Global stability analysis using overall imperfection method

General

The global stability analysis of steel structural members or frames may be performed by examination of the resistance of cross-sections. In this method the design forces should be calculated by second order stress analysis and the geometry of the model should be modified by global (initial sway) and local (initial bow) imperfections. The features of the method are summarized in the following table:

categories of models and analysis	details of method
imperfections	global and local
analysis	second order
examination of structural member	resistance of cross-sections (using conservative formula)

Numerical example

We will check the stability resistance of structural column (cross-section: HEA200; material: S235; height: 6000 mm) applying the specification of EN 1993-1-1 5.2.2. The simple column is fixed at the base and it is supported at the top cross-section in direction of the weak axes. The column is loaded by 160 kN concentrated and centric compression force at the top of the column (this force is equal to the resistance of the column given by EN 1993-1-1 6.3.1). The steps of the examination are the following:

- Calculation of the overall imperfections:

  - initial sway imperfection (EN 1993-1-1 5.3.2):

$$\phi_0 = \frac{1}{200} = 0{,}0050$$

$$\alpha_h = \frac{2}{\sqrt{L}} = \frac{2}{\sqrt{6}} = 0{,}816$$

$$\alpha_m = 1{,}0$$

$$\phi = \phi_0 \alpha_h \alpha_m = 0{,}0041$$

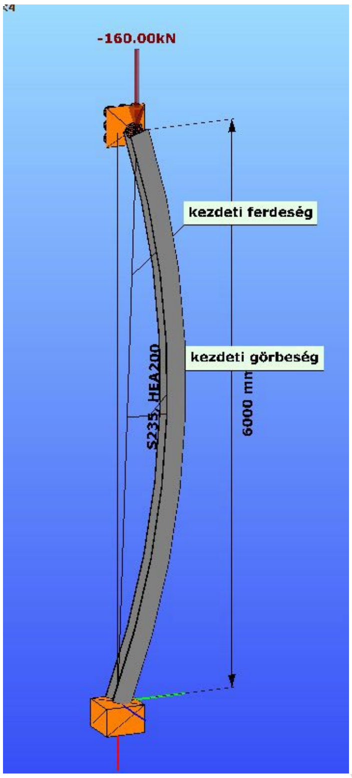
  - initial bow imperfection (EN 1993-1-1 5.3.2 Table 5.1):

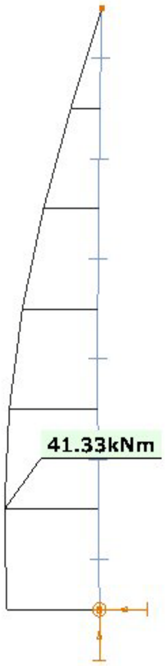
$$curve \ "c'$$

$$e_0 = \frac{L}{200}$$

- Calculation of the second order design forces (maximum bending moment and forces) on the initially imperfect model (ConSteel 4.0):

$$N_{Ed} = 160kN$$
$$M_{y.Ed} = 0$$
$$M_{z.Ed} = 41{,}33kNm$$





- Calculation of the cross-sectional resistance at the moment maximum applying the conservative design equation:

$$N_{pl.Rd} = \frac{Af_y}{\gamma_{M0}} = 1.265kN$$

$$M_{pl.z.Rd} = \frac{W_{pl.z} f_y}{\gamma_{M0}} = 47{,}9kNm$$

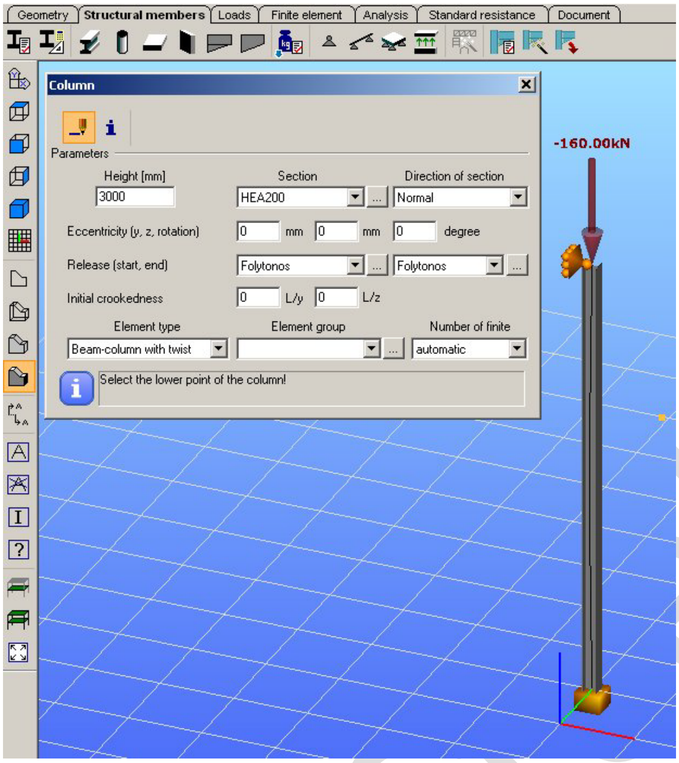
$$\frac{N_{Ed}}{N_{pl.Rd}} + \frac{M_{z.Ed}}{M_{pl.z.Rd}} = \frac{160}{1.265} + \frac{41{,}33}{47{,}9} = 0{,}99 < 1{,}0$$

Just adequate!

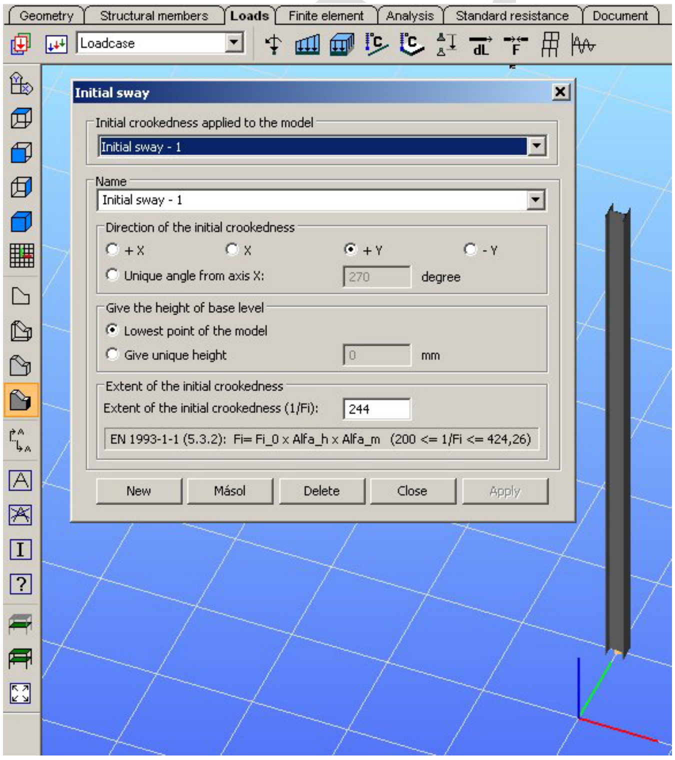
The above overall imperfection method gives the same resistance than the design method based on buckling curves.

How to use the overall imperfection method applying the ConSteel program

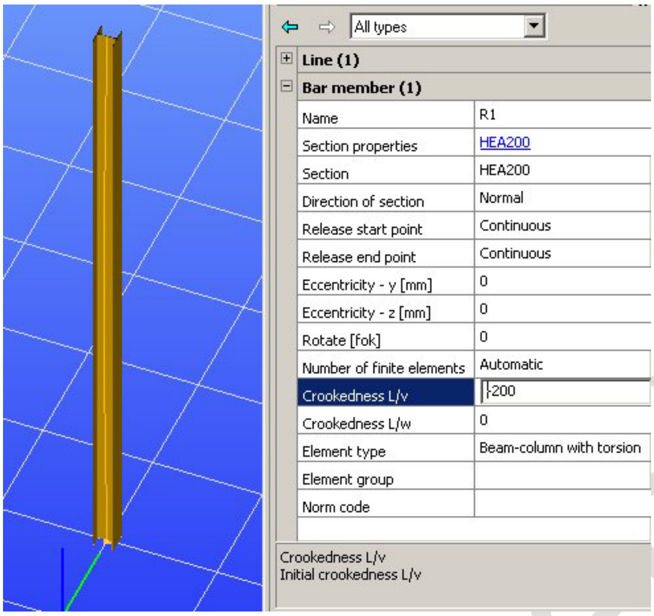
- Column is defined as a perfect model using ***Structural members/Column*** option:



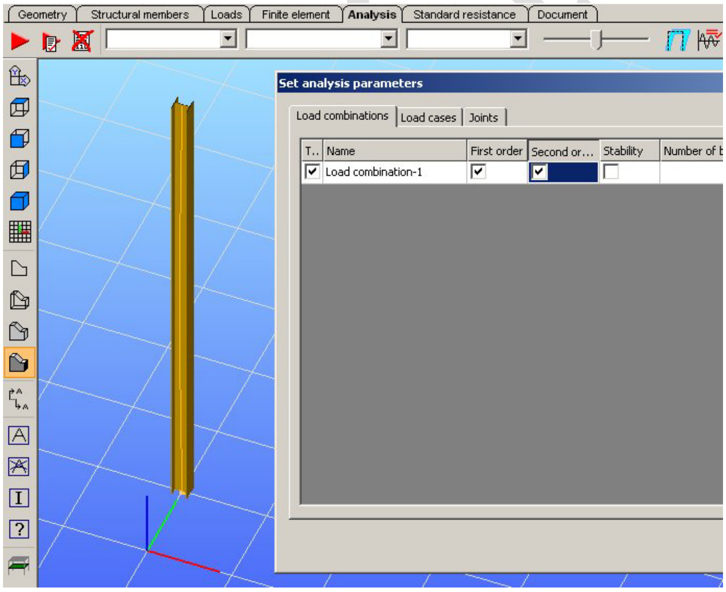
- Initial **sway** imperfection is added to the geometrical model:



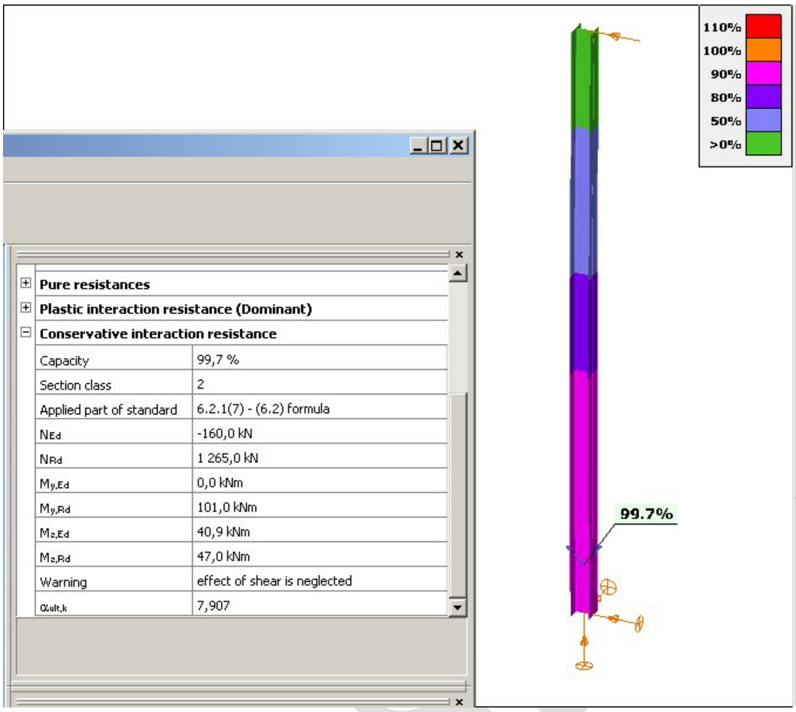
- Initial **bow** imperfection is added to the geometrical model:



- **Second order analysis** is performed:



- **Cross-sectional resistance** is calculated using the conservative interaction design equation of EN 1993-1-1 6.2.1 (6.2) specification:



The cross-sectional resistance of the column is used by 99.7%. This result is close to the result given by the general method based on the buckling curves (the difference is less than 0,3%).