.1	7.1	1.82	0.219	832.2	-3.81
			2.65	6.51	5.11	159.5	25.1	4.95	1.60	21.9	6.4	1.83	0.153	759.4	-3.85
			2.25	5.58	4.38	137.9	21.7	4.97	1.61	19.2	5.6	1.85	0.094	668.9	-3.88
			2.00	4.99	3.92	124.0	19.5	4.98	1.61	17.4	5.1	1.87	0.067	608.3	-3.90
127	50	15	1.50	3.79	2.97	95.1	15.0	5.01	1.61	13.5	4.0	1.89	0.028	477.4	-3.95

Como não há U enrijecido no ftool, devemos criar um perfil genérico inserindo informações básicas

Section Properties
UDC150X60X20X3,00

Integral Properties

A: 8.79 cm²
As: 8.79 cm²
I: 301.90 cm⁴
d: 150.00 mm
ȳ: 75.00 mm

Cálculo da longarina (largura 1000mm)

Corrimãos: 9kg/m

Longarina: 6,9kg/m

Degraus: (12 x 3,57 degraus,
metade para cada longarina = 22,4
kg/m

PP = 0,383 kN/m

SC = $3\text{kN/m}^2 \times 0,5\text{m} = 1,5\text{ kN/m}$

PP+SC = 188,3 kg/m (ELS)

$1,4\text{PP} + 1,5\text{SC} = 2,79\text{ kN/m}$ (ELU)

Degraus Xadrez:

Em geral:

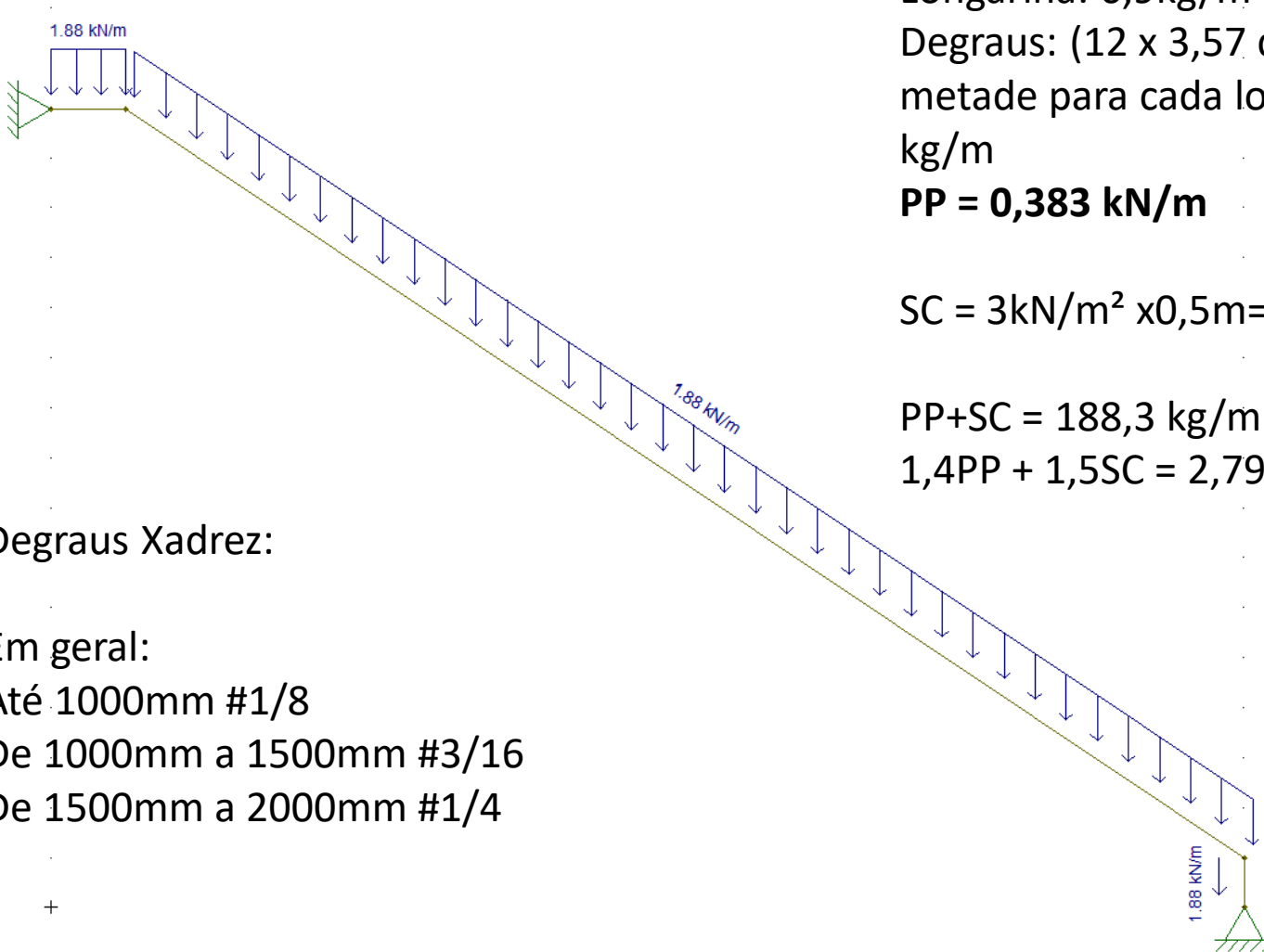
Até 1000mm #1/8

De 1000mm a 1500mm #3/16

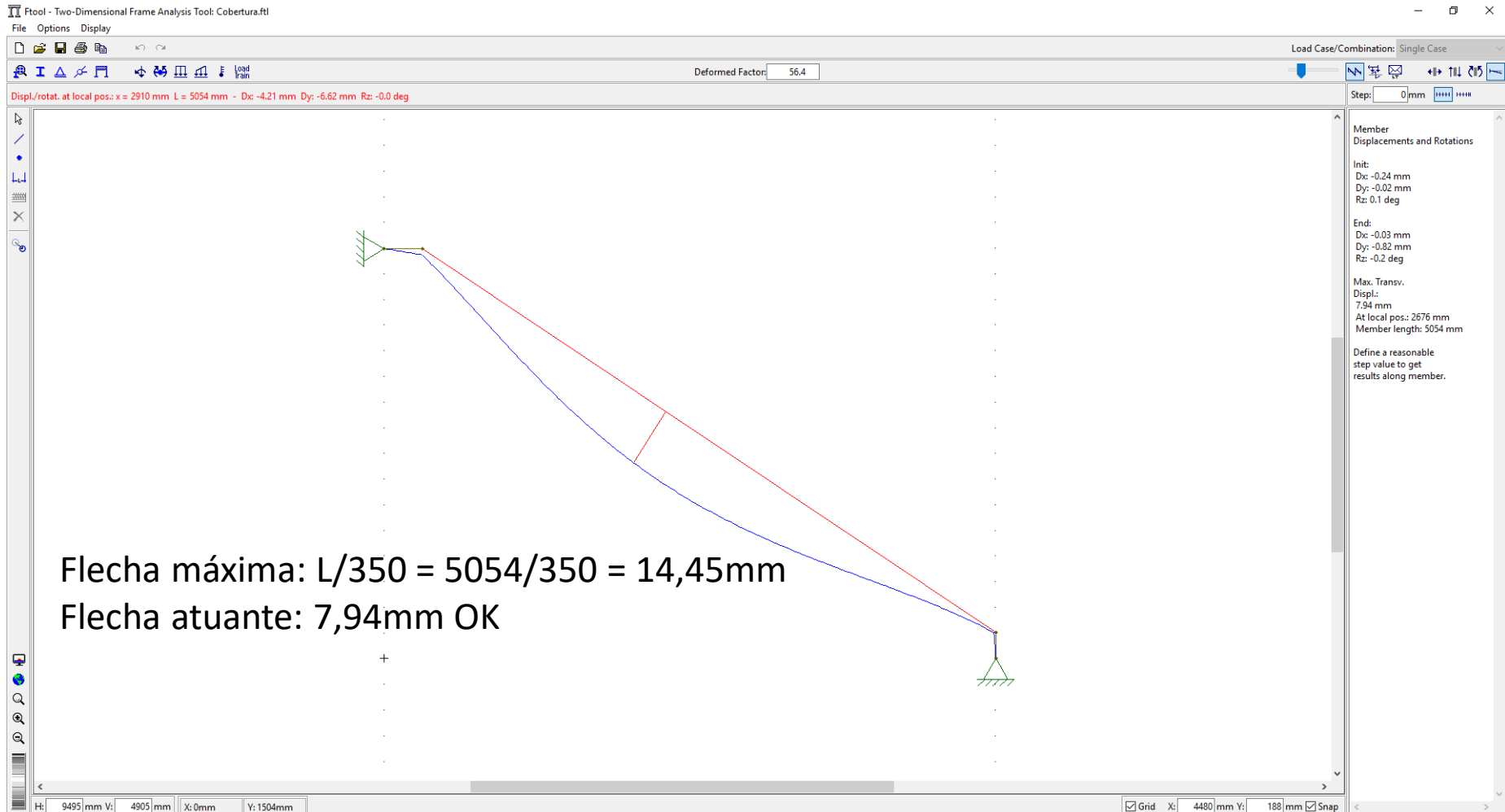
De 1500mm a 2000mm #1/4

+

$PP_{\text{degrau}} = ((20\text{mm} + 280\text{mm} + 20\text{mm})/1000) \times 0,00476\text{m} \times 7850 = 11,95\text{ kg/m}$



Cálculo da longarina (largura 1000mm)



Cálculo da longarina (largura 1000mm)

Ftool - Two-Dimensional Frame Analysis Tool

File Options Display

Editing Mode: Selection

Load Case/Combination: Single Case

Step: 0 mm

Uniform Loading

ELU: ESCADA

Direction

☒ Global

☐ Local

Qx: 0.00 kN/m

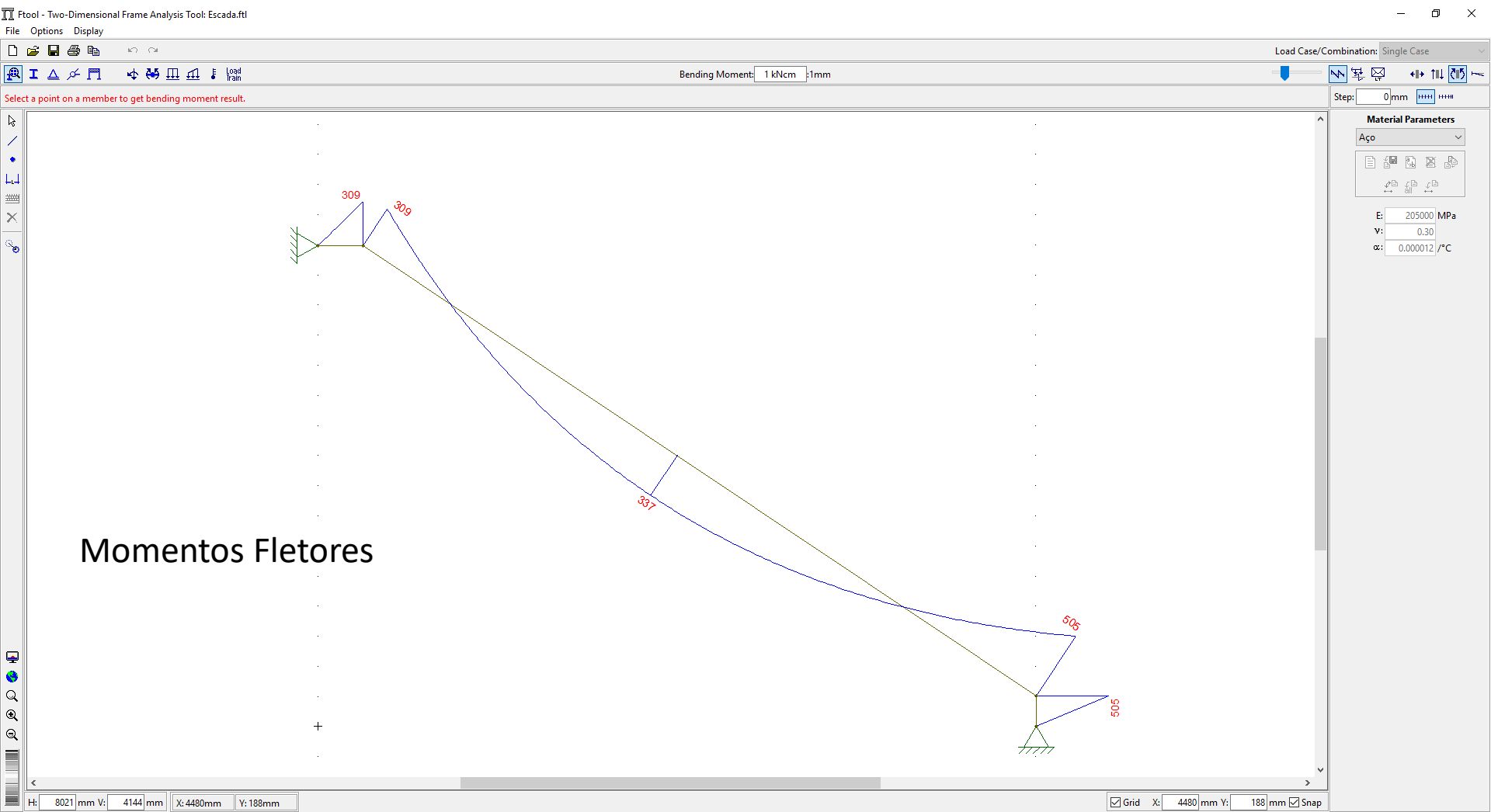
Qy: -2.79 kN/m

Lançamento ELU

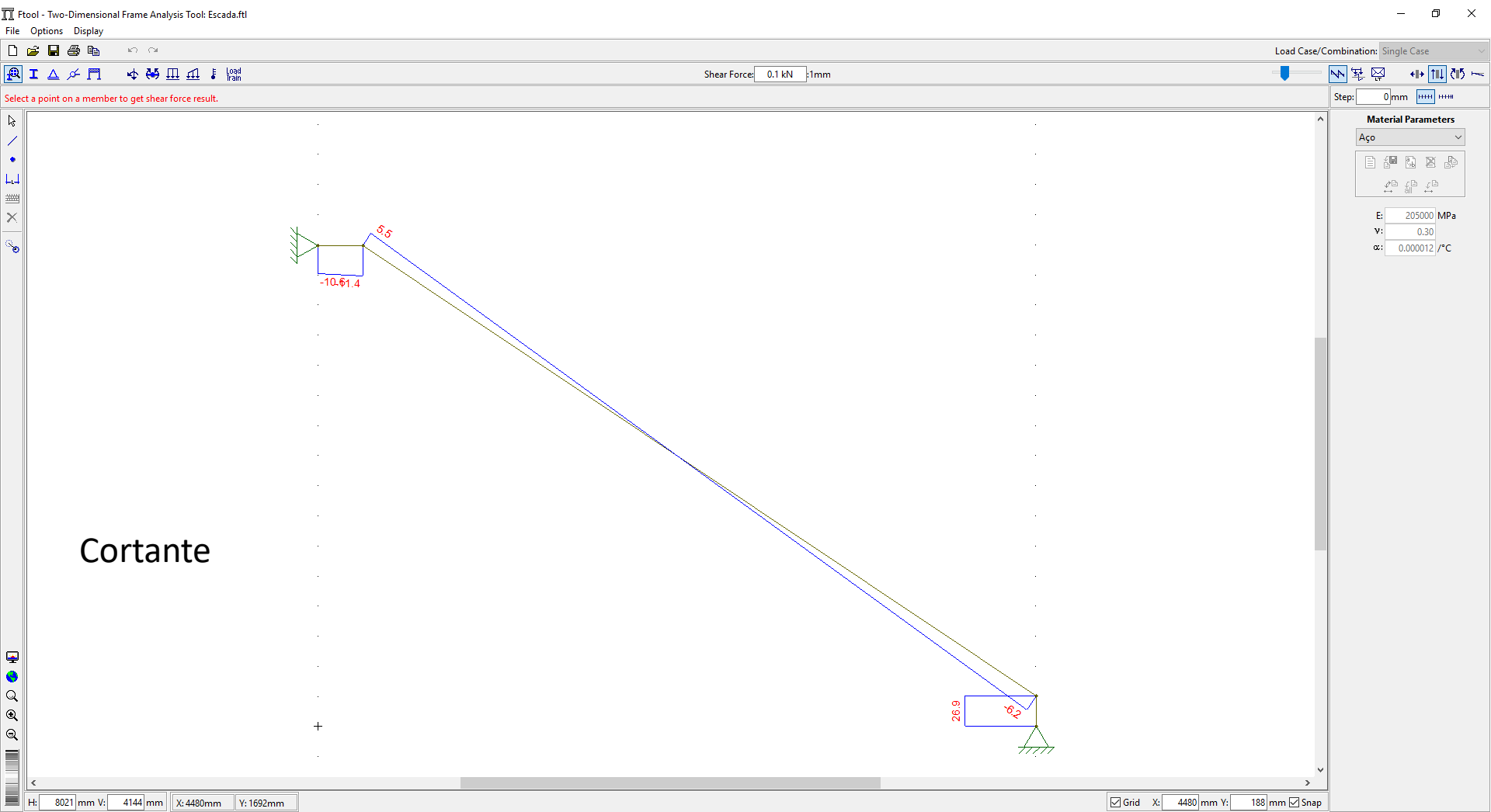
H: 8021 mm V: 4144 mm X: Y:

☒ Grid X: 4480 mm Y: 188 mm ☒ Snap

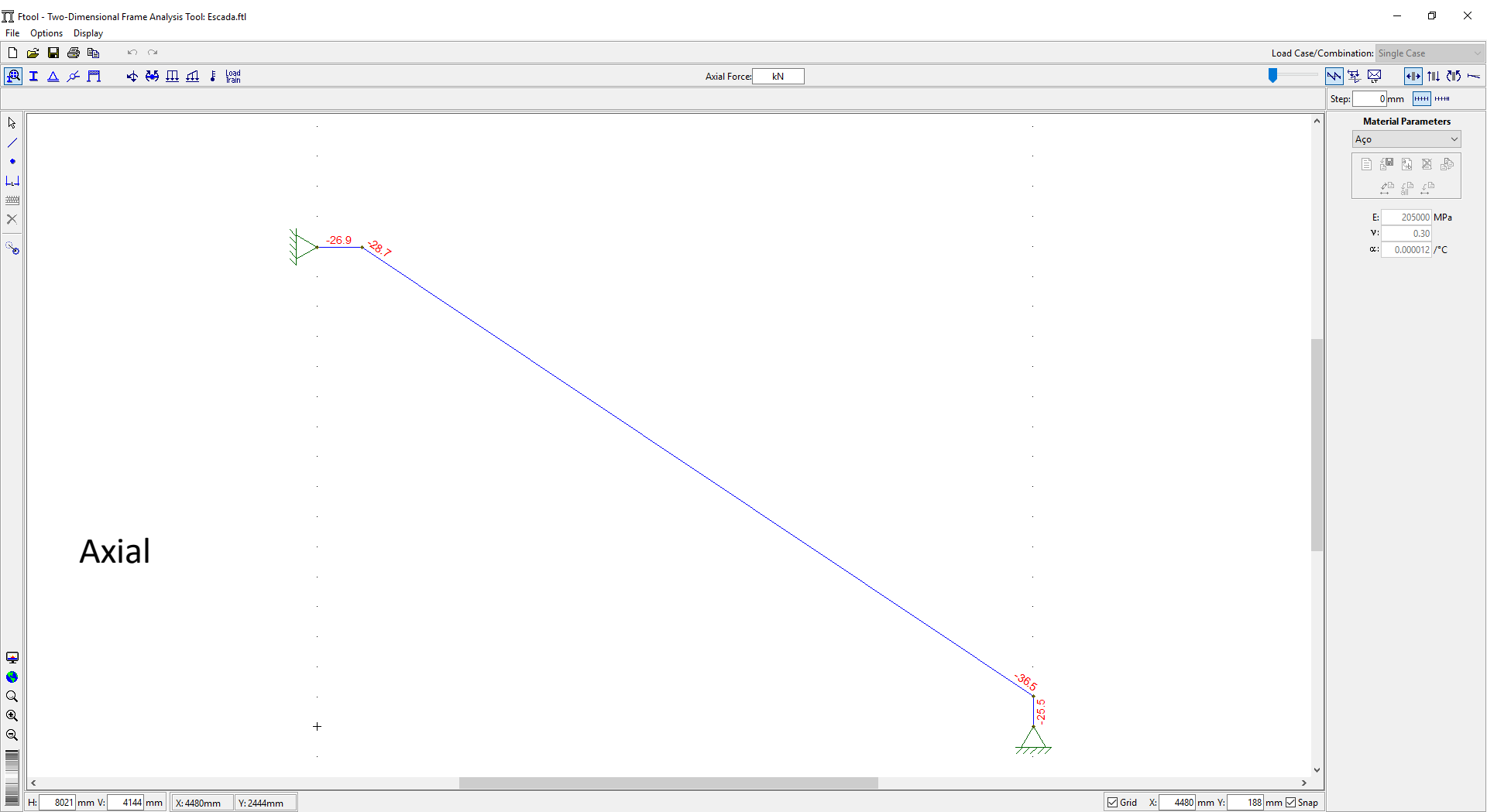
Cálculo da longarina (largura 1000mm)



Cálculo da longarina (largura 1000mm)



Cálculo da longarina (largura 1000mm)



Cálculo da longarina (largura 1000mm)

DimPerfil 4.0 - Dimensionamento de Perfis de Aço Formados a Frio

File Help

Escolha do Perfil Cálculo dos Esforços

Dimensões (cm)

$\alpha = 0$
 $b_w = 15$
 $b_f = 6$
 $D = 2$
 $t = 0.3$
 $\beta = 90$

Comprimentos (cm)

Lx: 553
Ly: 34
Lt: 34

Esforços Solicitantes

Nd: 37 kN
Mxd: 505 kN.cm
Myd: kN.cm
Vd: 27 kN

Coefficiente de Momento

Em X Cb: 1
Em Y Cb: 1

Resultados

Resultado:
Flexão Composta

NBR 14762:2001
0,92 (se ≤ 1 , ok!)

☒ Relatório: ☒ Limpar anterior

CALCULAR

Item a ser calculado: Var

Inequações de verificação p/
Flexão Composta

- NBR 14762:2010
 - Flexão Composta
 - Nrd
 - Mrd
 - Mxrd
 - Myrd
 - Flexão Composta
 - Cortante
 - Flexão e Cisalhamento

Mostrar perfil

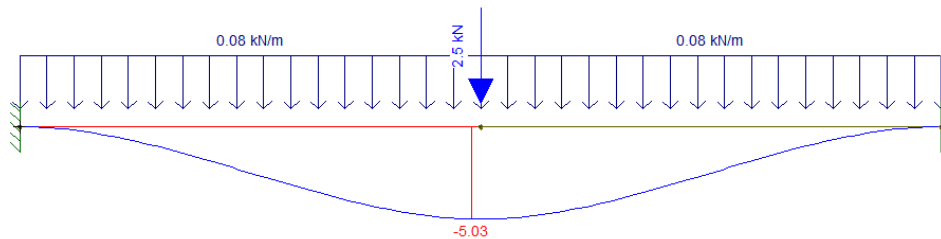
Esforços Solicitantes:
NSd= 37 kN
MxSd= 505 kN.cm
MySd= 0 kN.cm
Esforços Resistentes:
-> NcRd= 109,85 kN
-> MxRd= 865,63 kN.cm
-> MyRd= 224,6 kN.cm
Verificação a Flexão Composta [NBR 14762:2010 - 9.9]
Verificação de Flexo-Compressão
=> $0,34 + 0,58 + 0 = 0,92 \leq 1$ - Ok!
4 - Verificação da Esbeltez Limite
barra submetida a esforço de compressão:
 $\lambda_{limite} = 200$
Verificação em Relação a X
 $r_x = 5,85$ cm
Lx= 553 cm
 $\lambda_x = 94,6$ cm - ok!
Verificação em Relação a Y
 $r_y = 2,2$ cm
Ly= 34 cm
 $\lambda_y = 15,48$ cm - ok!

**Atenção: No DIM PERFIL
Compressão é positivo**

By Edson Lubas Silva

Cálculo da degrau (largura 1000mm)

ELS:

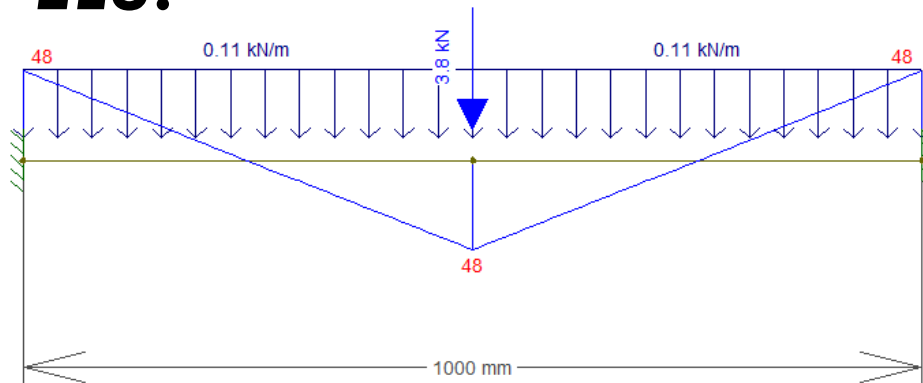


$$f_{max} = \frac{L}{350} = 1000 = 350 = 2,85mm$$

$$1,4PP = 0,112 \text{ kN/m}$$

$$1,5SC = 3,75 \text{ kN}$$

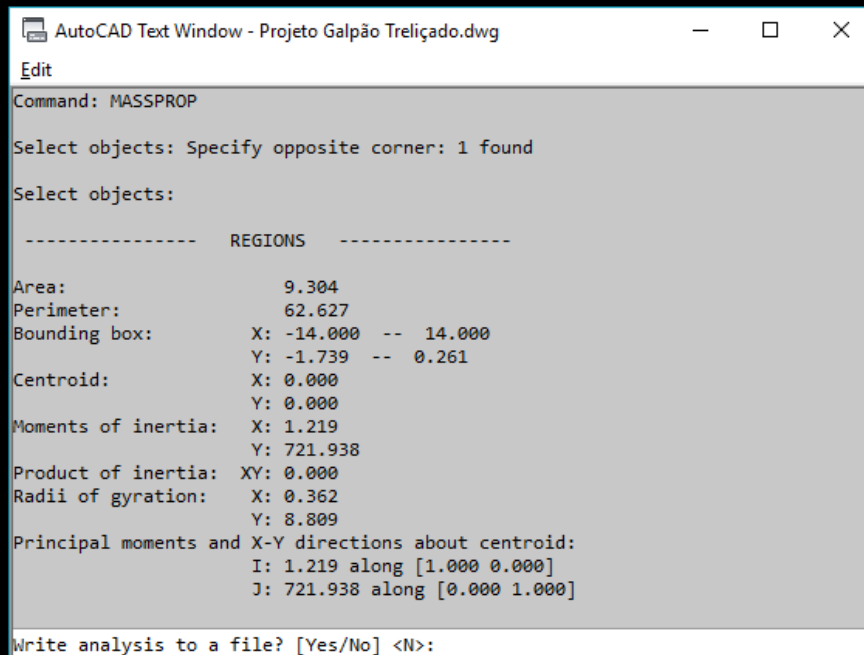
ELU:



TENTATIVA 1:
Espessura de
3,2mm (1/8")

Section Properties	
degrau	
C-shape	
d:	280.00 mm
b:	20.00 mm
tw:	3.18 mm
tf:	3.18 mm
ȳ:	17.34 mm
A:	9.97 cm ²
As:	1.27 cm ²
I:	1.28 cm ⁴

Cálculo da degrau (largura 1000mm)



```
AutoCAD Text Window - Projeto Galpão Trelçado.dwg
Edit
Command: MASSPROP

Select objects: Specify opposite corner: 1 found
Select objects:

----- REGIONS -----
Area:                9.304
Perimeter:           62.627
Bounding box:        X: -14.000 -- 14.000
                     Y: -1.739 -- 0.261
Centroid:            X: 0.000
                     Y: 0.000
Moments of inertia:  X: 1.219
                     Y: 721.938
Product of inertia:  XY: 0.000
Radii of gyration:   X: 0.362
                     Y: 8.809
Principal moments and X-Y directions about centroid:
                     I: 1.219 along [1.000 0.000]
                     J: 721.938 along [0.000 1.000]

Write analysis to a file? [Yes/No] <N>:
```

Cálculo da degrau (largura 1000mm)

Na fibra Comprimida

$$M_{rd} = W_x \cdot \frac{F_y}{1,1} = \frac{I_x}{y_{cg}} \cdot f_y = \frac{1,219}{0,261} \cdot \frac{25}{1,1} = 106,14 \text{ kN.cm} > 48 \text{ kN.cm OK}$$

Na fibra Tracionada

$$M_{rd} = W_x \cdot F_y = \frac{I_x}{y_{cg}} \cdot \frac{f_y}{1,1} = \frac{1,219}{1,739} \cdot \frac{25}{1,1} = 15,92 \text{ kN.cm} < 48 \text{ Não OK!}$$

$$\text{É necessário: } W = \frac{M_{sd} \cdot 1,1}{F_y} \rightarrow W = \frac{48 \cdot 1,1}{25} \rightarrow W = 2,11 \text{ cm}^3$$

Cálculo da degrau (largura 1000mm)

Projet ?

Type de profil

☐ Profil type cornière ☒ Profil type U ☐ Profil type Cé ☐ Profil type Sigma ☐ Profil type Zed

Données

h = 280 mm
t = 4,76 mm
re = 9,52 mm
b1 = 30 mm
b2 = 30 mm

Galvanisation : Noir
Section : Section globale

Référence du projet : Degrau

Section en U
- les semelles peuvent être dissymétriques

Unités de calcul: cm & degré

Orientation du premier élément $\gamma_o = 90^\circ$

1	droit	t=0,476	b=2,048	
2	courbe	t=0,476	re=0,952	$\gamma=-90^\circ$
3	droit	t=0,476	b=26,096	
4	courbe	t=0,476	re=0,952	$\gamma=-90^\circ$
5	droit	t=0,476	b=2,048	

Développée théorique = 32,4351 cm

A = 15,439 cm²

p = 12,12 Kg/m

J = 1,1658 cm⁴

Caractéristiques par rapport aux axes de référence

Coordonnées du centre de gravité :	$Y_g = 0,474$ cm	$Z_g = 14$ cm
Coordonnées du centre de cisailment :	$Y_c = -0,303$ cm	$Z_c = 14$ cm

$I_y = 1269,443$ cm⁴

$v_y = 14$ cm

$I_z = 6,072$ cm⁴

$v_{z,max} = 2,526$ cm

$v_{z,min} = 0,474$ cm

Moment d'inertie sectoriel = 873,8748 cm⁶

$i_y = 9,0677$ cm

$W_{el,y} = 90,674$ cm³

$i_z = 0,6271$ cm

$W_{el,z,min} = 2,404$ cm³

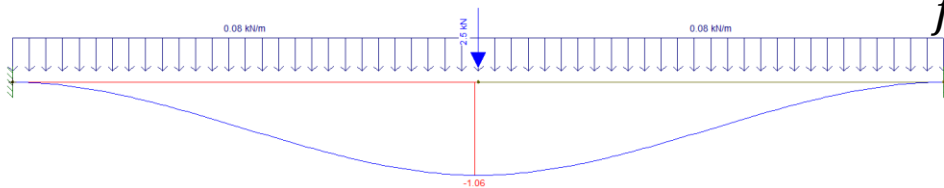
$W_{el,z,max} = 12,802$ cm³

CameliaX

Cálculo da degrau (largura 1000mm)

ELS:

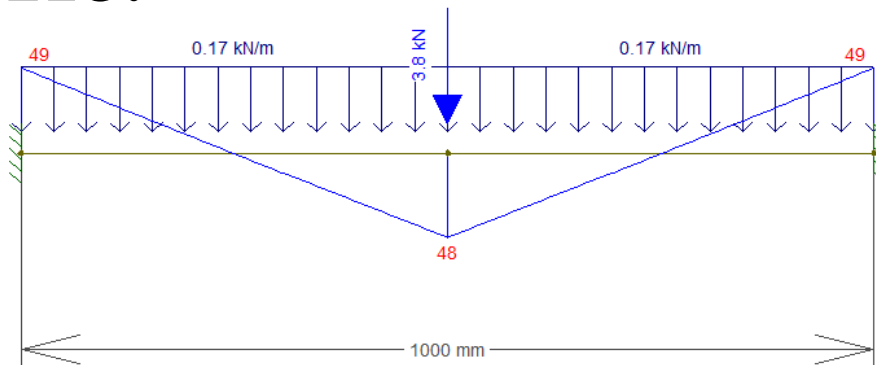
$$f_{max} = \frac{L}{350} = \frac{1000}{350} = 2,85mm$$



$$1,4PP = 0,17 \text{ kN/m}$$

$$1,5SC = 3,75 \text{ kN}$$

ELU:



TENTATIVA 2:
Espessura de
4,76mm (3/16")

Section Properties	
degrau	
C-shape	
d:	280.00 mm
b:	30.00 mm
tw:	4.76 mm
tf:	4.76 mm
ȳ:	25.33 mm
A:	15.73 cm ²
As:	2.86 cm ²
I:	6.11 cm ⁴

Cálculo da degrau (largura 1000mm)

Na fibra Comprimida

$$M_{rd} = W_x \cdot \frac{F_y}{1,1} = \frac{12,8 \cdot 25}{1,1} = 290,9 \text{ kN.cm} > 49 \text{ kN.cm OK}$$

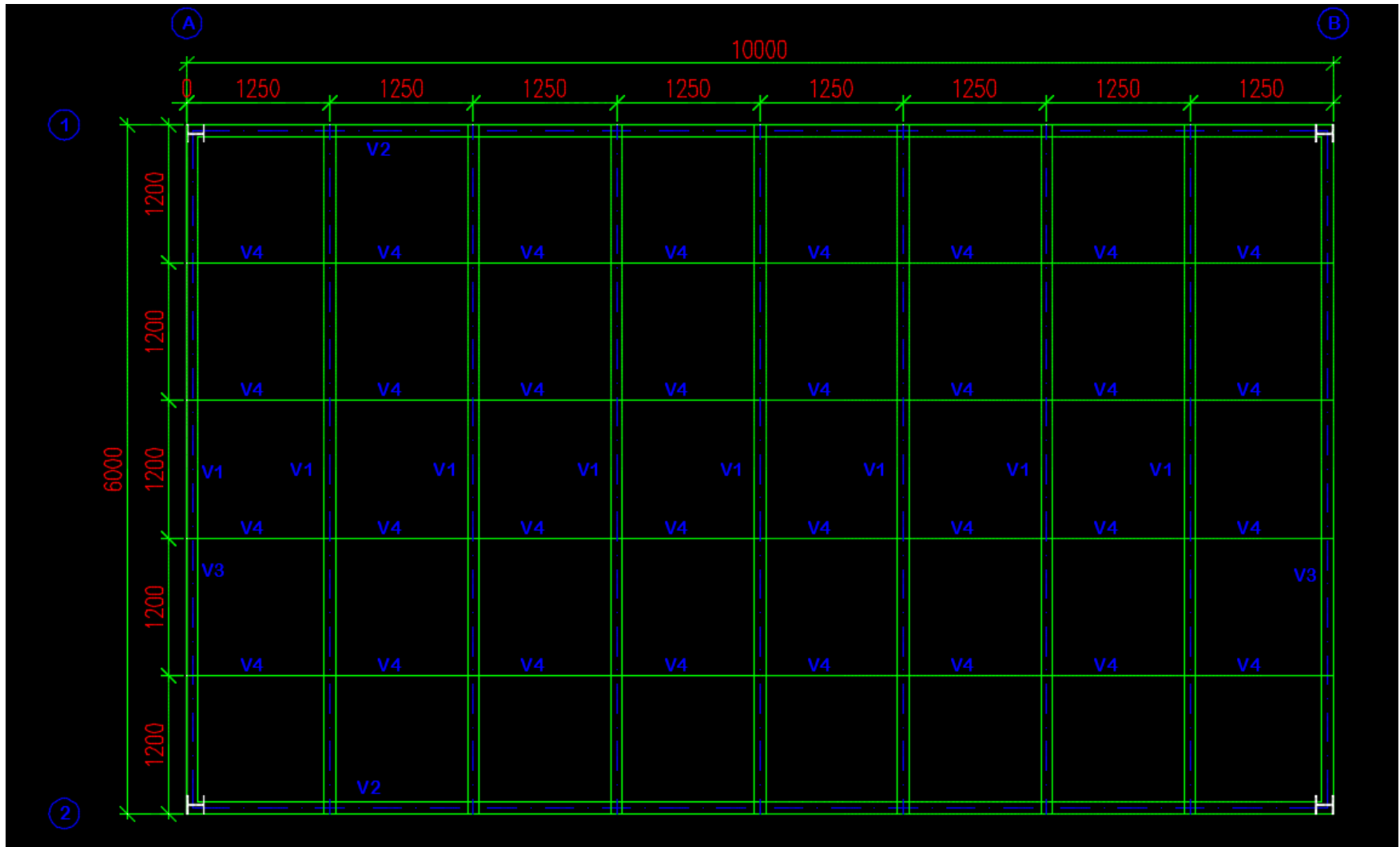
Na fibra Tracionada

$$M_{rd} = W_x \cdot F_y = \frac{2,4 \cdot 25}{1,1} = 54,5 \text{ kN.cm} > 48 \text{ OK!}$$

Dica: Para evitar problemas mantenha a aba abaixo de

$$FLM: \frac{b}{t} = \frac{30}{4,76} = 6,30 \quad \lambda = 0,38 \sqrt{\frac{E}{F_y}} \quad \lambda = 0,38 \sqrt{\frac{20500}{25}} \quad \lambda = 10,88$$

Calcular o Mezanino abaixo: Distância piso a piso= 3 m – Bases Engastadas SC = 500kg/m²



Cálculo de V1

PP

Painel Wall 34kg/m²

Peso da Viga (Aprox: 25kg/m)

PP Total = $(0,34) \cdot 1,25 + 0,25 = 0,675 \text{ kN/m}$ $(\times 1,4 = 0,945 \text{ kN/m})$

SC = $5 \text{ kN/m}^2 \times 1,25 = 6,25 \text{ kN/m}$ $(\times 1,5 = 9,375)$

ELS: PP + SC = $0,675 + 6,25 = 6,925 \text{ kN/m}$

ELU: $1,4PP + 1,5SC = 10,32 \text{ kN/m}$

Cálculo de V1

Considerando V1 bi-apoia temos:

$$f_{max} = \frac{L}{350} = \frac{6000}{350} = 17,14mm$$

$$I_{nec} = \frac{5 \cdot q \cdot L^4}{384 \cdot E \cdot f_{max}} = \frac{5 \cdot 0,06925 \cdot 6000^4}{384 \cdot 20500 \cdot 1,714} = 3325cm^4$$

$$M_{sd} = q \cdot \frac{L^2}{8} = \frac{0,1032 \cdot 6000^2}{8} = 4644kN \cdot cm$$

$$Z_x = M_{sd} \cdot \frac{1,1}{F_y} = 4644 \cdot \frac{1,1}{34,5} = 148cm^3$$

$$ELS: R_y = \frac{6,925 \cdot 6}{2} = 20,775kN$$

$$ELU: R_y = \frac{10,32 \cdot 6}{2} = 30,96kN$$

Cálculo de V1

BITOLA mm x kg/m	Massa Linear kg/m	d mm	b ₁ mm	ESPESSURA		h mm	d' mm	Área cm²	EIXO X - X				EIXO Y - Y				r _i cm	I _y cm⁴	ESBELTEZ		C _u cm⁴	u m²/m	BITOLA mm x kg/m
				t _e mm	t _i mm				I _x cm⁴	W _x cm³	r _x cm	Z _x cm³	I _y cm⁴	W _y cm³	r _y cm	Z _y cm³			ABA - λ ₁ b ₁ / 2t _e	ALMA - λ ₂ d' / t _e			
W 150 x 13,0	13,0	148	100	4,3	4,9	138	118	16,6	635	85,8	6,18	96,4	82	16,4	2,22	25,5	2,60	1,72	10,20	27,49	4.181	0,67	W 150 x 13,0
W 150 x 18,0	18,0	153	102	5,8	7,1	139	119	23,4	939	122,8	6,34	139,4	126	24,7	2,32	38,5	2,69	4,34	7,18	20,48	6.683	0,69	W 150 x 18,0
W 150 x 22,5 (H)	22,5	152	152	5,8	6,6	139	119	29,0	1.229	161,7	6,51	179,6	387	50,9	3,65	77,9	4,10	4,75	11,52	20,48	20.417	0,88	W 150 x 22,5 (H)
W 150 x 24,0	24,0	160	102	6,6	10,3	139	115	31,5	1.384	173,0	6,63	197,6	183	35,9	2,41	55,8	2,73	11,08	4,95	17,48	10.206	0,69	W 150 x 24,0
W 150 x 29,8 (H)	29,8	157	153	6,6	9,3	138	118	38,5	1.739	221,5	6,72	247,5	556	72,6	3,80	110,8	4,18	10,95	8,23	17,94	30.277	0,90	W 150 x 29,8 (H)
W 150 x 37,1 (H)	37,1	162	154	8,1	11,6	139	119	47,8	2.244	277,0	6,85	313,5	707	91,8	3,84	140,4	4,22	20,58	6,64	14,67	39.930	0,91	W 150 x 37,1 (H)
W 200 x 15,0	15,0	200	100	4,3	5,2	190	170	19,4	1.305	130,5	8,20	147,9	87	17,4	2,12	27,3	2,55	2,05	9,62	39,44	8.222	0,77	W 200 x 15,0
W 200 x 19,3	19,3	203	102	5,8	6,5	190	170	25,1	1.686	166,1	8,19	190,6	116	22,7	2,14	35,9	2,59	4,02	7,85	29,31	11.098	0,79	W 200 x 19,3
W 200 x 22,5	22,5	206	102	6,2	8,0	190	170	29,0	2.029	197,0	8,37	225,5	142	27,9	2,22	43,9	2,63	6,18	6,38	27,42	13.868	0,79	W 200 x 22,5
W 200 x 26,6	26,6	207	133	5,8	8,4	190	170	34,2	2.611	252,3	8,73	282,3	330	49,6	3,10	76,3	3,54	7,65	7,92	29,34	32.477	0,92	W 200 x 26,6
W 200 x 31,3	31,3	210	134	6,4	10,2	190	170	40,3	3.168	301,7	8,86	338,6	410	61,2	3,19	94,0	3,60	12,59	6,57	26,50	40.822	0,93	W 200 x 31,3
W 200 x 35,9 (H)	35,9	201	165	6,2	10,2	181	161	45,7	3.437	342,0	8,67	379,2	764	92,6	4,09	141,0	4,50	14,51	8,09	25,90	69.502	1,03	W 200 x 35,9 (H)
W 200 x 41,7 (H)	41,7	205	166	7,2	11,8	181	157	53,5	4.114	401,4	8,77	448,6	901	108,5	4,10	165,7	4,53	23,19	7,03	21,86	83.948	1,04	W 200 x 41,7 (H)
W 200 x 46,1 (H)	46,1	203	203	7,2	11,0	181	161	58,6	4.543	447,6	8,81	495,3	1.535	151,2	5,12	229,5	5,58	22,01	9,23	22,36	141.342	1,19	W 200 x 46,1 (H)
W 200 x 52,0 (H)	52,0	206	204	7,9	12,6	181	157	66,9	5.298	514,4	8,90	572,5	1.784	174,9	5,16	265,8	5,61	33,34	8,10	19,85	166.710	1,19	W 200 x 52,0 (H)
HP 200 x 53,0 (H)	53,0	204	207	11,3	11,3	181	161	68,1	4.977	488,0	8,55	551,3	1.673	161,7	4,96	248,6	5,57	31,93	9,16	14,28	155.075	1,20	HP 200 x 53,0 (H)
W 200 x 59,0 (H)	59,0	210	205	9,1	14,2	182	158	76,0	6.140	584,8	8,99	655,9	2.041	199,1	5,18	303,0	5,64	47,69	7,22	17,32	195.418	1,20	W 200 x 59,0 (H)
W 200 x 71,0 (H)	71,0	216	206	10,2	17,4	181	161	91,0	7.660	709,2	9,17	803,2	2.537	246,3	5,28	374,5	5,70	81,66	5,92	15,80	249.976	1,22	W 200 x 71,0 (H)
W 200 x 86,0 (H)	86,0	222	209	13,0	20,6	181	157	110,9	9.498	855,7	9,26	984,2	3.139	300,4	5,32	458,7	5,77	142,19	5,07	12,06	317.844	1,23	W 200 x 86,0 (H)
W 250 x 17,9	17,9	251	101	4,8	5,3	240	220	23,1	2.291	182,6	9,96	211,0	91	18,1	1,99	28,8	2,48	2,54	9,53	45,92	13.735	0,88	W 250 x 17,9
W 250 x 22,3	22,3	254	102	5,8	6,9	240	220	28,9	2.939	231,4	10,09	267,7	123	24,1	2,06	38,4	2,54	4,77	7,39	37,97	18.629	0,89	W 250 x 22,3
W 250 x 25,3	25,3	257	102	6,1	8,4	240	220	32,6	3.473	270,2	10,31	311,1	149	29,3	2,14	46,4	2,58	7,06	6,07	36,10	22.955	0,89	W 250 x 25,3
W 250 x 28,4	28,4	260	102	6,4	10,0	240	220	36,6	4.046	311,2	10,51	357,3	178	34,8	2,20	54,9	2,62	10,34	5,10	34,38	27.636	0,90	W 250 x 28,4
W 250 x 32,7	32,7	258	146	6,1	9,1	240	220	42,1	4.937	382,7	10,83	428,5	473	64,8	3,35	99,7	3,86	10,44	8,02	36,03	73.104	1,07	W 250 x 32,7
W 250 x 38,5	38,5	262	147	6,6	11,2	240	220	49,6	6.057	462,4	11,05	517,8	594	80,8	3,46	124,1	3,93	17,63	6,56	33,27	93.242	1,08	W 250 x 38,5
W 250 x 44,8	44,8	266	148	7,6	13,0	240	220	57,6	7.158	538,2	11,15	606,3	704	95,1	3,50	146,4	3,96	27,14	5,69	28,95	112.398	1,09	W 250 x 44,8
HP 250 x 62,0 (H)	62,0	246	256	10,5	10,7	225	201	79,6	8.728	709,6	10,47	790,5	2.995	234,0	6,13	357,8	6,89	33,46	11,96	19,10	417.130	1,47	HP 250 x 62,0 (H)
W 250 x 73,0 (H)	73,0	253	254	8,6	14,2	225	201	92,7	11.257	889,9	11,02	983,3	3.880	305,5	6,47	463,1	7,01	56,94	8,94	23,33	552.900	1,48	W 250 x 73,0 (H)
W 250 x 80,0 (H)	80,0	256	255	9,4	15,6	225	201	101,9	12.550	980,5	11,10	1.088,7	4.313	338,3	6,51	513,1	7,04	75,02	8,17	21,36	622.878	1,49	W 250 x 80,0 (H)
HP 250 x 85,0 (H)	85,0	254	260	14,4	14,4	225	201	108,5	12.280	966,9	10,64	1.093,2	4.225	325,0	6,24	499,6	7,00	82,07	9,03	13,97	605.403	1,50	HP 250 x 85,0 (H)
W 250 x 89,0 (H)	89,0	260	256	10,7	17,3	225	201	113,9	14.237	1.095,1	11,18	1.224,4	4.841	378,2	6,52	574,3	7,06	102,81	7,40	18,82	712.351	1,50	W 250 x 89,0 (H)
W 250 x 101,0 (H)	101,0	264	257	11,9	19,6	225	201	128,7	16.352	1.238,8	11,27	1.395,0	5.549	431,8	6,57	656,3	7,10	147,70	6,56	16,87	828.031	1,51	W 250 x 101,0 (H)
W 250 x 115,0 (H)	115,0	269	259	13,5	22,1	225	201	146,1	18.920	1.406,7	11,38	1.597,4	6.405	494,6	6,62	752,7	7,16	212,00	5,86	14,87	975.265	1,53	W 250 x 115,0 (H)
W 310 x 21,0	21,0	303	101	5,1	5,7	292	272	27,2	3.776	249,2	11,77	291,9	98	19,5	1,90	31,4	2,42	3,27	8,86	53,25	21.628	0,98	W 310 x 21,0
W 310 x 23,8	23,8	305	101	5,6	6,7	292	272	30,7	4.346	285,0	11,89	333,2	116	22,9	1,94	36,9	2,45	4,65	7,54	48,50	25.594	0,99	W 310 x 23,8
W 310 x 28,3	28,3	309	102	6,0	8,9	291	271	36,5	5.500	356,0	12,28	412,0	158	31,0	2,08	49,4	2,55	8,14	5,73	45,20	35.441	1,00	W 310 x 28,3
W 310 x 32,7	32,7	313	102	6,6	10,8	291	271	42,1	6.570	419,8	12,49	485,3	192	37,6	2,13	59,8	2,58	12,91	4,72	41,12	43.612	1,00	W 310 x 32,7
W 310 x 38,7	38,7	310	165	5,8	9,7	291	271	49,7	8.581	553,6	13,14	615,4	727	88,1	3,82	134,9	4,38	13,20	8,51	46,66	163.728	1,25	W 310 x 38,7
W 310 x 44,5	44,5	313	166	6,6	11,2	291	271	57,2	9.997	638,8	13,22	712,8	855	103,0	3,87	158,0	4,41	19,90	7,41	41,00	194.433	1,26	W 310 x 44,5
W 310 x 52,0	52,0	317	167	7,6	13,2	291	271	67,0	11.909	751,4	13,33	842,5	1.026	122,9	3,91	188,8	4,45	31,81	6,33	35,61	236.422	1,27	W 310 x 52,0
HP 310 x 79,0 (H)	79,0	299	306	11,0	11,0	277	245	100,0	16.316	1.091,3	12,77	1.210,1	5.258	343,7	7,25	525,4	8,20	46,72	13,91	22,27	1.089.258	1,77	HP 310 x 79,0 (H)
HP 310 x 93,0 (H)	93,0	303	308	13,1	13,1	277	245	119,2	19.682	1.299,1	12,85	1.450,3	6.387	414,7	7,32	635,5	8,26	77,33	11,76	18,69	1.340.320	1,78	HP 310 x 93,0 (H)
W 310 x 97,0 (H)	97,0	308	305	9,9	15,4	277	245	123,6	22.284	1.447,0	13,43	1.594,2	7.286	477,8	7,68	725,0	8,38	92,12	9,90	24,77	1.558.682	1,79	W 310 x 97,0 (H)
W 310 x 107,0 (H)	107,0	311	306	10,9	17,0	277	245	136,4	24.839	1.597,3	13,49	1.768,2	8.123	530,9	7,72	806,1	8,41	122,86	9,00	22,48	1.754.271	1,80	W 310 x 107,0 (H)
HP 310 x 110,0 (H)	110,0	308	310	15,4	15,5	277	245	141,0	23.703	1.539,1	12,97	1.730,6	7.707	497,3	7,39	763,7	8,33	125,66	10,00	15,91	1.646.104	1,80	HP 310 x 110,0 (H)

Cálculo de V4

PP

Painel Wall 34kg/m²

Peso da Viga (Aprox: 15kg/m)

PP Total = $(0,34) \cdot 1,20 + 0,15 = 0,56 \text{ kN/m}$ $(\times 1,4 = 0,78 \text{ kN/m})$

SC = $5 \text{ kN/m}^2 \times 1,20 = 6,0 \text{ kN/m}$ $(\times 1,5 = 9,00)$

ELS: $PP + SC = 0,56 + 6,00 = 6,56 \text{ kN/m}$

ELU: $1,4PP + 1,5SC = 9,78 \text{ kN/m}$

Cálculo de V4

Considerando V4 bi-apoiada temos:

$$f_{max} = \frac{L}{350} = \frac{1250}{350} = 3,57mm$$

$$Inec = \frac{5 \cdot q \cdot L^4}{384 \cdot E \cdot f_{max}} = \frac{5 \cdot 0,06 \cdot 125^4}{384 \cdot 20500 \cdot 0,357} = 26 \text{ cm}^4$$

$$M_{sd} = q \cdot \frac{L^2}{8} = \frac{0,0978 \cdot 125^2}{8} = 191kN \cdot cm$$

$$M_{Rd} = \frac{W_x \cdot F_y}{1,1} \rightarrow W_x = \frac{1,1 \cdot M_{sd}}{F_y} \rightarrow \frac{1,1 \cdot 191}{25} \rightarrow 8,4cm^3$$

$$FLM: \frac{b}{t} = \frac{76,2}{6,35} = 12$$

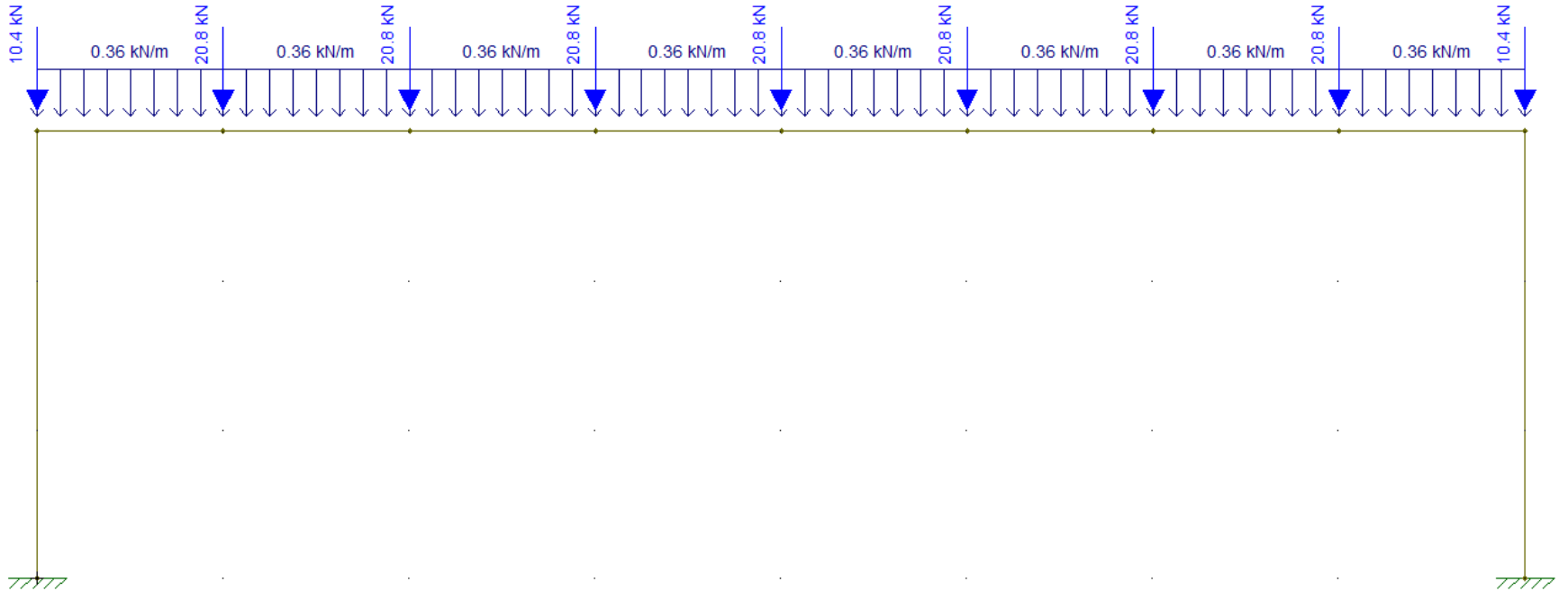
$$\lambda = 0,56 \sqrt{\frac{20500}{25}} = 16$$

Cantoneira em Polegadas										
b	Peso Nominal	t	Área	I _x =I _y	W _x =W _y	r _x =r _y	r _z min.	x		
pol	mm	kg/m	pol	mm	cm ²	cm ⁴	cm ³	cm	cm	cm
5/8"	15,88	0,57		2,5						
3/4"	19,05	0,71		2,5						
1/2"	12,70	0,55	1/8"	3,18	0,70	0,10	0,11	0,37	0,25	0,43
5/8"	15,88	0,71	1/8"	3,18	0,90	0,20	0,19	0,47	0,32	0,51
3/4"	19,05	0,87	1/8"	3,18	1,11	0,36	0,27	0,57	0,38	0,59
7/8"	22,20	1,04	1/8"	3,18	1,32	0,58	0,38	0,66	0,46	0,66
1"	25,40	1,19	1/8"	3,18	1,48	0,83	0,49	0,79	0,48	0,76
		1,73	3/16"	4,76	2,19	1,25	0,66	0,76	0,48	0,81
		2,22	1/4"	6,35	2,84	1,66	0,98	0,76	0,48	0,86
1.1/4"	31,75	1,50	1/8"	3,18	1,93	1,67	0,82	0,97	0,64	0,89
		2,20	3/16"	4,76	2,77	2,50	1,15	0,97	0,61	0,97
		2,86	1/4"	6,35	3,62	3,33	1,47	0,94	0,61	1,02
1.1/2"	38,10	1,83	1/8"	3,18	2,32	3,33	1,15	1,17	0,76	1,07
		2,68	3/16"	4,76	3,42	4,58	1,64	1,17	0,74	1,12
		3,48	1/4"	6,35	4,45	5,83	2,13	1,15	0,74	1,19
1.3/4"	44,45	2,14	1/8"	3,18	2,71	5,41	1,64	1,40	0,89	1,22
		3,15	3/16"	4,76	4,00	7,50	2,30	1,37	0,89	1,30
		4,12	1/4"	6,35	5,22	9,57	3,13	1,35	0,86	1,35
2"	50,80	2,46	1/8"	3,18	3,10	7,91	2,13	1,60	1,02	1,40
		3,63	3/16"	4,76	4,58	11,70	3,13	1,58	1,02	1,45
		4,74	1/4"	6,35	6,06	14,60	4,10	1,55	0,99	1,50
		5,83	5/16"	7,94	7,42	17,50	4,91	1,53	0,99	1,55
2.1/2"	63,50	6,99	3/8"	9,52	8,76	20,00	5,73	1,50	0,99	1,63
		4,57	3/16"	4,76	5,80	23,00	4,91	1,98	1,24	1,75
		6,10	1/4"	6,35	7,67	29,00	6,40	1,96	1,24	1,83
		7,44	5/16"	7,94	9,48	35,00	7,87	1,93	1,24	1,88
3"	76,20	8,78	3/8"	9,52	11,16	41,00	9,35	1,91	1,22	1,93
		5,52	3/16"	4,76	7,03	40,00	7,21	2,39	1,50	2,08
		7,29	1/4"	6,35	9,29	50,00	9,50	2,36	1,50	2,13
		9,07	5/16"	7,94	11,48	62,00	11,60	2,34	1,50	2,21
3.1/2"	88,90	10,71	3/8"	9,52	13,61	75,00	13,60	2,31	1,47	2,26
		14,00	1/2"	12,7	17,74	91,00	18,00	2,29	1,47	2,36
		8,56	1/4"	6,35	10,90	83,70	13,00	2,77	1,76	2,46
		10,59	5/16"	7,94	13,50	102,00	16,00	2,75	1,75	2,52
4"	101,60	12,58	3/8"	9,52	16,00	121,00	19,20	2,75	1,75	2,58
		9,81	1/4"	6,35	12,51	125,00	16,40	3,17	2,00	2,77
		12,19	5/16"	7,94	15,48	154,00	21,30	3,15	2,00	2,84
		14,57	3/8"	9,52	18,45	183,00	24,60	3,12	2,00	2,90
5"	127,00	16,80	7/16"	11,11	21,35	208,00	29,50	3,12	1,98	2,95
		19,03	1/2"	12,7	24,19	233,00	32,80	3,10	1,98	3,00
		12,34	1/4"	6,35	15,73	251,63	27,09	4,00	2,53	3,41
		15,31	5/16"	7,94	19,50	308,00	33,40	3,97	2,53	3,47
6"	152,40	18,30	3/8"	9,52	23,29	362,00	39,50	3,94	2,51	3,53
		24,10	1/2"	12,7	30,64	470,00	52,50	3,91	2,49	3,63
		29,80	5/8"	15,88	37,80	566,00	64,00	3,86	2,46	3,76
		23,52	7/16"	11,11	26,96	416,68	45,71	3,93	2,50	3,58
8"	203,20	22,20	3/8"	9,52	28,10	641,00	57,40	4,78	3,02	4,17
		29,20	1/2"	12,7	37,09	828,00	75,40	4,72	3,00	4,27
		36,00	5/8"	15,88	45,86	1007,00	93,50	4,67	2,97	4,39
		42,70	3/4"	19,05	54,44	1173,00	109,90	4,65	2,97	4,52

Vamos usar uma cantoneira L3"X6,35mm

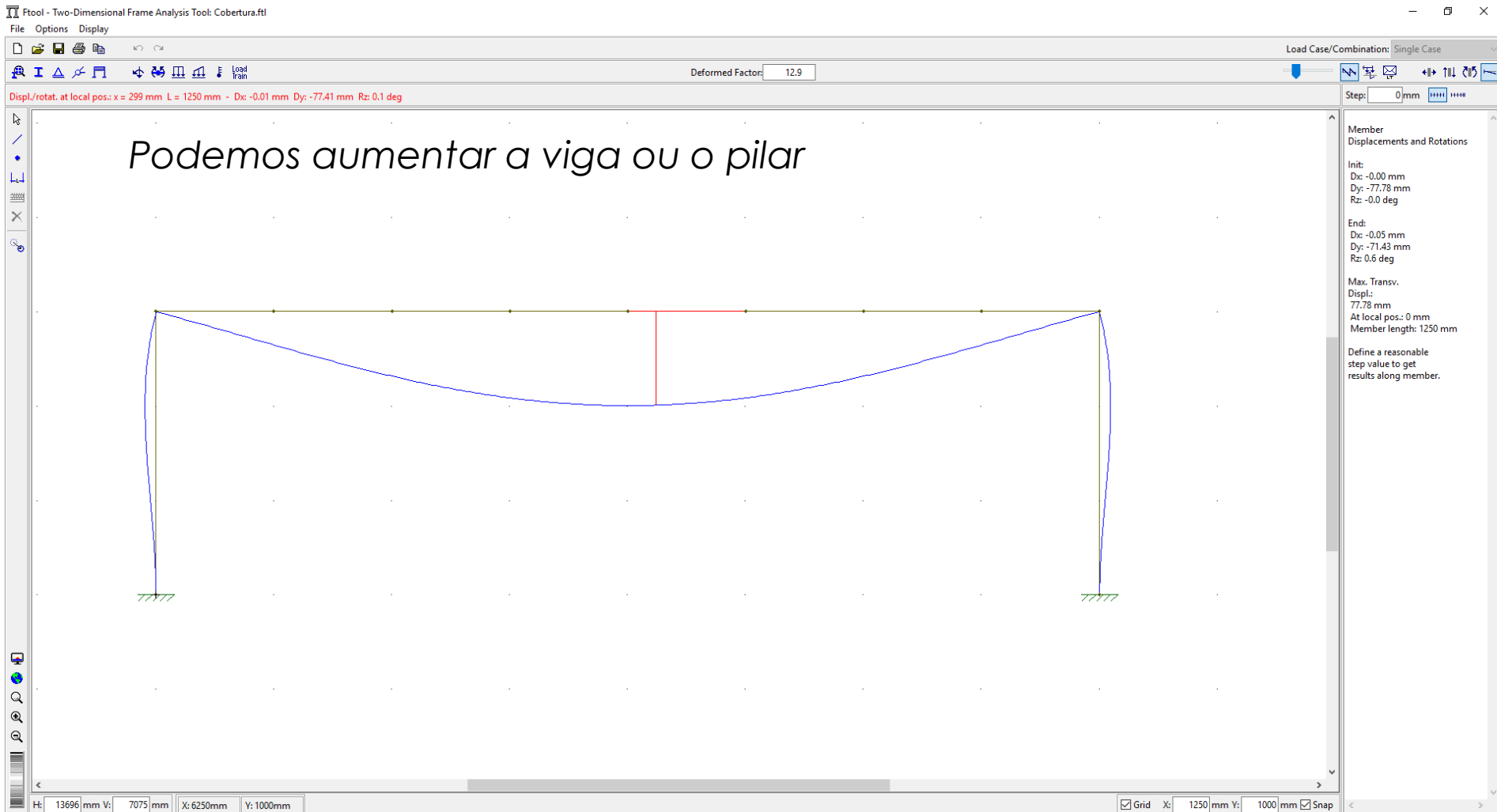
Cálculo de V2

Tentativa 1: Viga W360X32,9 Pilar W150X22,5 H



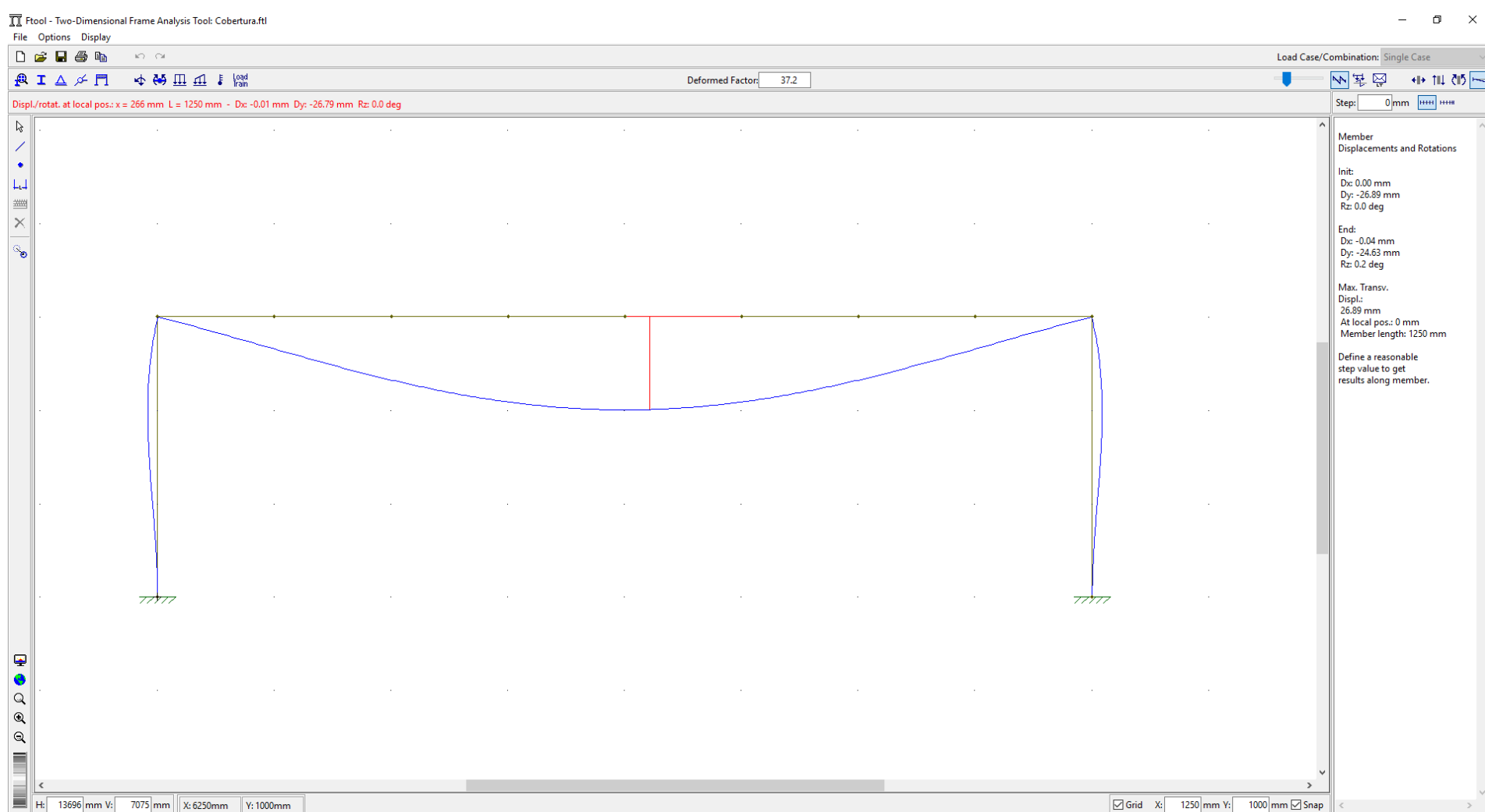
Cálculo de V2

Flecha muito elevada.



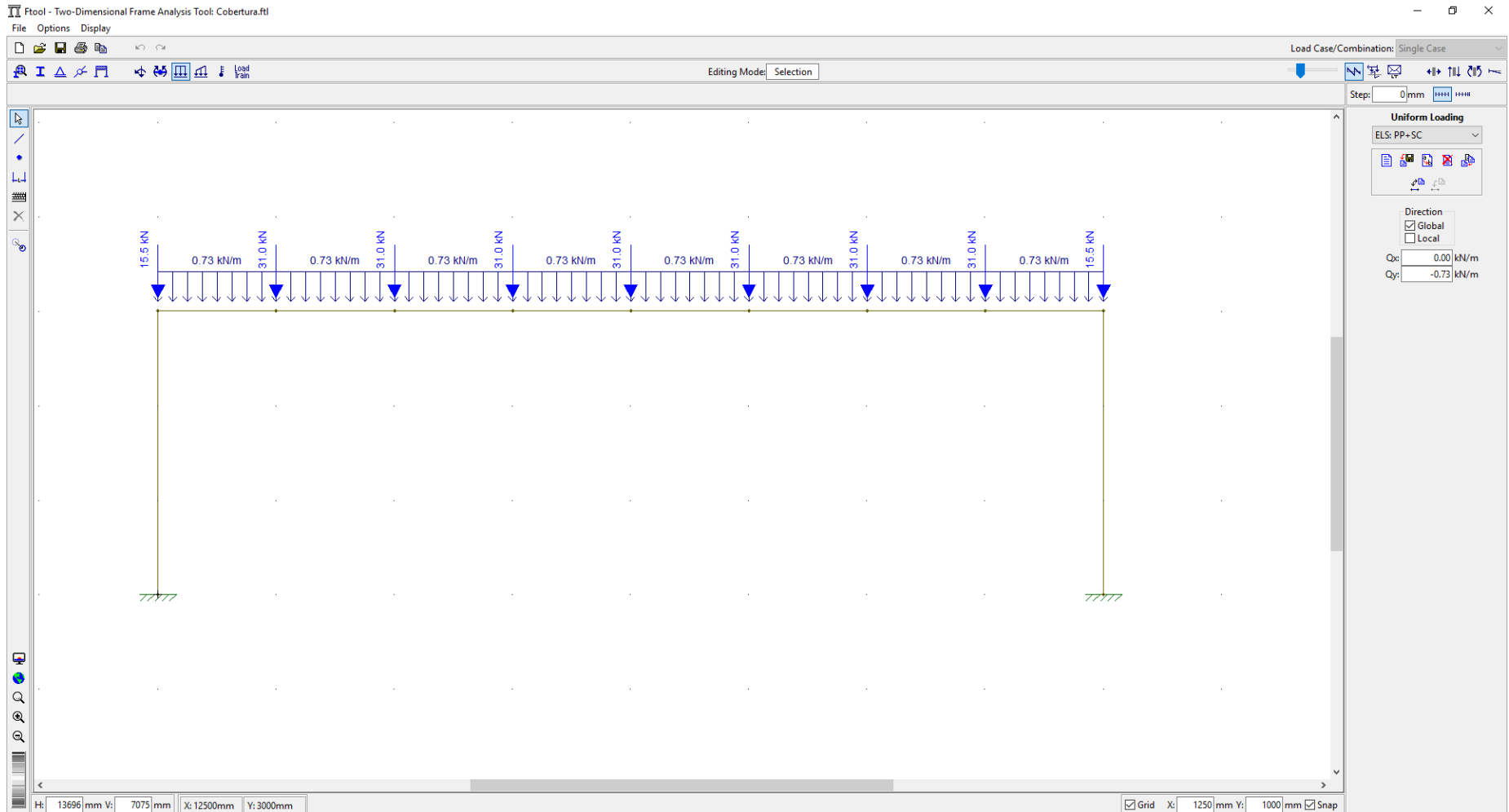
Cálculo de V2

Atingiu-se a flecha ideal com:
Viga W460X53 Pilar W200X46,1



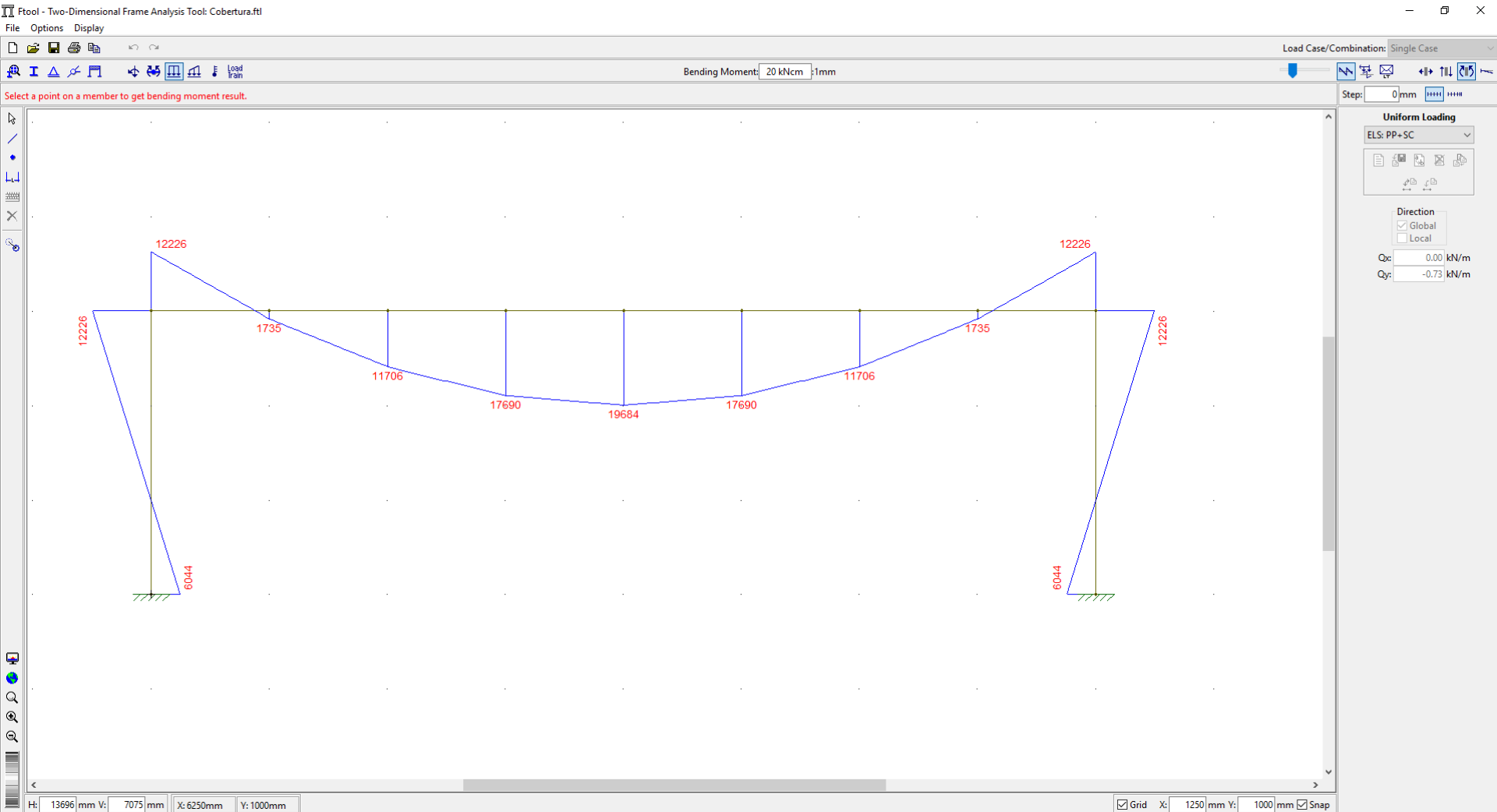
Cálculo de V2 Carregamentos para ELU

Atingiu-se a flecha ideal com:
Viga W460X52 Pilar W200X46,1



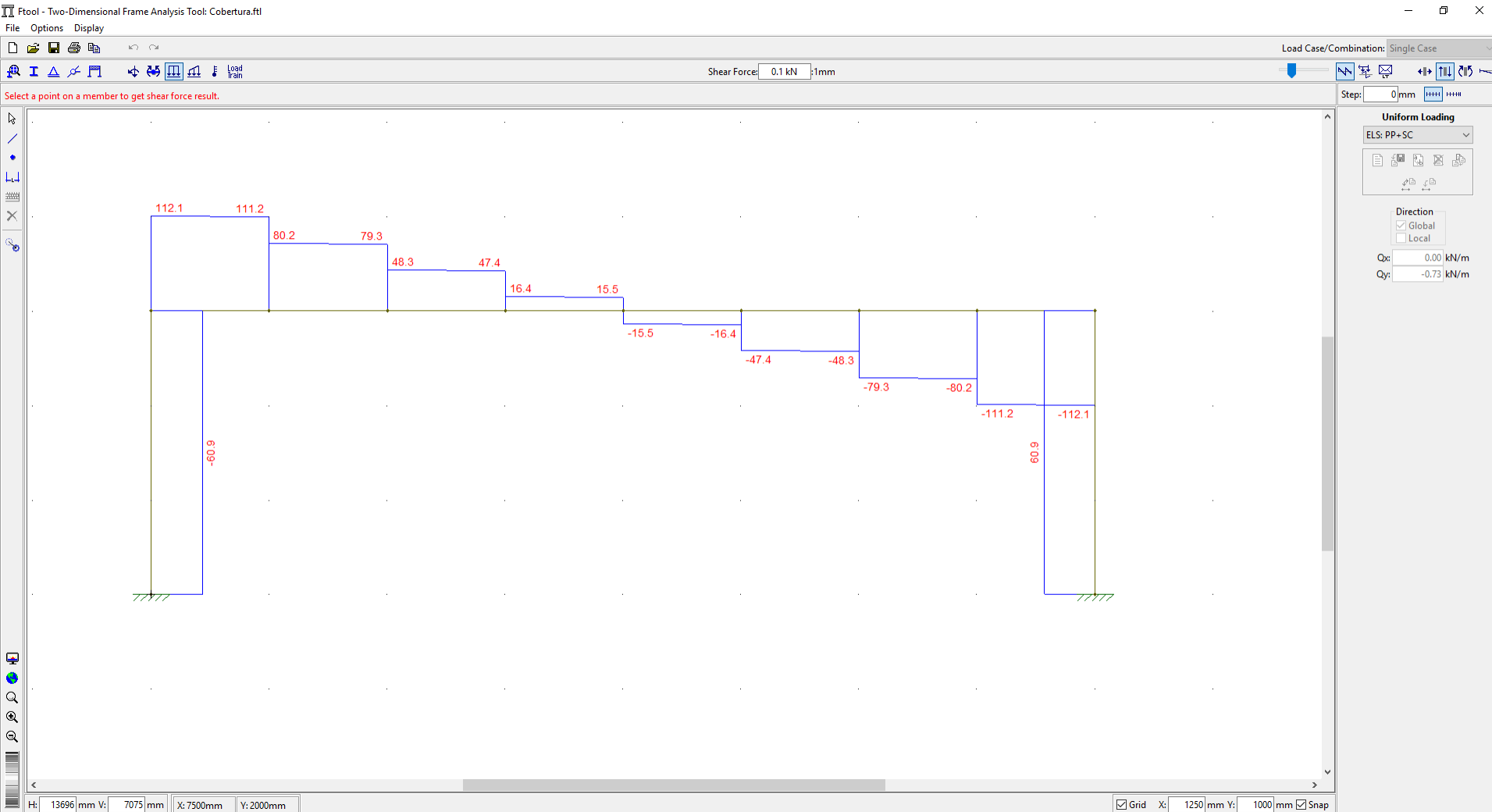
Cálculo de V2

Atingiu-se a flecha ideal com:
Viga W460X52 Pilar W200X46,1



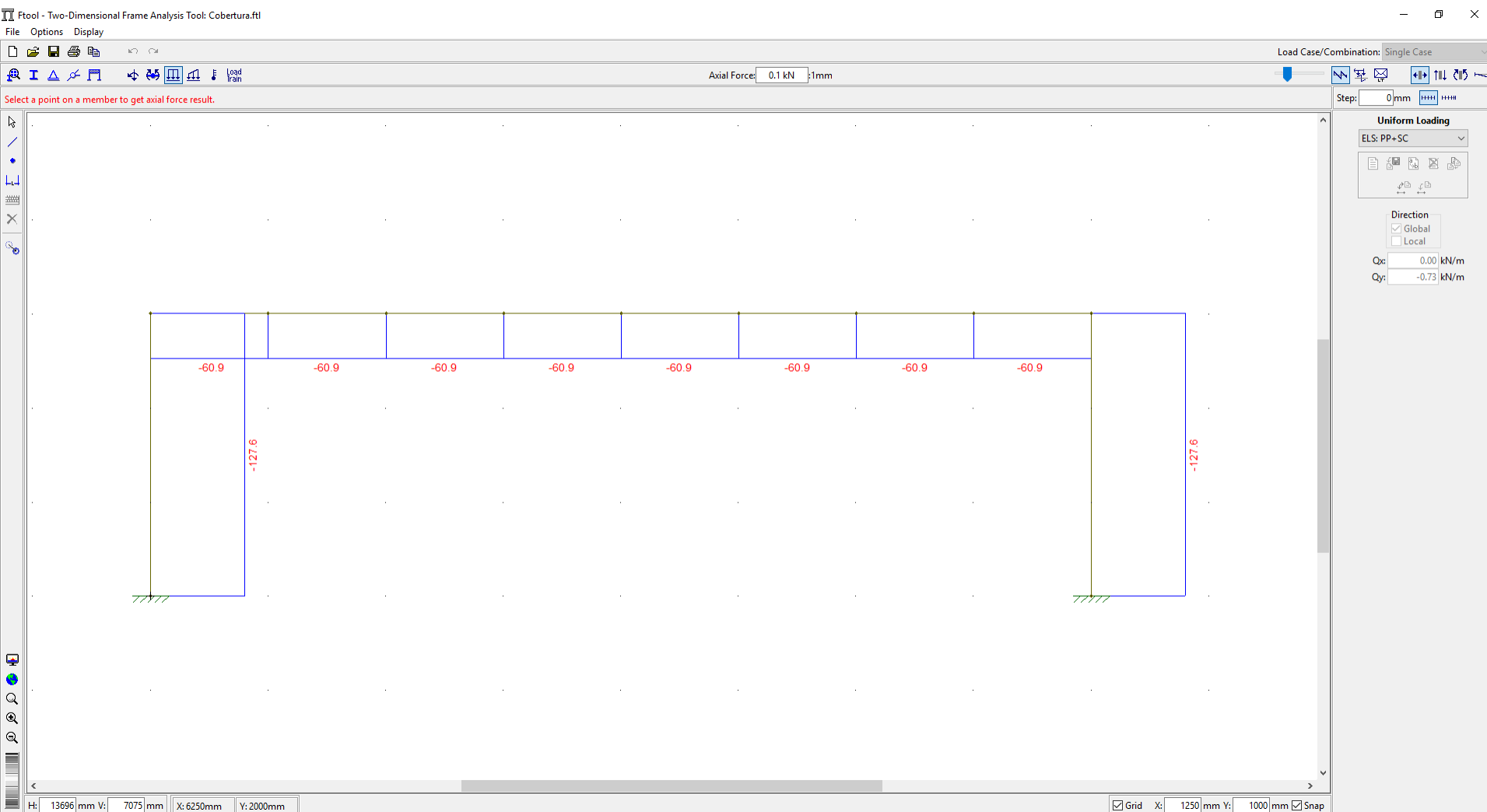
Cálculo de V2

Atingiu-se a flecha ideal com:
Viga W460X52 Pilar W200X46,1



Cálculo de V2

Atingiu-se a flecha ideal com:
Viga W460X52 Pilar W200X46,1



Cálculo de V2

Atingiu-se a flecha ideal com:
Viga W460X52 Pilar W200X46,1

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Arial

11

A

A

N

I

B

Fonte

Quebrar Texto Automaticamente

Mesclar e Centralizar

Alinhamento

Geral

%

000

0,00

0%

Número

Formatação Condicional

Formatar como Tabela

Normal 2

Virgula 2

Normal

Bom

Incorreto

Neutra

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Edição

C13

19684

A

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C

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E

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G

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L

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P

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S

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28

29

30

31

Ativar Planilha

Esforços e Distâncias

Lx (mm)

10000

Ly (mm)

1250

N(kN)

-60,9

Vx(kN)

0

Vy(kN)

112

Mx(kN.cm)

19684

My(kN.cm)

0

Ixx

1

Iyy

1

ky

1

kz

1

d (mm)

0

Lb (mm)

1250

Material

ASTM A572GR50

Fy (kN/cm²)

34,5

Dados para Cálculo de Nrd

Qa

1,00

Qs

1,00

Q

1,00

Nex(kN)

4323,7

r0(cm)

18,2

Ney(kN)

8209,6

Nez(kN)

12458,04

λ0

0,73

χ

0,801

Resultado:

59,1%

W 460 x 52,0

d(mm)

450

Wx(cm²)

949,8

rx(cm)

17,91

bff(mm)

152

Wy(cm²)

83,5

ry(cm)

3,09

d'(mm)

404

Zx(cm³)

1095,9

Área(cm²)

66,6

tw(mm)

7,6

Zy(cm³)

131,7

ho/tw

53,2

tf(mm)

10,8

Ix(cm4)

21370

b/ff

7,0

h(mm)

428,4

Iy(cm4)

634

Peso (kg/m)

52,0

1. Verificação da Esbeltez do perfil

Limite

Real

Status

%

27,9%

200

56

OK

27,9%

λx

200

40

OK

20,2%

λy

2. Resistência à tração

Nrd(kN)

Nsd(kN)

Status

%

Coef. S

N.A

0

N.A

0,0%

1,1

3. Resistência à Compressão

Nrd(kN)

Nsd(kN)

Status

%

Coef. S

1672

60,9

OK

3,6%

1,1

4. Resistência à Flexão eixo X-X

Mrd(kN.cm)

Msd(kN.cm)

Status

%

Coef. S

34371

19684

OK

57,3%

1,1

Listar Perfis que atendem

Perfil

Peso

%

W 250 x 25,3

25,30

82,50%

W 200 x 26,6

26,60

71,61%

W 310 x 28,3

28,30

66,66%

W 250 x 28,4

28,40

69,00%

W 150 x 29,8 (H)

29,80

72,87%

W 200 x 31,3

31,30

58,21%

W 250 x 32,7

32,70

47,54%

W 310 x 32,7

32,70

54,29%

W 360 x 32,9

32,90

44,08%

W 200 x 35,9 (H)

35,90

48,47%

W 150 x 37,1 (H)

37,10

56,69%

W 250 x 38,5

38,50

38,52%

W 310 x 38,7

38,70

32,69%

W 410 x 38,8

38,80

65,99%

W 360 x 39,0

39,00

34,95%

W 200 x 41,7 (H)

41,70

40,61%

W 360 x 44,0

44,00

26,11%

W 310 x 44,5

44,50

27,95%

W 250 x 44,8

44,80

32,42%

W 200 x 46,1 (H)

46,10

35,48%

W 410 x 46,1

46,10

29,66%

W 360 x 51,0

51,00

22,61%

W 200 x 52,0 (H)

52,00

30,60%

W 310 x 52,0

52,00

23,40%

Perfis I-H Laminados

Calcular Lista

Tabela de Perfis

Aços

Plan5

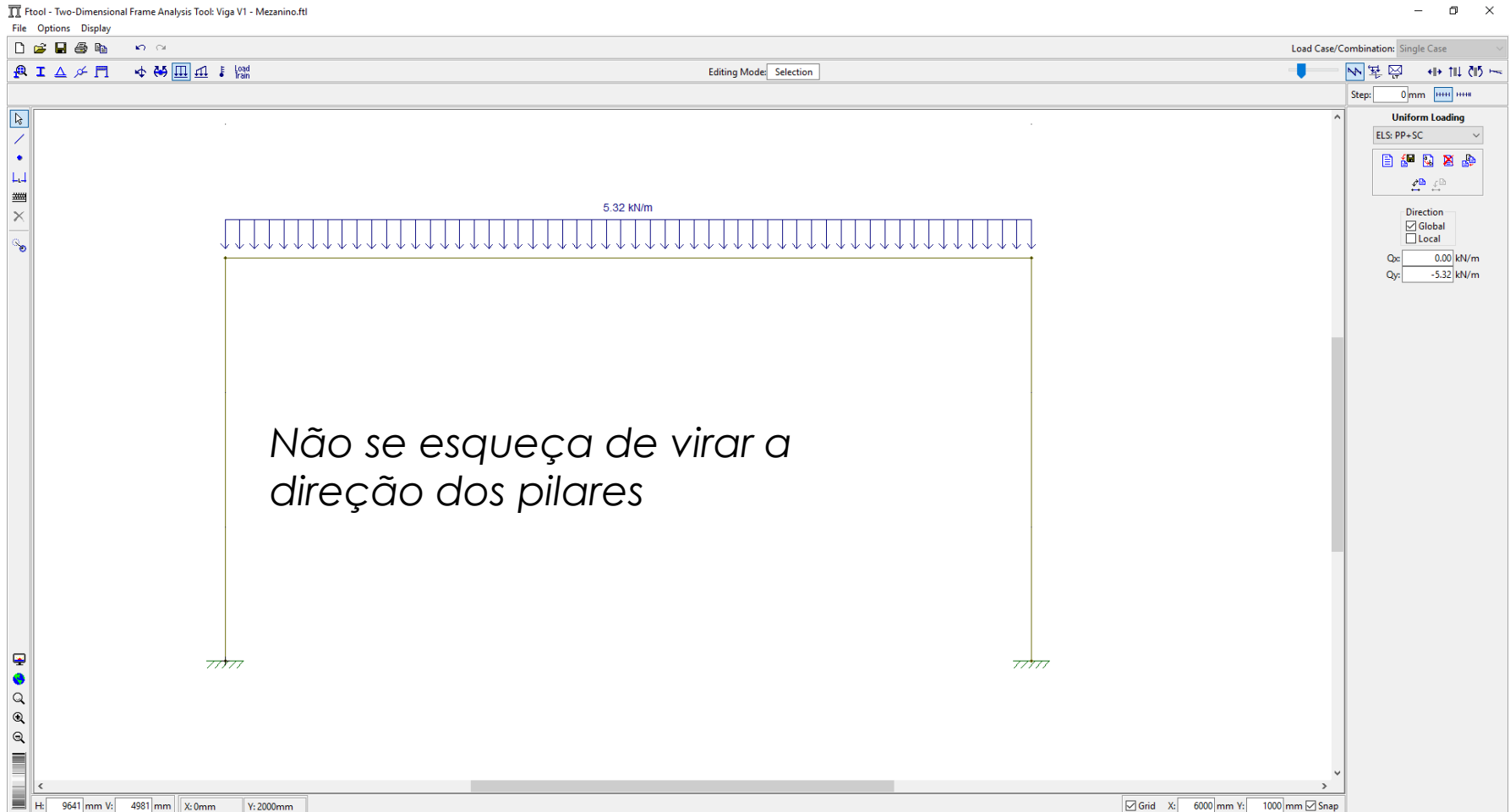
Pronto

115%

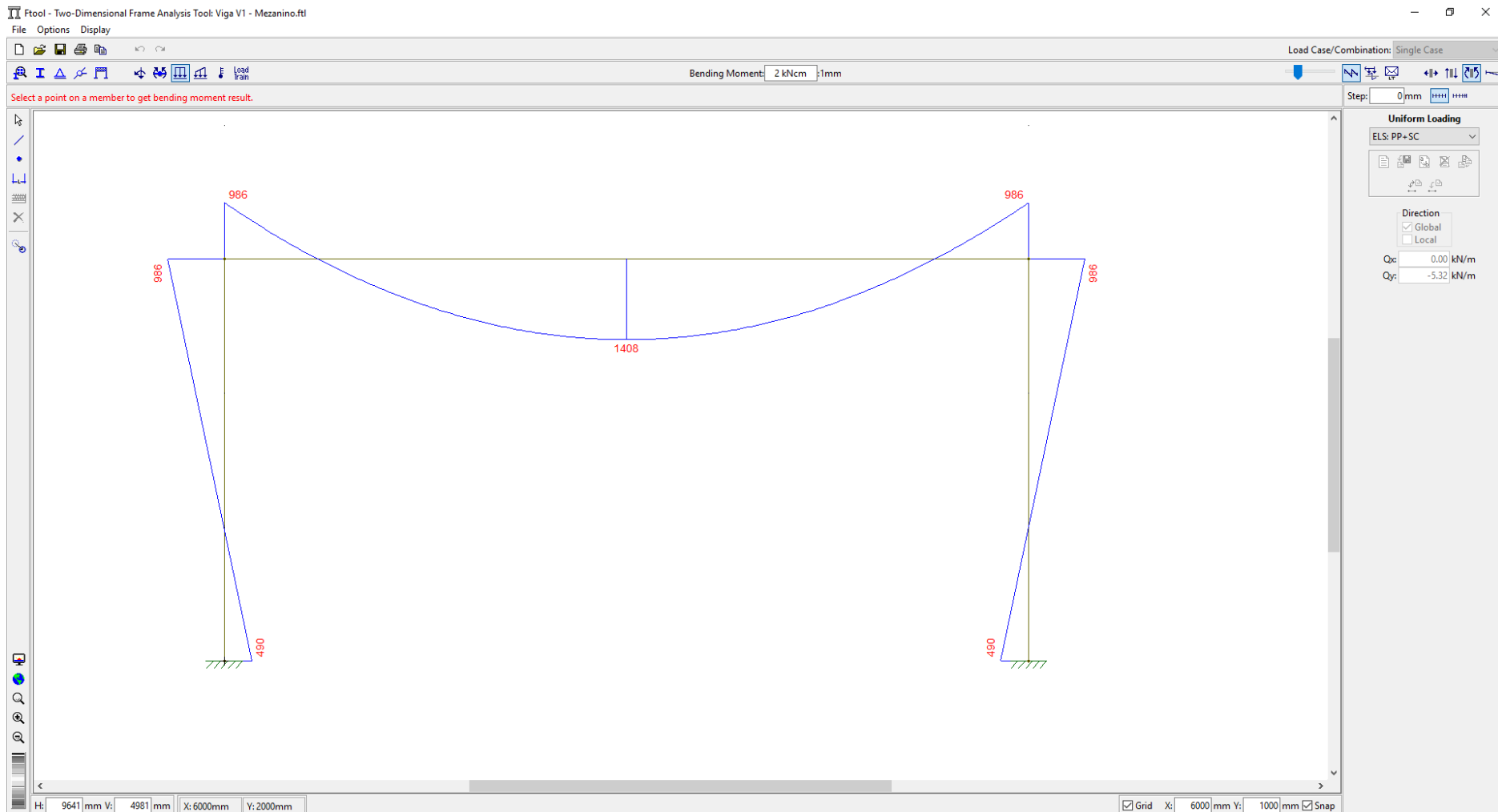
Cálculo dos pilares

Eixo A ou B

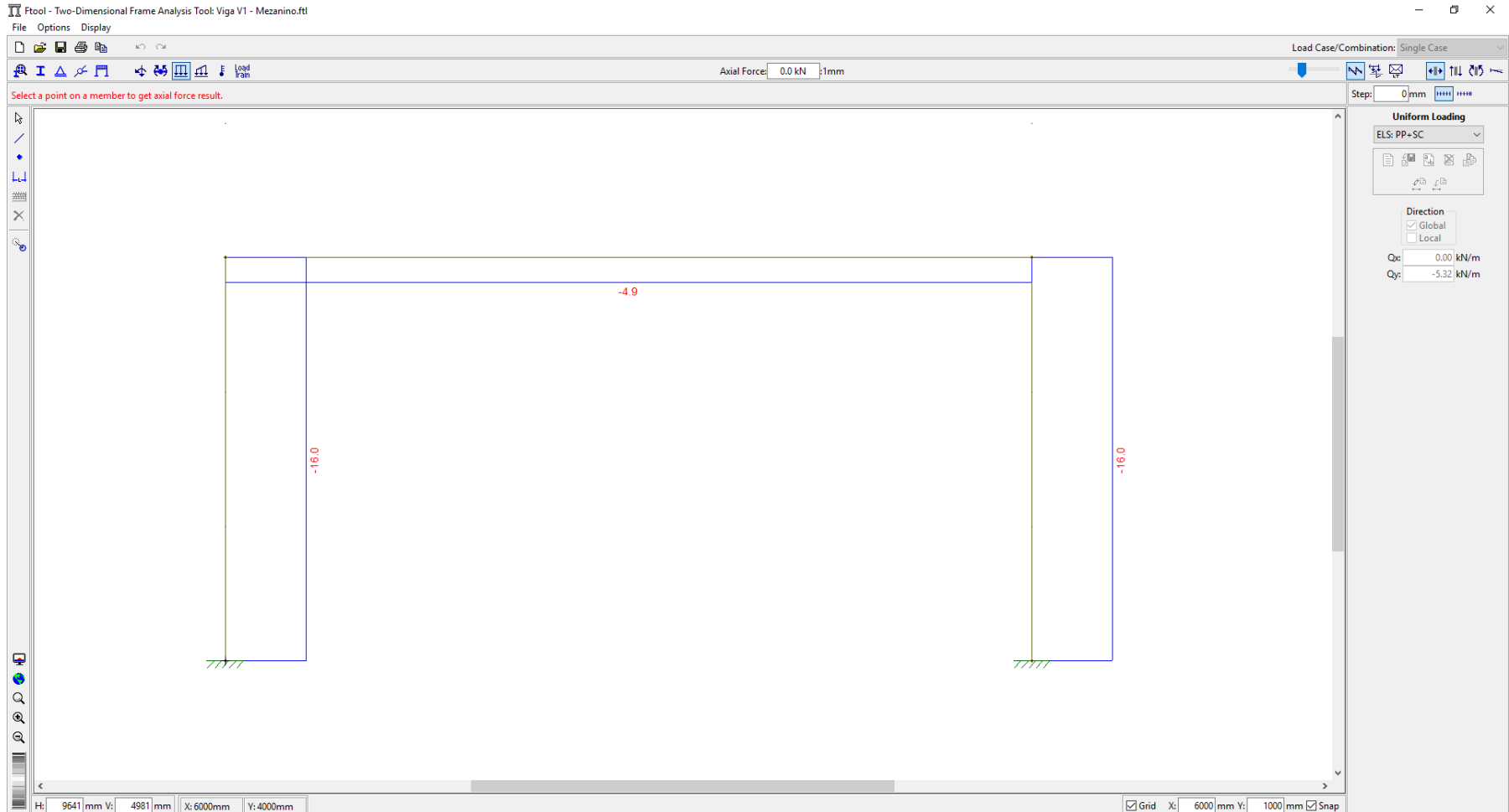
Lança-se a Carga no ELU para extrair a compressão e o momento fletor oriundos desse eixo



Cálculo dos pilares



Cálculo dos pilares



Cálculo dos pilares

Dimensionamento de Perfis I e H Laminados Padrão Açominas

Esforços e Distâncias			
Lx (mm)	3000		
Ly (mm)	3000		
N(kN)	-143,6		
Vx(kN)	0		
Vy(kN)	60,9		
Mx(kN.cm)	12226		
My(kN.cm)	986		
kx	0,7		
ky	0,7	kz	1
d (mm)	0	Cb	1
Lb (mm)	3000		
Material			
ASTM A572GR50			
Fy (kN/cm²)	34,5		

Dados para Cálculo de NRD			
Q	1,00		
Nex(kN)	20842,9	r0(cm)	10,2
Ney(kN)	7042,4	Nez(kN)	4692,50
λ0	0,66		
χ	0,835		
Esbeltez Limite FLA X-X		Esbeltez Limite FLA Y-Y	
λalma	25,14	λalma	25,14
λb	21,85	λb	27,20

Resultado:

101,7%

W 200 x 46,1 (H)					
d(mm)	203	Wx(cm²)	447,6	rx(cm)	8,81
bf(mm)	203	Wy(cm²)	151,2	ry(cm)	5,12
d'(mm)	161	Zx(cm³)	495,3	Área(cm²)	58,6
tw(mm)	7,2	Zy(cm³)	229,5	ho/tw	22,4
tf(mm)	11	Ix(cm4)	4543	b/tf	9,2
h(mm)	181	Iy(cm4)	1535	Peso (kg/m)	46,1
Limite:		36,3	Compacta		
Limite:		13,7	25,1	Compacta	

1. Verificação da Esbeltez do perfil				
Limite	Real	Status	%	20,5%
200	24	OK	11,9%	λx
200	41	OK	20,5%	λy

2. Resistência à tração				
Nrd(kN)	Nsd(kN)	Status	%	Coef. S
N.A	0	N.A	0,0%	1,1

3. Resistência à Compressão				
Nrd(kN)	Nsd(kN)	Status	%	Coef. S
1535	143,6	OK	9,4%	1,1

4. Resistência à Flexão eixo X-X				
Mrd(kN.cm)	Msd(kN.cm)	Status	%	Coef. S
14700	12226	OK	83,2%	1,1

5. Resistência à Flexão eixo Y-Y				
Mrd(kN.cm)	Msd(kN.cm)	Status	%	Coef. S
7442	986	OK	13,2%	1,1

bef	21,2
Iy	1534,3
Wx	447,6

Listar Perfis que atendem		
Perfil	Peso	%
W 310 x 38,7	38,70	99,31%
W 360 x 44,0	44,00	83,22%
W 310 x 44,5	44,50	85,42%
W 250 x 44,8	44,80	94,95%
W 200 x 46,1 (H)	46,10	89,90%
W 410 x 46,1	46,10	88,30%
W 360 x 51,0	51,00	71,67%
W 200 x 52,0 (H)	52,00	77,77%
W 310 x 52,0	52,00	71,75%
W 460 x 52,0	52,00	75,05%
HP 200 x 53,0 (H)	53,00	81,06%
W 410 x 53,0	53,00	65,66%
W 360 x 57,8	57,80	63,15%
W 200 x 59,0 (H)	59,00	67,95%
W 410 x 60,0	60,00	56,59%
W 460 x 60,0	60,00	61,88%
HP 250 x 62,0 (H)	62,00	65,81%
W 360 x 64,0	64,00	51,15%
W 530 x 66,0	66,00	57,03%
W 410 x 67,0	67,00	49,71%
W 460 x 68,0	68,00	52,95%
W 200 x 71,0 (H)	71,00	55,42%
W 360 x 72,0	72,00	45,41%
W 530 x 72,0	72,00	45,83%
W 250 x 73,0 (H)	73,00	49,23%
W 460 x 74,0	74,00	42,42%
W 530 x 74,0	74,00	40,00%

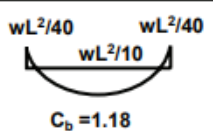
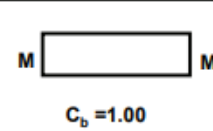
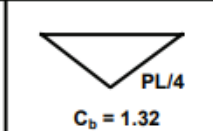
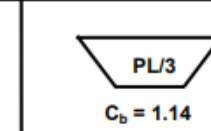
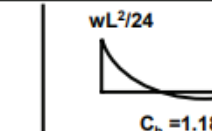
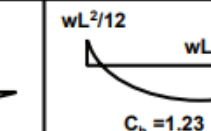
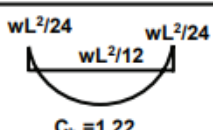
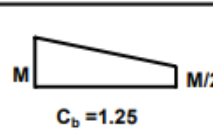
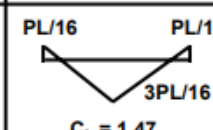
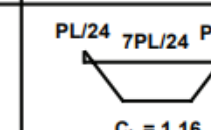
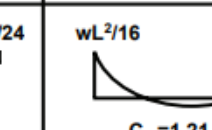
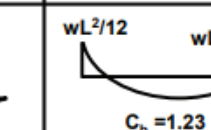
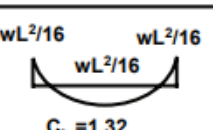
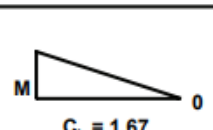
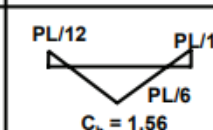
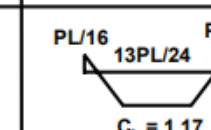
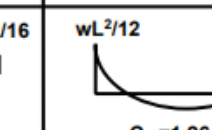
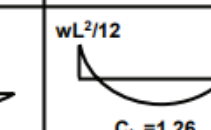
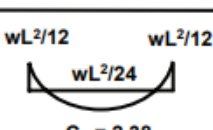
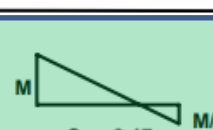
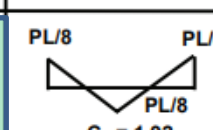
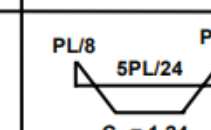
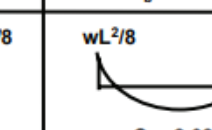
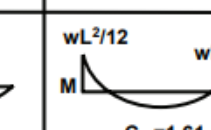
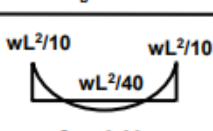
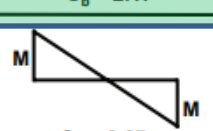
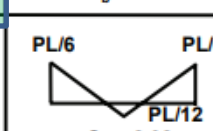
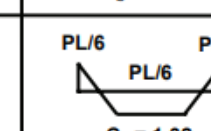
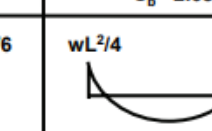
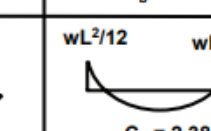
Atenção: PILAR REPROVADO COM Cb = 1,0

Porém, o gráfico de momentos se iguala aproximadamente ao da figura seguinte

Cálculo dos pilares

C_b Values for Different Load Cases

AISC Equation F1-1

 $C_b = 1.18$	 $C_b = 1.00$	 $C_b = 1.32$	 $C_b = 1.14$	 $C_b = 1.18$	 $C_b = 1.23$
 $C_b = 1.22$	 $C_b = 1.25$	 $C_b = 1.47$	 $C_b = 1.16$	 $C_b = 1.21$	 $C_b = 1.23$
 $C_b = 1.32$	 $C_b = 1.67$	 $C_b = 1.56$	 $C_b = 1.17$	 $C_b = 1.26$	 $C_b = 1.26$
 $C_b = 2.38$	 $C_b = 2.17$	 $C_b = 1.92$	 $C_b = 1.24$	 $C_b = 2.08$	 $C_b = 1.61$
 $C_b = 3.00$	 $C_b = 2.27$	 $C_b = 2.08$	 $C_b = 1.32$	 $C_b = 3.00$	 $C_b = 2.38$



Cálculo dos pilares

Dimensionamento de Perfis I e H Laminados Padrão Açominas

Esforços e Distâncias	
Lx (mm)	3000
Ly (mm)	3000
N(kN)	-143,6
Vx(kN)	0
Vy(kN)	60,9
Mx(kN.cm)	12226
My(kN.cm)	986
kx	0,7
ky	0,7
d (mm)	0
Lb (mm)	3000
Material	
ASTM A572GR50	
Fy (kN/cm²)	34,5

Dados para Cálculo de NRd			
Q	1,00		
Nex(kN)	20842,9	r0(cm)	10,2
Ney(kN)	7042,4	Nez(kN)	4692,50
λ0	0,66		
χ	0,835		
Esbeltez Limite FLA X-X		Esbeltez Limite FLA Y-Y	
λalma	25,14	λalma	25,14
λb	21,65	λb	27,20

Resultado:

90,1%

W 200 x 46,1 (H)					
d(mm)	203	Wx(cm³)	447,6	rx(cm)	8,81
bf(mm)	203	Wy(cm³)	151,2	ry(cm)	5,12
d'(mm)	161	Zx(cm³)	495,3	Área(cm²)	58,6
tw(mm)	7,2	Zy(cm³)	229,5	ho/tw	22,4
tf(mm)	11	Ix(cm4)	4543	b/tf	9,2
h(mm)	181	Iy(cm4)	1535	Peso (kg/m)	46,1

Limite: 36,3 Compacta
Limite: 13,7 25,1 Compacta

1. Verificação da Esbeltez do perfil

Limite	Real	Status	%	
200	24	OK	11,9%	λx
200	41	OK	20,5%	λy

2. Resistência à tração

Nrd(kN)	Nsd(kN)	Status	%	Coef. S
N.A	0	N.A	0,0%	1,1

3. Resistência à Compressão

Nrd(kN)	Nsd(kN)	Status	%	Coef. S
1535	143,6	OK	9,4%	1,1

4. Resistência à Flexão eixo X-X

Mrd(kN.cm)	Msd(kN.cm)	Status	%	Coef. S
17088	12226	OK	71,5%	1,1

5. Resistência à Flexão eixo Y-Y

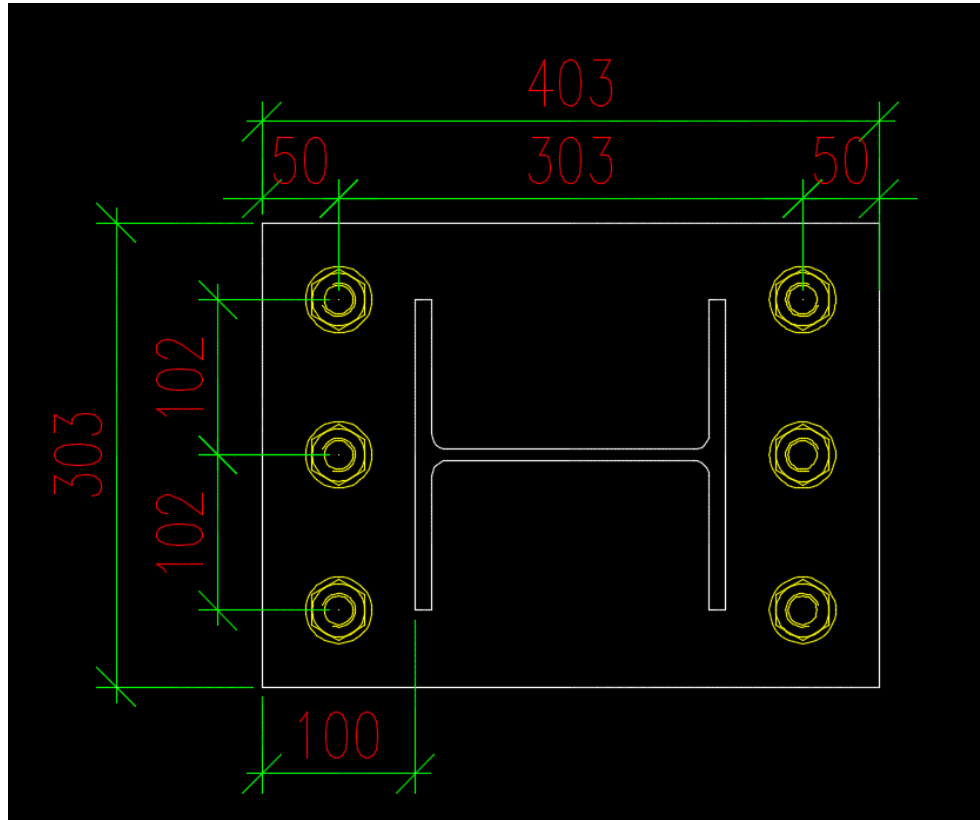
Mrd(kN.cm)	Msd(kN.cm)	Status	%	Coef. S	bef	21,2
7442	986	OK	13,0%	1,1	Iy	1534,3

Listar Perfis que atendem

Perfil	Peso	%
W 310 x 38,7	38,70	99,31%
W 360 x 44,0	44,00	83,22%
W 310 x 44,5	44,50	85,42%
W 250 x 44,8	44,80	94,95%
W 200 x 46,1 (H)	46,10	89,90%
W 410 x 46,1	46,10	88,30%
W 360 x 51,0	51,00	71,67%
W 200 x 52,0 (H)	52,00	77,77%
W 310 x 52,0	52,00	71,75%
W 460 x 52,0	52,00	75,05%
HP 200 x 53,0 (H)	53,00	81,06%
W 410 x 53,0	53,00	65,66%
W 360 x 57,8	57,80	63,15%
W 200 x 59,0 (H)	59,00	67,95%
W 410 x 60,0	60,00	56,59%
W 460 x 60,0	60,00	61,88%
HP 250 x 62,0 (H)	62,00	65,81%
W 360 x 64,0	64,00	51,15%
W 530 x 66,0	66,00	57,03%
W 410 x 67,0	67,00	49,71%
W 460 x 68,0	68,00	52,95%
W 200 x 71,0 (H)	71,00	55,42%
W 360 x 72,0	72,00	45,41%
W 530 x 72,0	72,00	45,83%
W 250 x 73,0 (H)	73,00	49,23%
W 460 x 74,0	74,00	42,42%
W 530 x 74,0	74,00	40,00%

Pilar aprovado com Cb = 2,17

Placas de Base com carga excêntrica – Momentos fletores



$$\sigma_c = \frac{N}{A_p} + \frac{M}{W} = \frac{Nsd}{A \cdot B} + \frac{6 \cdot Msd}{B \cdot A^2}$$

$$\sigma_c = \frac{143,6}{30,3 \cdot 40,3} + \frac{6 \cdot 6044}{30,3 \cdot 40,3^2} = 0,86 \text{ kN/cm}^2$$

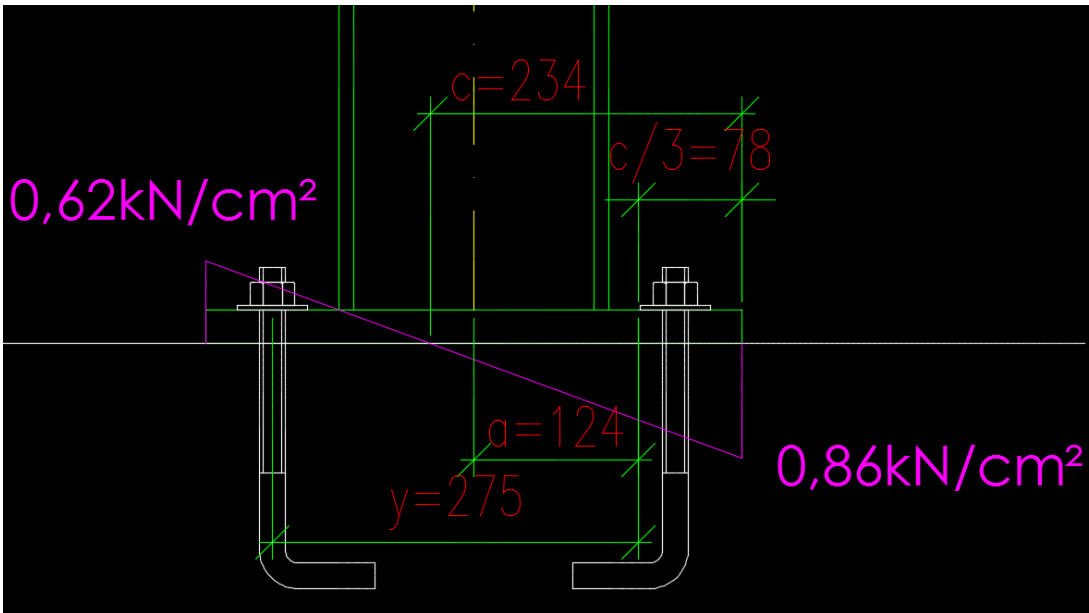
$$\sigma_t = \frac{N}{A_p} - \frac{M}{W} = \frac{Nsd}{B \cdot A} - \frac{6 \cdot Msd}{B \cdot A^2}$$

$$\sigma_t = \frac{143,6}{30,3 \cdot 40,3} - \frac{6 \cdot 6044}{30,3 \cdot 40,3^2} = -0,62 \text{ kN/cm}^2$$

**Devemos proteger o concreto contra a carga de compressão
(Considerando f_{ck} 20MPa)**

$$\sigma_{adm} = 0,51 F_{ck} = 0,51 \cdot 2,0 = 1,02 \text{ kN/cm}^2 \quad \text{OK!}$$

Placas de Base com carga excêntrica – Momentos fletores



$$T = (M - N \cdot a) / y$$

$$T = \frac{6044 - 143,6 \cdot 12,4}{27,5} = 155 \text{ kN}$$

Como são 3 chumbadores tracionados
 $\rightarrow T = 51,66 \text{ kN}$

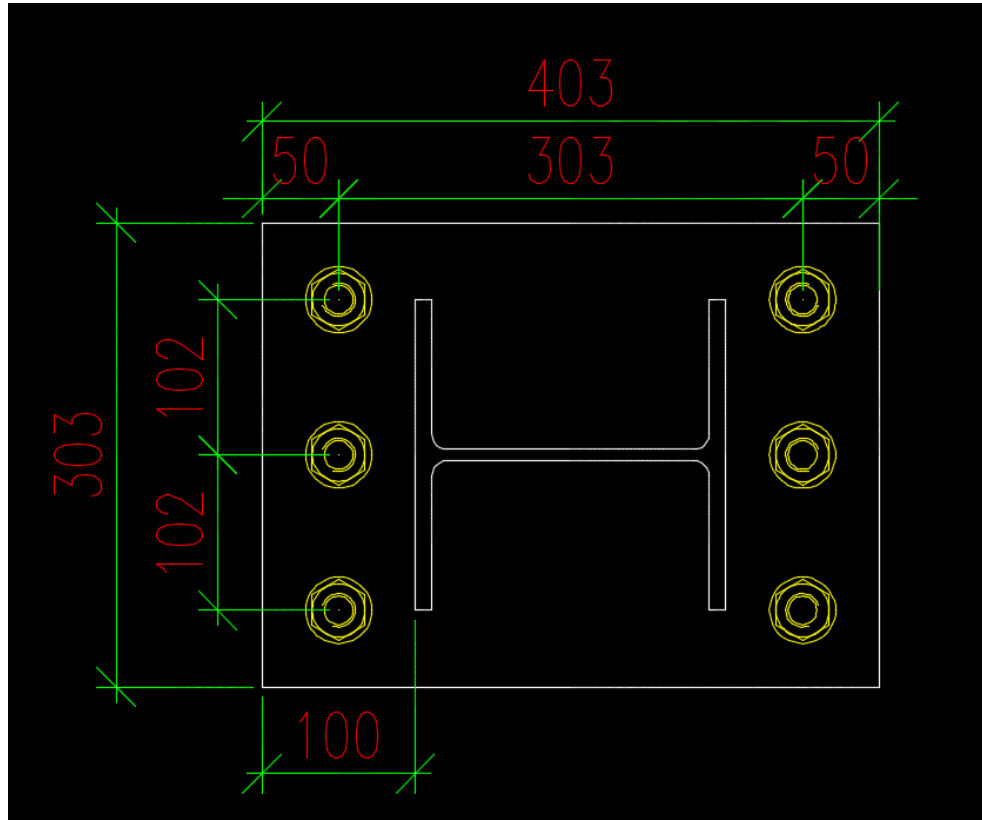
$$\text{Esforço Cortante Máximo} = \frac{60,2}{6} = 10 \text{ kN}$$

$$d_{chu} = \sqrt{1,27 \cdot \sqrt{\frac{11,39 \cdot V_{sd}^2 + 3,24 \cdot N_{sd}^2}{Fu^2}}}$$

$$d_{chu} = \sqrt{1,27 \cdot \sqrt{\frac{11,39 \cdot 10^2 + 3,24 \cdot 51,66^2}{40^2}}}$$

$$d_{chu} = 1,77 \text{ cm} \sim 19 \text{ mm}$$

Placas de Base com carga excêntrica – Momentos fletores



$$M_{ch} = \frac{0,86.10^2}{2} = 43 \text{ kN.cm}$$

$$t = \sqrt{\frac{6 \cdot M_{ch}}{1,35 \cdot F_y}} = \sqrt{\frac{6 \cdot 43}{1,35 \cdot 25}} = 2,76 \text{ cm} \sim 32 \text{ mm}$$