BUCKLING OF TWCFS OPEN-SECTION MEMBERS UNDER ECCENTRIC COMPRESSION

M. KOTEŁKO, A. KARMAZYN, Ł. BORKOWSKI
Department of Strength of Materials, Lodz University of Technology
Stefanowskiego 1/15, 90-924 Łódź, Poland

V. UNGUREANU, D. DUBINA
Dep. of Steel Structures and Structural Mechanics, Politehnica University of Timisoara
Romanian Academy, Timisoara Branch, Steel Structures Laboratory
Ioan Curea 1, 300224, Timisoara, Romania

1. SUBJECT AND OBJECTIVES OF THE ANALYSIS

Thin-walled cold-formed steel (TWCFS) sections commonly have mono-symmetric or point symmetric shapes, and normally have stiffening lips on flanges and/or intermediate stiffeners in wide flanges and webs. Both simple and complex shapes can be formed for structural and non-structural applications. Cold-formed steel design is dominated by some main problems, i.e., (1) stability behaviour, which is dominant for design criteria of cold-formed steel sections, and (2) connecting technology, which is specific and strongly influences the structural behaviour and design detailing. In the last years, the seismic performance (3) of cold-formed steel structures started to be examined. The problem of buckling loads and the load carrying capacity of TWCFS members subjected to simple loading systems (pure bending or uniform compression) has been with satisfactory accuracy solved within the theory of thin-walled structures, as well as in design code specifications. However, the same problem concerning members subjected to combined loadings (compression and bending, eccentric compression) is still an open question.

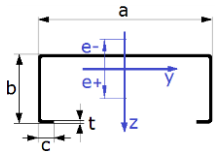

Fig. 1. Subject of investigation - lipped channel section TWCFS under eccentric compression

The objective of the present work is an experimental study on buckling behaviour of TWCFS lipped channel section columns subjected to eccentric compression about the minor axis. The subject of the study is shown in Fig. 1.

2. THEORETICAL STUDY

Buckling loads of members under investigation were determined using Finite Element (FE) and Finite Strip (FS) methods. FE calculations were carried out using the commercial FE codes, for two options of boundary conditions (BC1 and BC2). FS calculations were performed using CUFSM code.

The length of the columns was L = 450 mm. The dimensions of the lipped channel cross-section are $a \times b \times c \times t$ =150×60×20×1 mm, as shown in Fig. 1.

3. EXPERIMENTAL DETERMINATION OF BUCKLING LOADS

Experimental tests were performed on the testing machine Instron, as shown in Fig. 2a. In total, 12 eccentricities and axial load (3 tests for each loading conditions) were performed. The buckling loads were determined using two methods: P-ε_{av} and P-w^2 [1].

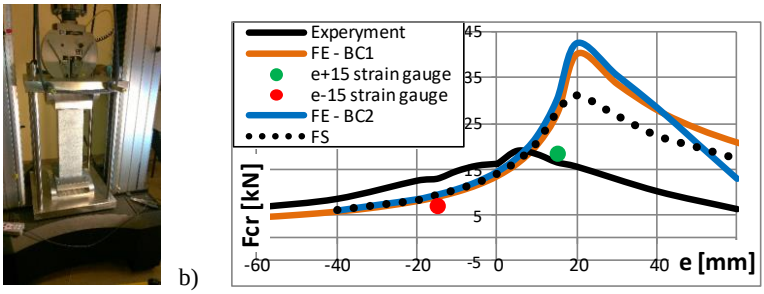

Fig. 2. Buckling tests results: a) experimental stand, b) buckling load versus eccentricity

Buckling loads in terms of applied eccentricity are shown in Fig. 2b (experimental and numerical results). The maximum force in case of experimental results is obtained for an eccentricity of e = +5 mm, while in case of FS and FE analyses for e =+20 mm. Maximum of buckling load for certain positive eccentricity was also obtained in FS and FE calculations for wider range of lipped channel section dimensions. For both greater positive and absolute value of negative eccentricities buckling load decreases significantly.

4. FINAL REMARKS

There is a significant discrepancy between both numerical FS and FE buckling loads in comparison with experimental loads for positive eccentricities, particularly at the vicinity of maximum value. This problem and a question of a maximum for certain positive eccentricity demands further both numerical and experimental research for a wider range of column dimensions and eccentricities. Such a maximum was also observed for plain channel section columns, but for small negative eccentricity [2].

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REFERENCES

[1] Paszkiewicz M., Kubiak T., Selected problems concerning determination of the buckling load of channel section beams and columns, Thin-Walled Struc., 93, 112-121, 2015.

[2] Wysmulski P., Teter A., Dębski H., Effect of eccentricity of load on the buckling of thin-walled composite C-columns, Proc. of the 22nd CMM-2017, Lublin, Poland, 2017.