WRF cross section in tension verification using S16-19:

1.1.1 Description

The test verifies the tension strength of WRF section column.

The column is subjected to end tension.

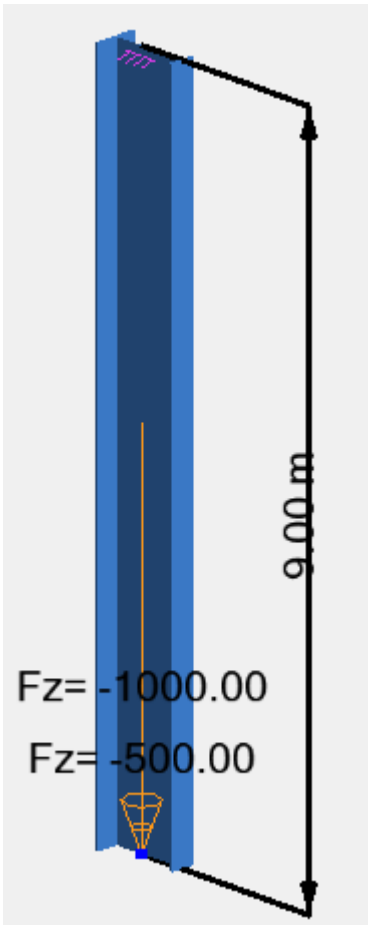
1.1.2 Background

The test verifies the available tension strength of an WRF 1000x275 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



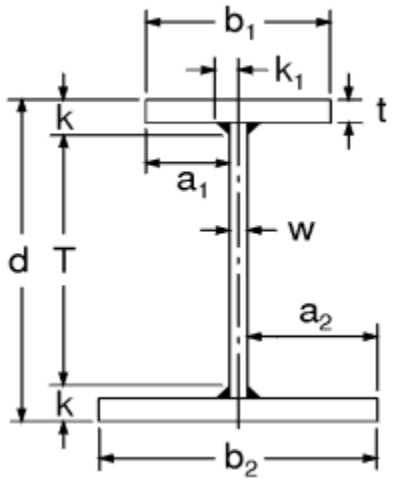
ADVANCE DESIGN	TENSION	TEST	WRF member
		MODEL1	

Units

Metric System

Geometry

- Cross section:

Dimensions and surface area			***Properties***	
	***Area***		***Weak Axis (Y-Y)***	
	A	***350.00 cm²***	***I_y***	***631318.17 cm⁴***
	Depth		***S_y***	***15951.49 cm³***
	d	***100.0 cm***	***Z_y***	***13904.66 cm³***
	Web thickness		***Strong Axis (Z-Z)***	
	w	***1.00cm***	***Iz***	***48351.58 cm⁴***
	Flange width		***Sz***	***10452.29 cm³***
	b_1	***30.00 cm***	***Zz***	***2967.25 cm³***
	b_2	***55.00 cm***	***Shear area***	
	Flange thickness		***A_y***	***256.00 cm²***
	t	***3.00cm***	***A_z***	***100.00 cm²***
	Filet radius		***Torsional constant***	
	r	***0.00cm***	***J***	***771.35 cm⁴***
			Warping constant	
			C_w	***54.64x10⁶ cm⁶***
WRF 1000x275				

- 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 (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
$\|Fx\| = 1.25 \times 500 + 1.5 \times 1000$ $\|Fx\| = 2125\ kN$

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
$\phi = 0.9$ $T_r = \phi \times Ag \times Fy = 0.9 \times 35000 \times 350 = 11025\ kN$ $T_f = Fx = 2125\ kN < T_r = 11025\ kN$ O.K Work ratio: $r = {T_f}/{T_r} = 19.27\%$

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	11025 kN	11025 kN	0.00%
r	Design ratio	19%	19%	0.00%

	Cas défavorable	Vérification	Taux de travail
Traction Compression	n°102	Cf ≤ Cr (13.2) 2125.00 < 11025.00 kN	19%
Forces combinées	n°102	Mf/Mr - (Tf*Z)/(Mr*A) ≤ 1 (13.9.2.a) 0.193 < 1.000	19%

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