WT cross section tension verification using S16-19:

1.1.1 Description

The test verifies the tension strength of WT shape section column.

The column is subjected to end tension.

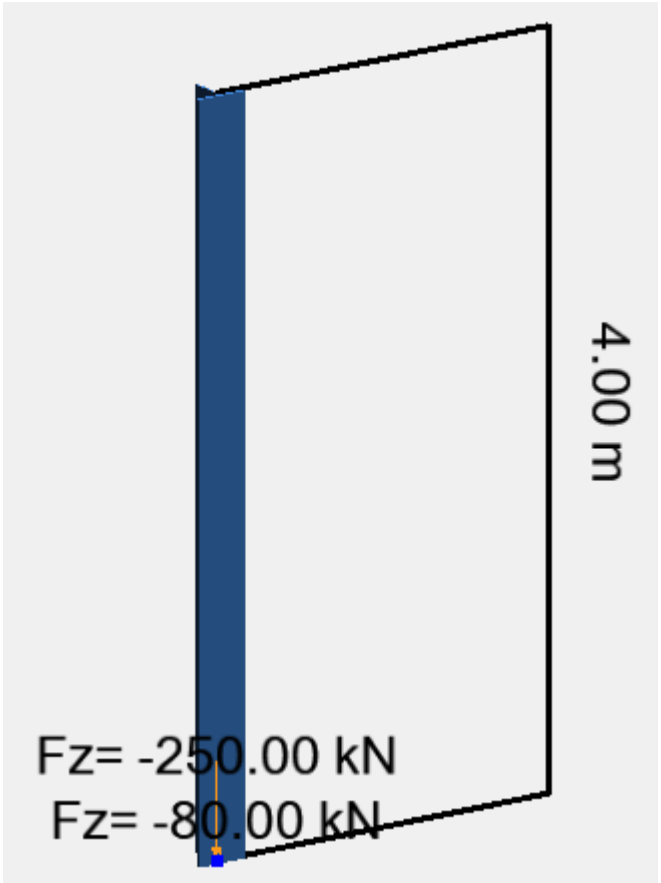
1.1.2 Background

The test verifies the available tension strength of a WT 230x64 column shown in the figure below. The column is subjected to tension of 80 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= -80 kN; F_L= -250 kN



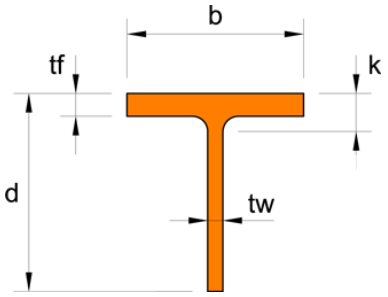
ADVANCE DESIGN	TENSION	TEST	WT member
		MODEL1	

Units

Metric System

Geometry

- Cross section:

Dimensions and surface area			***Properties***	
	***Area***		***Strong Axis (Y-Y)***	
	A	***81.90 cm^2***	***I_y***	***3430 cm^4***
	Depth		***S_y***	***184 cm^3***
	d	***23.40 cm***	***Z_y***	***326 cm^3***
	Web thickness		***Weak Axis (Z-Z)***	
	t_w	***1.22cm***	***I_z***	***3650 cm^4***
	Flange width		***S_z***	***259 cm^3***
	b	***28.20cm***	***Zy***	***397 cm^3***
	Flange thickness		***Shear area***	
	t_f	***1.96cm***	***A_y***	***46.06 cm^2***
	Filet radius		***A_z***	***28.55 cm^2***
	r	***2.14cm***	***Torsional constant***	
			J	***83.7549 cm^4***
			Warping constant	
			C_w	***1741.05 cm^6***
WT 230x64				

- Beam length: L =400 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 = 400 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

Reference solution

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

ULS
$\|Fx\| = 1.25 \times 80 + 1.5 \times 250$ $\|Fx\| = 475.0\ kN$

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

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

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

ULS
$\phi = 0.9$ $T_r = \phi \times Ag \times Fy = 0.9 \times 8190 \times 350 = 2579.85\ kN$ $T_f = Fx = 475.0\ kN < T_r = 2579.85\ kN$ O.K Work ratio: $r = {T_f}/{T_r} = 18\%$

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
Tr	Factored tensile resistance	2579.85 kN	2579.85 kN	0.00%
r	Design ratio	18%	18%	0.00%

	Cas défavorable	Vérification	Taux de travail
Traction Compression	n°102	Cf ≤ Cr (13.2) 475.00 < 2579.85 kN	18%
Forces combinées	n°102	Tf/Tr + Mf/Mr ≤ 1 (13.9.1) 0.184 < 1.000	18%

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