

Double angle unequal cross section in tension verification using S16-19:

1.1.1 Description

The test verifies the tension strength of double angle unequal section column.

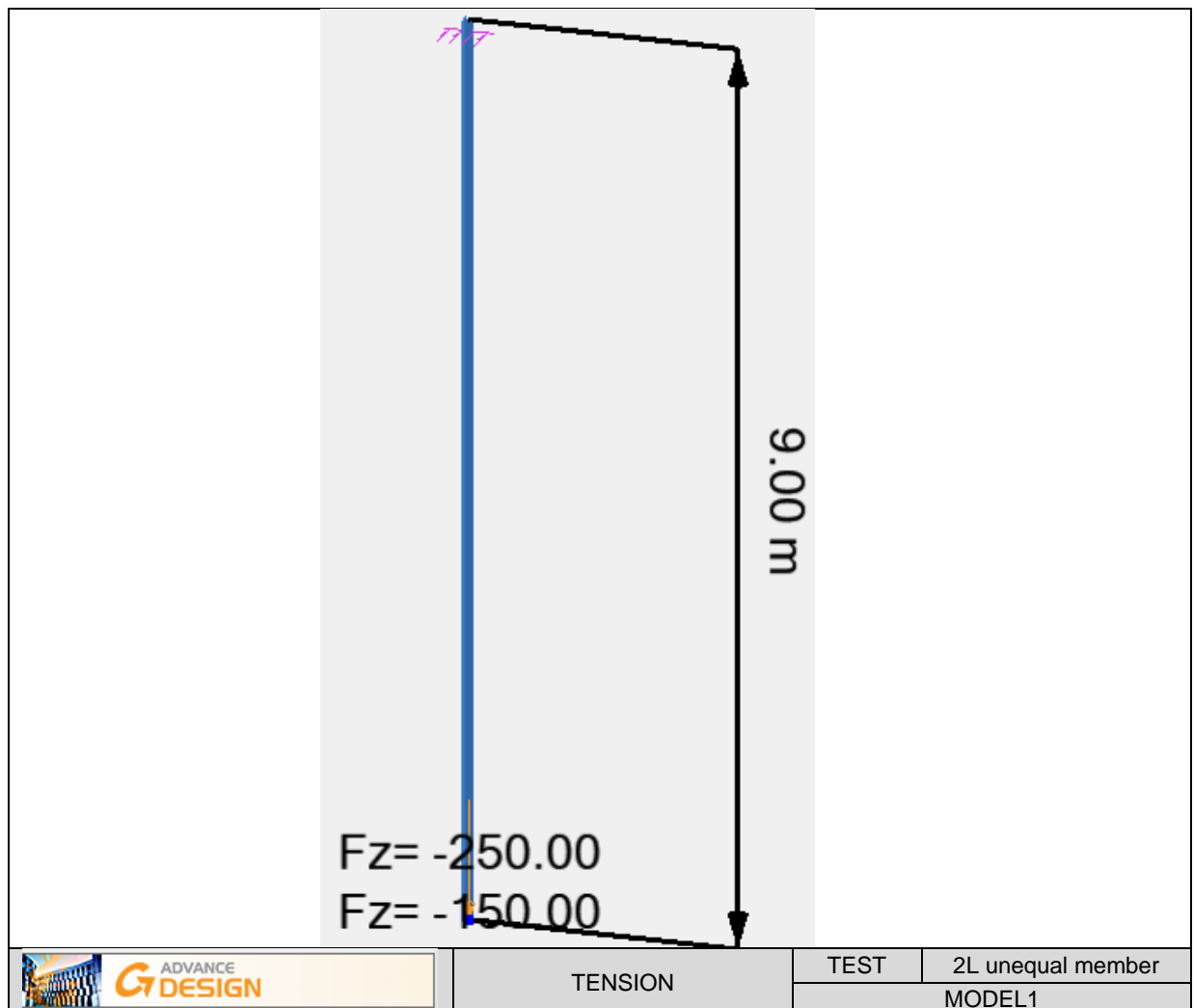
The column is subjected to end tension.

1.1.2 Background

The test verifies the available tension strength of an 2L 89x64x13LLB column shown in the figure below. The column is subjected to tension of 150 kN from dead load and 250 kN from live load. Material G40.21M-350W ($F_y=350$ MPa) steel is selected for this example.

1.1.2.1 Model description

- Analysis type: static linear (plane problem)
- Element type: linear
- The following load case is used:
- Load cases: $F_D = -150$ kN : $F_L = -250$ kN

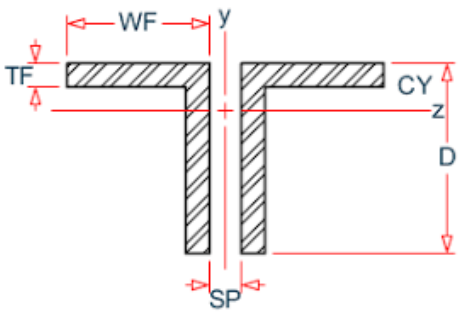


Units

Metric System

Geometry

- Cross section:

<u>Dimensions and surface area</u>		<u>Properties</u>		
	Area		Weak Axis (Y-Y)	
	A	35.50 cm ²	I_y	270.00 cm ⁴
	Depth		S_y	46.20 cm ³
	D	8.89 cm	Z_y	82.60 cm ³
	Web thickness		Strong Axis (Z-Z)	
	t_w	1.27 cm	I_z	227.23 cm ⁴
	Flange width		S_z	46.20 cm ³
	WF	6.35 cm	Z_y	45.60 cm ³
	Flange thickness		Shear area	
	t_f	1.27 cm	A_y	13.44 cm ²
	Fillet radius		A_z	18.82 cm ²
	r	1.11 cm	Torsional constant	
	Separation		J	19.10 cm ⁴
	SP	0.00 cm	Warping constant	
		C_w	85.26 cm ⁶	
<u>2L89x64x13xLLBB</u>				

- Beam length: L =900 cm

Materials properties

Steel G40.21M-350W is used. The following characteristics are used in relation to this material:

- Yield strength $f_y=350$ MPa
- Longitudinal elastic modulus: $E=200000$ MPa
- Shear modulus of rigidity: $G=76923.1$ MPa

Boundary conditions

The boundary conditions are described below:

- Outer:
 - ▶ Support at X = 900 cm (Restrains: TX, TY, TZ, Rx, Ry, Rz)
- Inner: None.

Loading

The column is subjected to the following load combinations and actions:

- ULS: $q = 1.25 \times D + 1.5 \times L$
- LSS: $q = 1 \times D + 1 \times L$

1.1.2.2 Reference results in calculating

Reference solution

From the NBC 2015, the required tension strength for the design is:

ULS
$ Fx = 1.25 \times 150 + 1.5 \times 250$ $ Fx = 562.5 \text{ kN}$

The Factored tensile resistance T_r of a member subjected to axial tension is computed from the clause 13.2:

$$T_r = \phi \times A_g \times F_y$$

In order to verify the plasticity of the gross section with the factored load computed at ULS:

ULS
$\phi = 0.9$ $T_r = \phi \times A_g \times F_y = 0.9 \times 3550 \times 350$ $= 1118.25 \text{ kN}$ $T_f = Fx = 562.5 \text{ kN} < T_r = 1118.25 \text{ kN} \text{ O.K}$ Work ratio: $r = \frac{T_f}{T_r} = 50.30\%$

Since the member is under tension forces only the verification of bending resistance and combined forces is unnecessary.

Finite elements modeling

- Linear element: S beam,
- 6 nodes,
- 1 linear element.

1.1.2.3 Results comparison

Result name	Result description	Reference value	AD value	Percent Difference
T_r	Factored tensile resistance	1118.25 kN	1118.25 kN	0.00%
r	Design ratio	50.30 %	50.30 %	0.00%

	Cas défavorable	Vérification	Taux de travail
Traction Compression	n°102	$C_f \leq C_r$ (13.2) 562.50 < 1118.25 kN	50%
Forces combinées	n°102	$T_f/Tr + M_f/Mr \leq 1$ (13.9.1) 0.503 < 1.000	50%



ADVANCE
DESIGN

Tension

TEST

2L unequal section

Model 1



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