L member in tension verification using S16-19:

1.1.1 Description

The test verifies the tension strength of L section column. (CISC 11 Angle identical)

The column is subjected to end tension.

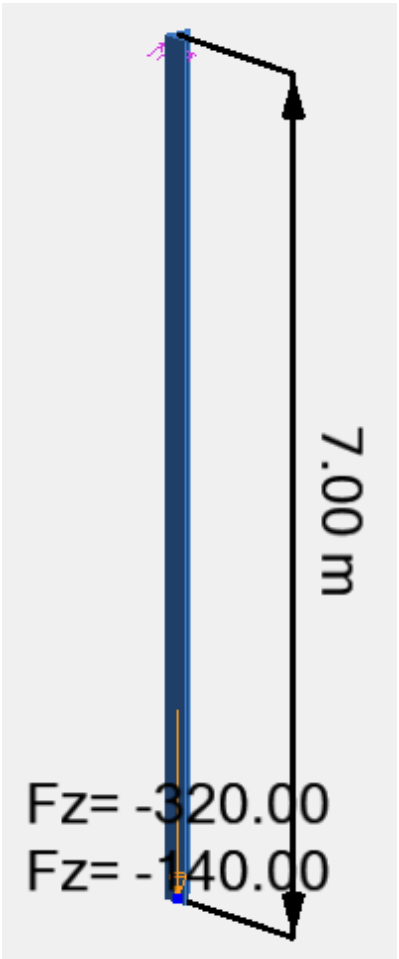
1.1.2 Background

The test verifies the available tension strength of an L 254x254x32 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



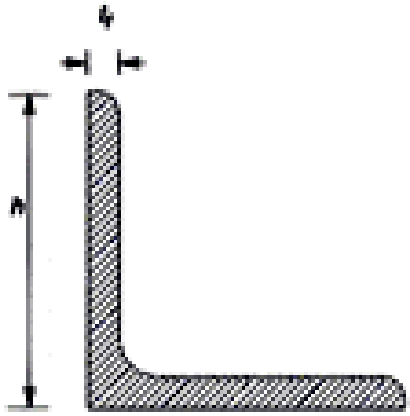
ADVANCE DESIGN	TENSION	TEST	L member
		MODEL1	

Units

Metric System

Geometry

- Cross section:

Dimensions and surface area			***Properties***	
	***Area***		***Strong Axis (Y-Y)***	
	A	***151.00 cm^2***	***I_y***	***9050 cm^4***
	Depth		***S_y***	***1211.68 cm^3***
	h	***25.40 cm***	***Z_y***	***0.0 cm^3***
	Thickness		***Weak Axis (Z-Z)***	
	t	***3.18 cm***	***Iz***	***9050 cm^4***
	Filet radius		***Sz***	***1211.68 cm^3***
	r	***1.58 cm***	***Zz***	***0.0 cm^3***
			Shear area	
			A_y	***0.00 cm^2***
			A_z	***0.00 cm^2***
			Torsional constant	
			J	***510.00 cm^4***
			Warping constant	
			C_w	***24100 cm^6***
L 254x254x32				

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

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
$\phi = 0.9$ $T_r = \phi \times Ag \times Fy = 0.9 \times 15100 \times 350 = 4756.5\ kN$ $T_f = Fx = 655\ kN < T_r = 4756.5\ kN$ O.K Work ratio: $r = {T_f}/{T_r} = 13.77\%$

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
Tr	Factored tensile resistance	4756.5 kN	4756.5 kN	0.00%
r	Design ratio	13.77%	14%	1.64%

	Unfavorable case	Verification	Work ratio
Tension Compression	n°102	Cf ≤ Cr (13.2) 655.00 < 4756.50 kN	14%
Combined forces	n°102	Tf/Tr + Mf/Mr ≤ 1 (13.9.1) 0.138 < 1.000	14%

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