

## WWF cross section in tension verification using S16-19:

### 1.1.1 Description

The test verifies the tension strength of WWF section column.

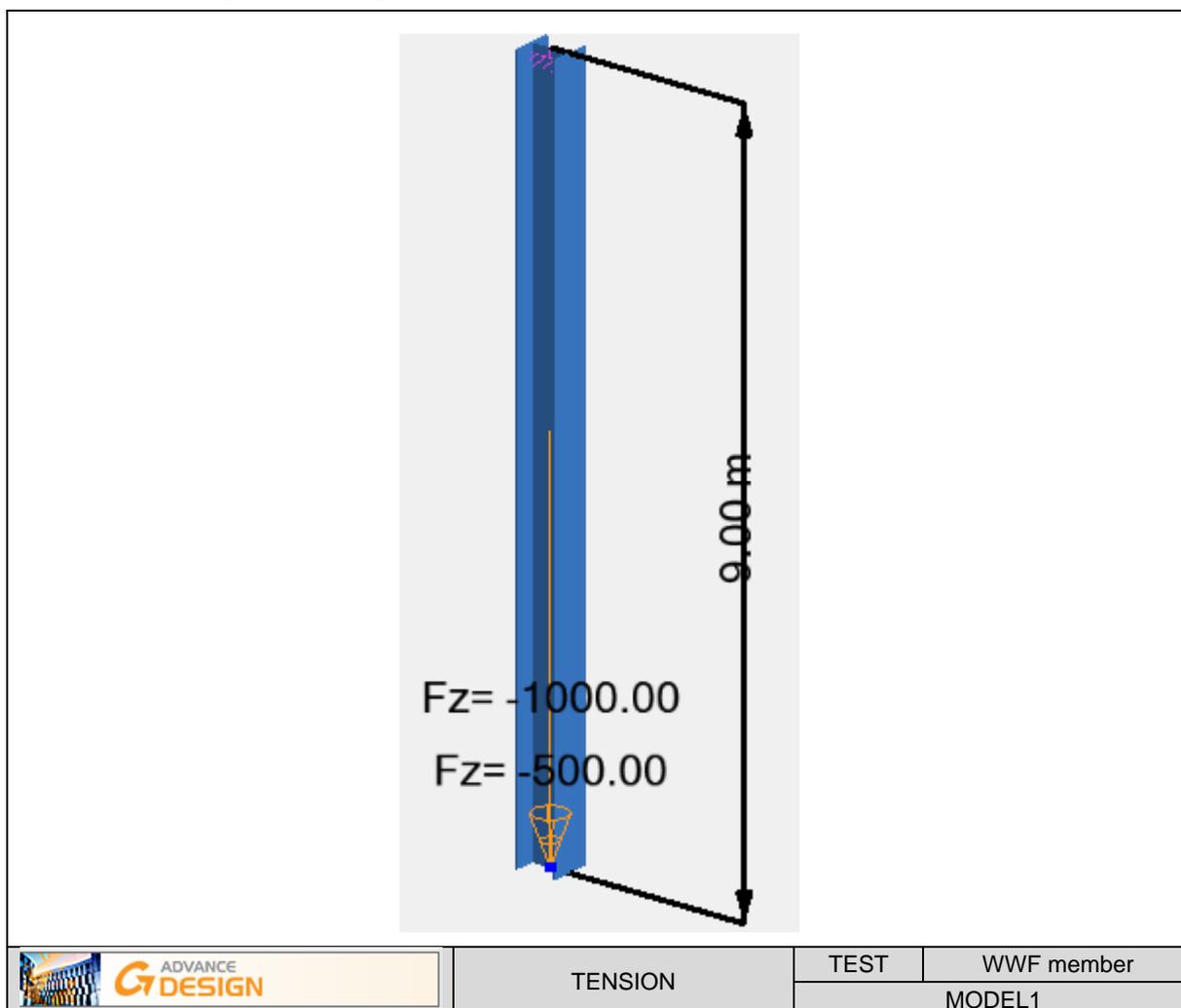
The column is subjected to end tension.

### 1.1.2 Background

The test verifies the available tension strength of an WWF 500x197 column shown in the figure below. The column is subjected to tension of 500 kN from dead load and 1000 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:  $F_D = -500$  kN :  $F_L = -1000$  kN

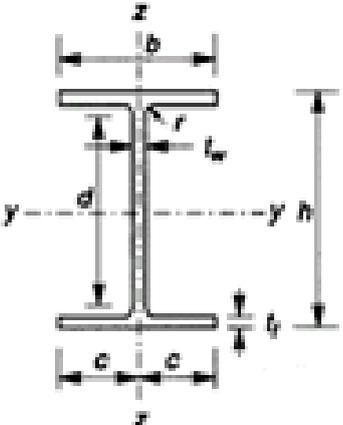


#### Units

Metric System

Geometry

- Cross section:

<u>Dimensions and surface area</u>		<u>Properties</u>		
	<b>Area</b>		<b>Weak Axis (Y-Y)</b>	
	<b>A</b>	252.00 cm <sup>2</sup>	<b>I<sub>y</sub></b>	125000 cm <sup>4</sup>
	<b>Depth</b>		<b>S<sub>y</sub></b>	4990 cm <sup>3</sup>
	<b>h</b>	50.00 cm	<b>Z<sub>y</sub></b>	5410 cm <sup>3</sup>
	<b>Web thickness</b>		<b>Weak Axis (Z-Z)</b>	
	<b>t<sub>w</sub></b>	1.10 cm	<b>I<sub>z</sub></b>	41700 cm <sup>4</sup>
	<b>Flange width</b>		<b>S<sub>z</sub></b>	1670 cm <sup>3</sup>
	<b>b</b>	50.00cm	<b>Z<sub>z</sub></b>	2510 cm <sup>3</sup>
	<b>Flange thickness</b>		<b>Shear area</b>	
	<b>t<sub>f</sub></b>	2.00 cm	<b>A<sub>y</sub></b>	201.21 cm <sup>2</sup>
	<b>Filet radius</b>		<b>A<sub>z</sub></b>	55.00 cm <sup>2</sup>
	<b>r</b>	0.00 cm	<b>Torsional constant</b>	
		<b>J</b>	283.889 cm <sup>4</sup>	
		<b>Warping constant</b>		
		<b>C<sub>w</sub></b>	24.0029x10 <sup>6</sup> cm <sup>6</sup>	
<b><u>WWF 500x197</u></b>				

- 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 = 700 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 500 + 1.5 \times 1000$ $ Fx  = 2125 \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
$\phi = 0.9$ $T_r = \phi \times A_g \times F_y = 0.9 \times 25200 \times 350$ $= 7938 \text{ kN}$ $T_f = Fx = 2125 \text{ kN} < T_r = 7938 \text{ kN} \text{ O.K}$ Work ratio: $r = \frac{T_f}{T_r} = 26.77\%$

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	7938 kN	7938 kN	0.00%
r	Design ratio	26.77%	26.77%	0.00%

	Cas défavorable	Vérification	Taux de travail
Traction Compression	n°102	$C_f \leq C_r$ (13.2) 2125.00 < 7938.00 kN	27%
Forces combinées	n°102	$M_f/M_r - (T_f^*Z)/(M_r^*A) \leq 1$ (13.9.2.a) 0.268 < 1.000	27%



ADVANCE  
DESIGN

TENSION

TEST

WWF Section

RESULTS 1



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