THE INFLUENCE OF SECONDARY BUCKLING MODE ON INTERACTIVE BUCKLING OF STEEL CHANNEL SECTION BEAMS UNDER PURE BENDING

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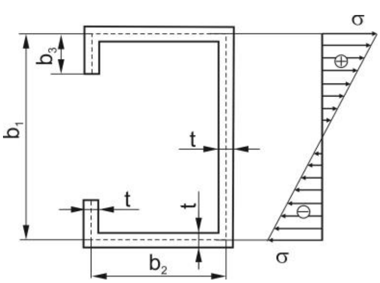
1. INTRODUCTION

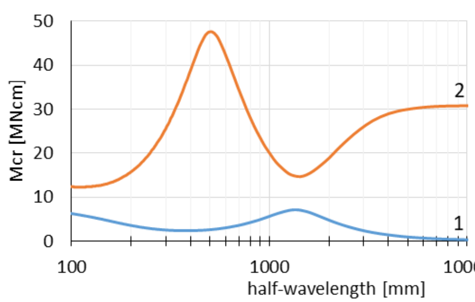
Open section (e.g. I-section or C-section) beams are the basic structural elements in different structures, which are primarily subjected to bending. A capacity of resist loads in thin-walled beams is limited not only by their strength but first of all due to stability. The influence of secondary buckling mode with one half-wave of sinusoid on interactive buckling and load-carrying capacity of channel section beams subjected to bending in web plane has been investigated by Kolakowski and Jankowski [1]. Similar researches have been done by Camotim et. al. [2] who take into consideration the distortional-global modes interaction in nonlinear stability analysis of lipped channel beams under uniform major-axis bending employing Generalised Beam Theory (GBT). In present paper the influence of secondary buckling mode on postbuckling behaviour and load carrying-capacity of lip-channel (LC) section beams have been analysed with similar consideration as in have been presented in papers [1] and [2].

2. ANALYSIS OF THE CALCULATION RESULTS

Thin-walled steel lip channel section beams (LC) subjected to the pure bending (Fig. 1a) were considered. The boundary condition corresponding to simply support at beam ends have been assumed. A plate model (i.e. 2D) of thin-walled structures was applied. The beams were made obeyed Hooke’s law.



a)



b)

Fig. 1. Lip channel section under consideration (a) and buckling bending moment vs. length of one halfwave (b) for LC-1 and LC-2

The nonlinear problem of stability was solved with Koiter's asymptotic perturbation theory with the semi-analytical method (SAM) [1].

The problem have been solved considering all four cases of lip channel section beams presented in paper [2] with the following geometrical dimension (c.f. Fig. 1a):

a) LC-1 - b1 = 190 mm, b2 = 90 mm, b3 = 10 mm, t = 3.08 mm, L = 400 mm;
b) LC-2 - b1 = 190 mm, b2 = 90 mm, b3 = 10 mm, t = 3.08 mm, L = 2000 mm;
c) LC-3 - b1 = 175 mm, b2 = 100 mm, b3 = 13 mm, t = 3.6 mm, L = 4500 mm;
d) LC-4 - b1 = 125 mm, b2 = 75 mm, b3 = 10 mm, t = 3.0 mm, L = 2050 mm.

The following material properties have been assumed: Young modulus E = 210 GPa and Poisson ratio $\nu = 0.3$.

The buckling bending moment as a function of length of one half-wave of sinusoid (buckling mode) for cases LC-1 and LC-2 are presented in Fig. 1b. The values of buckling bending moment for all considered beams are summarized in Table 1. The following index notations are introduced: 1 - the lowest value of the local buckling moment, 2 - the value of the buckling moment corresponding to the primary global buckling mode for $m = 1$ (curve 1 in Fig. 1b), 3 - the value of the buckling load corresponding to the secondary global buckling mode for $m = 1$ (curve 2 in Fig. 1b).

In the nonlinear analysis of the interactive buckling for the assumed absolute imperfections, their signs were selected in the safest way [1]. The postbuckling equilibrium paths for the LC-beams with imperfections: local |0.1| and global |1.0| were determined. Additional, in Table 1 the ratios calculated as load carrying capacity (or secondary bifurcation) value to the lowest buckling moment with consideration interaction of three buckling modes are presented. Analysing the results, it can be said that the local buckling modes have been observed only for case LC-1, it means that the secondary buckling mode (curve 2 in Fig. 1b) corresponds to local buckling mode.

Table 1. Buckling moments and load carrying capacities of the LC-beams

denoted	M_1 [MNcm]	M_2 [MNcm]	M_3 [MNcm]	M_s/M_{min} [-]	M_s/M_{min} [2] [-]
LC-1	2.413	-	38.916	1.086	-
LC-2	2.413	4.807	18.947	0.803	0.919
LC-3	3.499	1.765	31.230	0.770	0.775
LC-4	1.575	1.587	11.641	0.675	0.838

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