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Statics and stability for thin-walled shear beam with cross-section distortion

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Master's thesis

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July 12, 2010

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Abstract

This Master's thesis deals with the thin-walled shear beam statics and stability with cross-section distortion. The linear statics based on reference [6] includes the bending in the cross-section of each wall as a Bernoulli beam, Timoshenko beam behavior (in-plane stretch, bending and shear of walls) with free torsion as a Saint-Venant torsion of the walls in the thin-walled beam's element direction. The material is elastic. The stability phenomenon includes formulation of the element stiffness matrix and the stress-stabilization matrix under constant compression load and under in-plane banding. Then the stiffness matrix and the stress-stabilization matrix on the system level with eigenvalue problem formulation are presented.

The purposes of this work are the following:

- to implement an example for theory presented in [6] due to better understanding of the linear statics formulation of the thin-walled beam,
- to present the solution of homogeneous differential equations in terms of polynomial solution and solution consisting of the exponential modes on arbitrary chosen thin-walled beam cross-sections,
- to extend theory in reference [6] by the buckling theory,
- to implement above theories into MatLab and create the program which can handle different cases of the thin-walled beam's buckling modes,
- to compare results given in the program with the existing theories.

The created program called "Thin-walled beam statics and stability" (TWBSaS) has been checked for the following cases of the buckling modes:

- the warping mode with I-profile cross-section,
- the column buckling mode with and without shear consideration with a single wall and I-profile cross-section under constant compression load,
- the torsion buckling mode with a cruciform cross-section under constant compression load,
- the mode caused by in-plane bending with a slender I-profile cross-section,
- the local buckling mode and distortional mode with hollow-core rectangular cross-section under constant compression load.

The software used for the present work is MatLab (numerical calculus) and Maxima (analytical calculus).