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ON STABILITY BEHAVIOUR OF THIN-WALLED COLUMNS ACCOUNTING FOR INITIAL GEOMETRICAL IMPERFECTIONS

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Some stability problems related to effects of initial geometrical imperfections of axially compressed thin-walled columns with bisymmetric cross-section are considered. The flexural buckling of columns with an initial cross-section angle of twist and the torsional one accounting for an initial curvature of the column axis are investigated. Our attention is paid only for elastic the column material. The problems formulated are solved in an analytical and numerical manner. The simply supported I column is taken as an example.

The analytical solutions of the problems are based upon the classical theory of thin-walled beams with non-deformable cross-section [1]. The total potential energy of the column is derived accounting for the imperfections mentioned above. The minimum potential energy theorem allows to derive the governing differential equations of the stability problem. The critical buckling loads are determined by means in approximated way of the Galerkin's approach. At first only one term approximation of the buckling mode is taken into consideration and next the critical buckling loads are found with aid of two terms approximation.

Next, the same critical buckling loads are established using ABAQUS software [2]. Evidently the numerical model of the I column has no restrictions on the cross-section deformation. In the numerical analysis fully integrated finite strain square (6 dof and 4 nodes) shell elements called S4R are applied. The non-linear buckling analysis with application of the modified Riks method is carried out.

The numerical examples deal with the simply-supported I column presented in Fig.1. It is well known [3, 4] that for axially compressed the columns without any geometrical imperfection both flexural and torsional bifurcation points are symmetric and stable. This property means that any reduction of the critical loads for flexural nor torsional buckling due to small initial imperfection similar to the buckling mode is not possible.

At first, the critical buckling loads for both formulated problems are found in analytical approach for one term approximation of the buckling mode and in the next step for two-term approximation. The effects of the imperfection amplitude on the critical buckling loads and the pre-buckling paths are investigation for different width of flanges. The analytical results are compared with numerical one.

The results obtained allow us to draw some conclusions related to effects of initial imperfections, its amplitudes and the cross-section dimensions on the critical load under consideration.

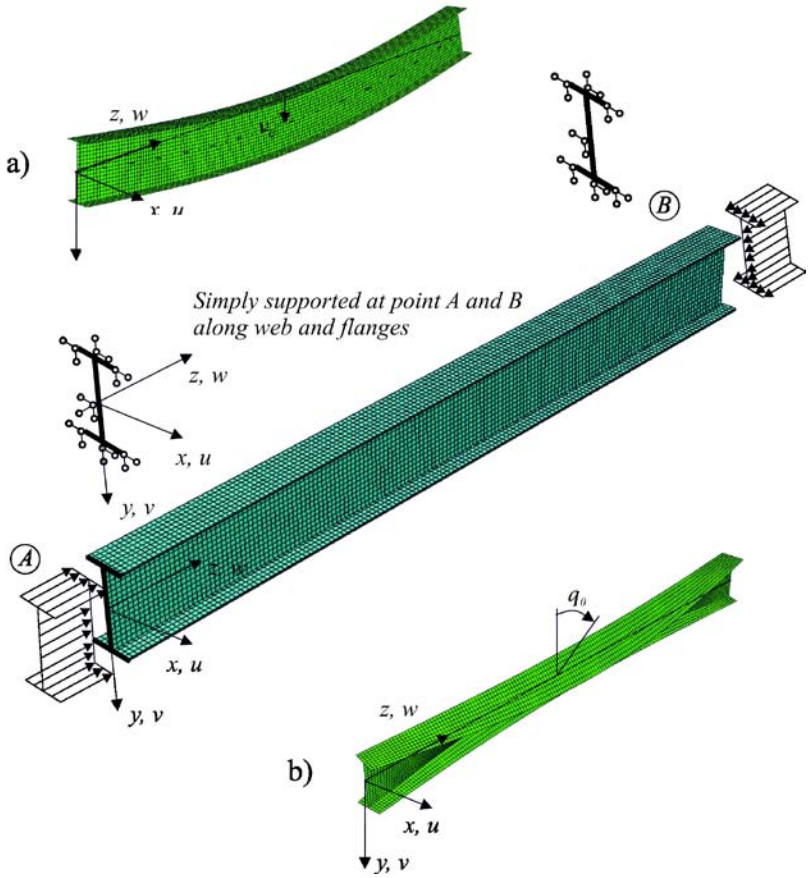

Fig. 1. Axially compressed simply supported I column a) with initial curvature of its axis v_0 and b) with initial twist of cross-section q_0

- The initial curvature of the column axis may leads to reduction of the critical torsional loads. The bigger imperfection amplitude the higher decrease of the critical load. The reduction strongly depends on the flange width and only narrow flanges occurs.
- However for the initial twist of the column for all values of the imperfection amplitudes and all dimensions of the cross-section an increase of the flexural buckling loads is observed.
- Comparison of the numerical study results to the analytical one is satisfactory accurate only for narrow flanges because for wider flanges interaction of local and global stability is visible. In the case of the two terms approximation of the buckling mode compatibility of both analytical and numerical solutions is better than for one term approximation.

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