HSS rectangular section in tension verification using S16-19:

1.1.1 Description

The test verifies the tension strength of HSS rectangular section column.

The column is subjected to end tension.

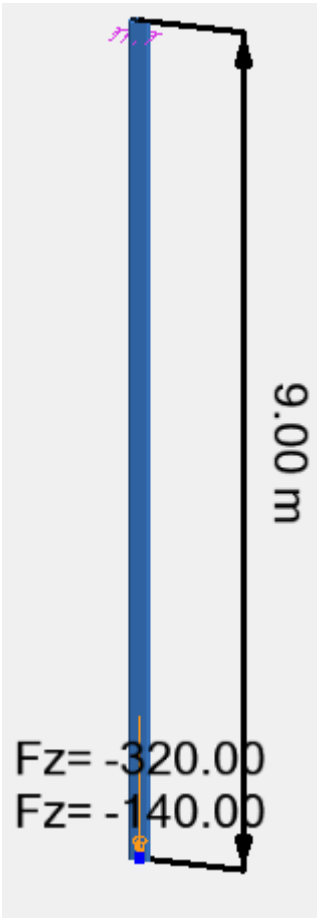
1.1.2 Background

The test verifies the available tension strength of an HSS 203.2x101.6x9.53 column shown in the figure below. The column is subjected to tension of 140 kN from dead load and 320 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= -140 kN : F_L= -320 kN



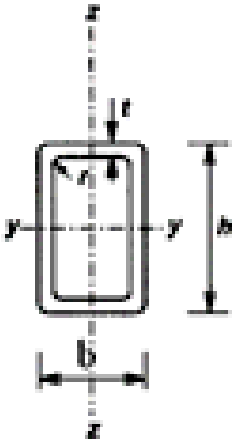
ADVANCE DESIGN	TENSION	TEST	HSS rectangular member
		MODEL1	

Units

Metric System

Geometry

- Cross section:

Dimensions and surface area		***Properties***	
	***Area***	***Weak Axis (Y-Y)***	
	A 48.90 cm^2	***I_y*** 2440 cm^4	
	Depth	***S_y*** 241 cm^3	
	h 20.32 cm	***Z_y*** 308 cm^3	
	Web thickness	***Strong Axis (Z-Z)***	
	t_w 0.95cm	***Iz*** 816 cm^4	
	Flange width	***Sz*** 161 cm^3	
	b 10.16cm	***Zz*** 188 cm^3	
	Flange thickness	***Shear area***	
	t_f 0.95cm	***A_y*** 15.73 cm^2	
	Filet radius	***A_z*** 33.27 cm^2	
	r 1.91cm	***Torsional constant***	
		J 2177.62 cm^4	
		Warping constant	
		C_w 0.00 cm^6	
HSS 203x203x6.4			

- 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

Reference solution

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

ULS
$\|Fx\| = 1.25 \times 140 + 1.5 \times 320$ $\|Fx\| = 655\ kN$

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
$\phi = 0.9$ $T_r = \phi \times Ag \times Fy = 0.9 \times 4890 \times 350 = 1540.3\ kN$ $T_f = Fx = 655\ kN < T_r = 1540.3\ kN$ O.K Work ratio: $r = {T_f}/{T_r} = 42.52\%$

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	1540.3 kN	1479.93 kN	3.92%
r	Design ratio	44.26%	42.52%	3.92%

	Cas défavorable	Vérification	Taux de travail
Traction Compression	n°102	Cf ≤ Cr (13.2) 655.00 < 1479.93 kN	44%
Forces combinées	n°102	Tf/Tr + Mf/Mr ≤ 1 (13.9.1) 0.443 < 1.000	44%

- Section properties:

Section brute

début fin HSS 203.2X101.6X9.53

Dimensions(cm)	h = 20.32 w = 10.16 Épaisseur = 0.95 r = 1.91 r1 = 0.95
Sections(cm2)	Aire = 46.9821 Avy = 14.4798 Avz = 31.8991
Inerties(cm4)	It = 2005.84 Iy = 2339.65 Iz = 786.606
Inerties(cm6)	Iw = 0
Modules d'inertie(cm3)	Welyinf = 230.28 Welysup = 230.28 Welzinf = 154.844 Welzsup = 154.844 Wply = 294.643 Wplz = 181.243

Matériau et nuance d'acier

Matériau : G40.21M-350W

Nuance d'acier : E = 200000.00 MPa Nu =

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