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

1.1.1 Description

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

The column is subjected to end tension.

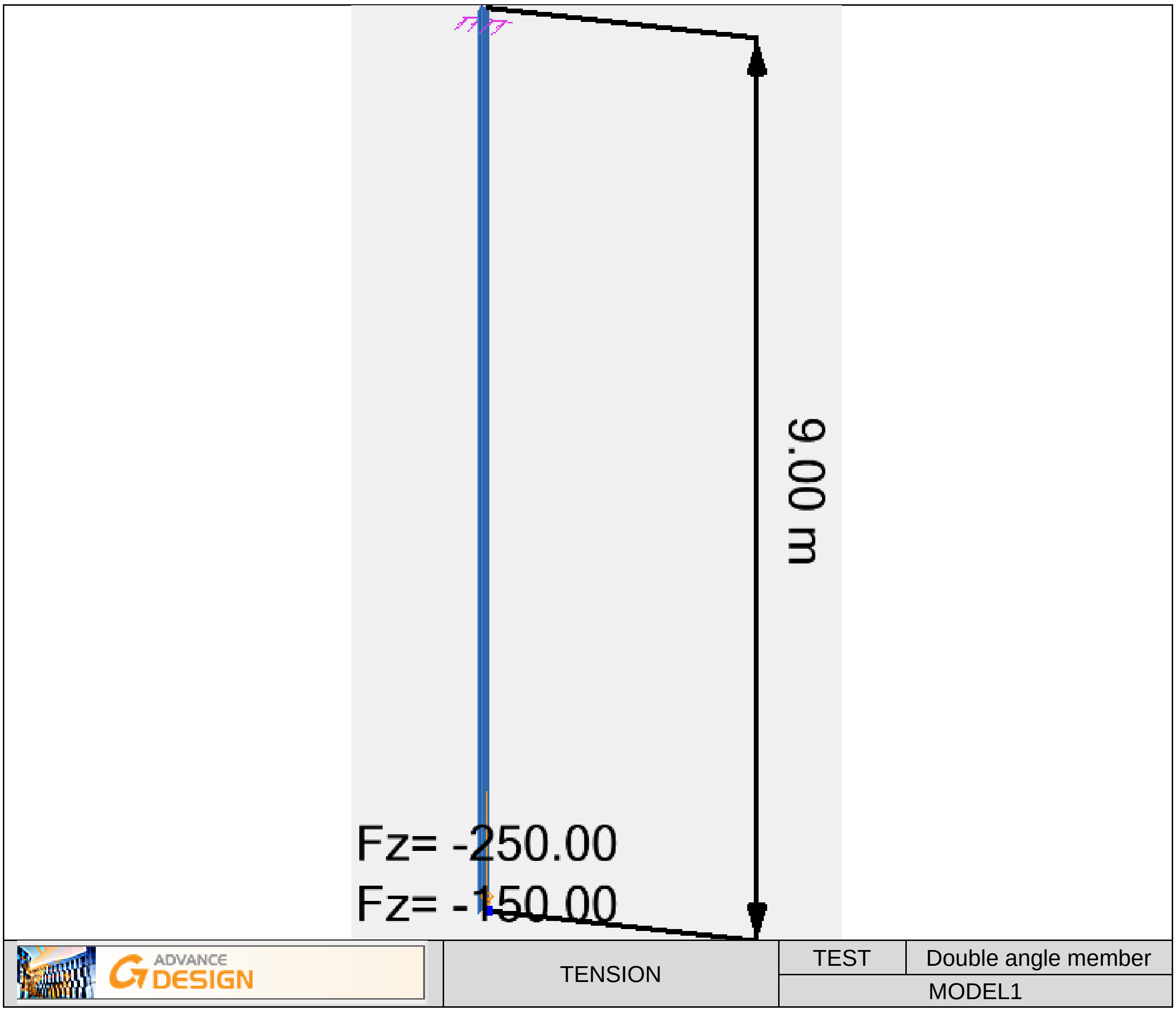
1.1.2 Background

The test verifies the available tension strength of an 2L 89x89x6.4 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

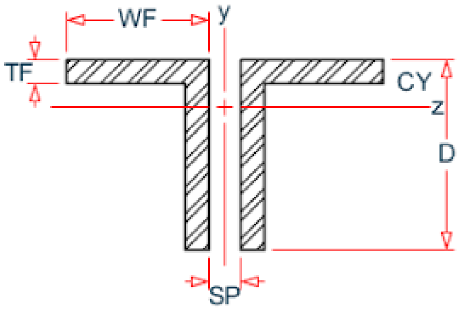


Units

Metric System

Geometry

- Cross section:

Dimensions and surface area			**Properties**	
	*Area*		*Weak Axis (Y-Y)*	
	A	*21.80 cm²*	I_y	*167.00 cm⁴*
	Depth		S_y	*26.00 cm³*
	D	*8.89 cm*	Z_y	*46.20 cm³*
	Web thickness		*Strong Axis (Z-Z)*	
	t_w	*0.64 cm*	I_z	*298.44 cm⁴*
	Flange width		S_z	*25.80 cm³*
	WF	*8.89 cm*	*Zy*	*46.20 cm³*
	Flange thickness		*Shear area*	
	t_f	*0.64 cm*	A_y	*9.41 cm²*
	Filet radius		A_z	*9.41 cm²*
	r	*0.94 cm*	*Torsional constant*	
	Separation		*J*	*2.93 cm⁴*
	SP	*0.00 cm*	*Warping constant*	
			C_w	*17.92 cm⁶*
2L89x89x6.4				

- 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 (Restraints: TX, TY, TZ, Rx, Ry, Rz)
- Inner: None.

Loading

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

- ULS: q = 1.25 x D +1.5 x L
- LSS: q =1 x D + 1 x L

1.1.2.2 Reference results in calculating

<u>Reference solution</u>

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

ULS
$|Fx| = 1.25 \times 150 + 1.5 \times 250$ $|Fx| = 562.5\ kN$

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

$$T_r = \phi \times Ag \times Fy$$

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

ULS
$\phi = 0.9$ $T_r = \phi \times Ag \times Fy = 0.9 \times 2180 \times 350 = 686.70\ kN$ $T_f = Fx = 562.5\ kN < T_r = 686.70\ kN$ O.K Work ratio: $r = T_f / T_r = 81.91\%$

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

<u>Finite elements modeling</u>

- 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
Tr	Factored tensile resistance	686.70 kN	686.70 kN	0.00%
r	Design ratio	81.91 %	81.91 %	0.00%

	Cas défavorable	Vérification	Taux de travail
Traction Compression	n°102	Cf ≤ Cr (13.2) 562.50 < 686.70 kN	82%
Forces combinées	n°102	Tf/Tr + Mf/Mr ≤ 1 (13.9.1) 0.819 < 1.000	82%

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