HSS square cross section tension verification using S16-19:

1.1.1 Description

The test verifies the tension strength of HSS square shape section column.

The column is subjected to end tension.

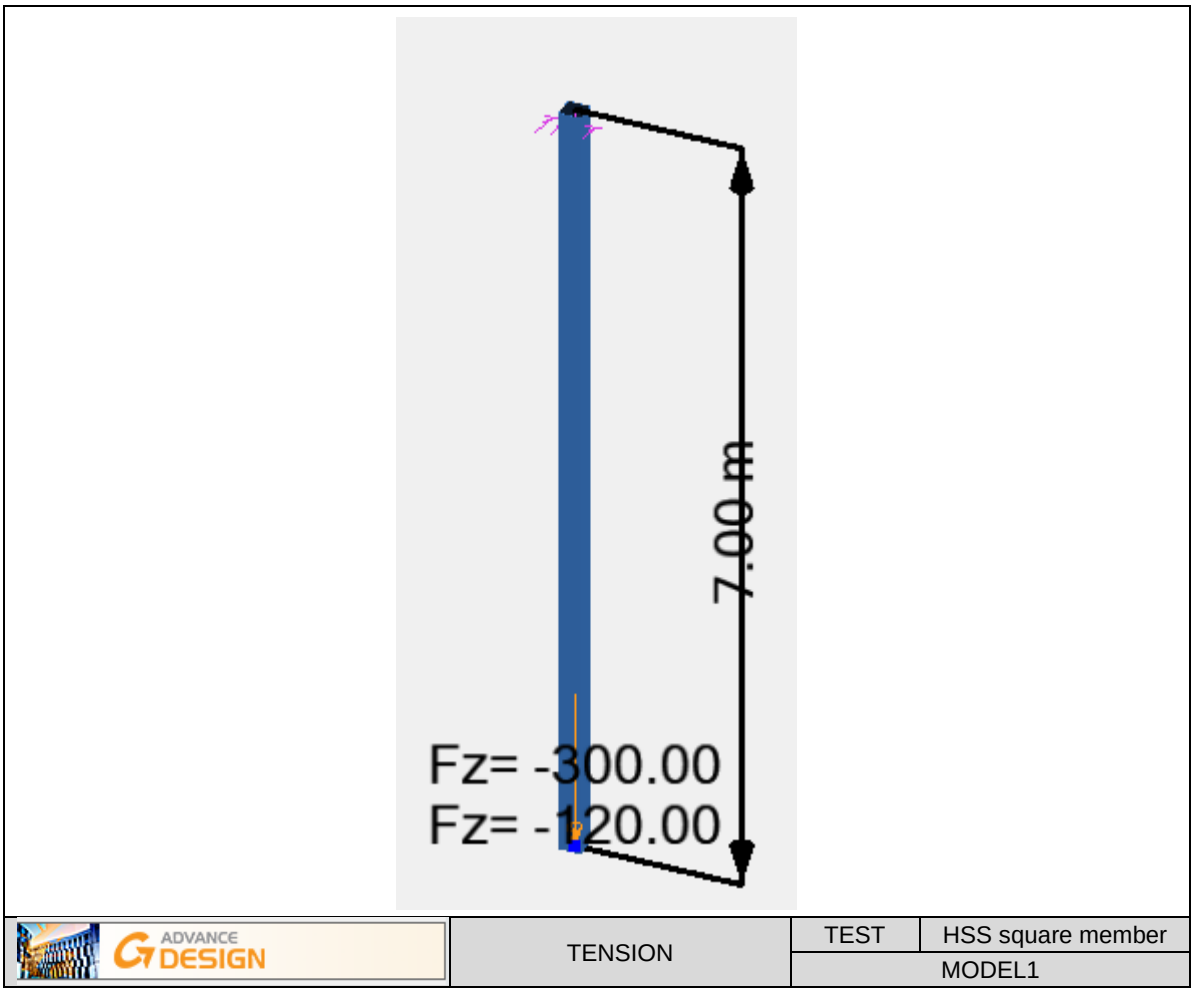
1.1.2 Background

The test verifies the available tension strength of an HSS 203x203x6.4 CSA G40.20 column shown in the figure below. The column is subjected to tension of 120 kN from dead load and 300 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= -120 kN ; F_L= -300 kN

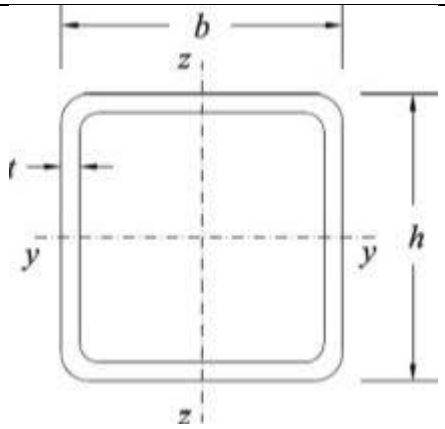


Units

Metric System

Geometry

- Cross section:

Dimensions and surface area		***Properties***	
	***Area***		***Strong Axis (Y-Y)***
	A	***49.00 cm²***	***I_y*** ***3130 cm⁴***
	Depth		***S_y*** ***308 cm³***
	h	***20.32 cm***	***Z_y*** ***359 cm³***
	Web thickness		***Weak Axis (Z-Z)***
	t_w	***0.64cm***	***Iz*** ***3130 cm⁴***
	Flange width		***Sz*** ***308 cm³***
	b	***20.32cm***	***Zz*** ***359 cm³***
	Flange thickness		***Shear area***
	t_f	***0.64cm***	***A_y*** ***10.79 cm²***
	Filet radius		***A_z*** ***18.87 cm²***
	r	***0.00cm***	***Torsional constant***
			J ***4930.00 cm⁴***
			Warping constant
			C_w ***0.00 cm⁶***
HSS 203x203x6.4			

- Beam length: L =700 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
$\|Fx\| = 1.25 \times 120 + 1.5 \times 300$ $\|Fx\| = 600\ kN$

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
$\phi = 0.9$ $T_r = \phi \times Ag \times Fy = 0.9 \times 4900 \times 350 = 1543.5\ kN$ $T_f = Fx = 600\ kN < T_r = 1543.5\ kN$ O.K Work ratio: $r = {T_f}/{T_r} = 39\%$

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	1543.5 kN	1432.94 kN	7.00%
r	Design ratio	39%	42%	7.00%

	Cas défavorable	Vérification	Taux de travail
Traction Compression	n°102	Cf ≤ Cr (13.2) 600.00 < 1432.94 kN	42%
Forces combinées	n°102	Tf/Tr + Mf/Mr ≤ 1 (13.9.1) 0.419 < 1.000	42%

- Section Properties

Dimensions(cm)	h = 20.32 w = 20.32 Épaisseur = 0.64 r = 0.00 r1 = 0.00
Sections(cm2)	Aire = 45.4902 Avy = 22.0815 Avz = 22.0815
Inerties(cm4)	It = 4434.6 Iy = 2958.05 Iz = 2958.05
Inerties(cm6)	Iw = 0
Modules d'inertie(cm3)	Welyinf = 291.147 Welysup = 291.147 Welzinf = 291.147 Welzsup = 291.147 Wply = 336.905 Wplz = 336.905

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