ULTIMATE AND POST-FAILURE PERFORMANCE OF TWCFS OPEN-SECTION MEMBERS UNDER ECCENTRIC COMPRESSION

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1. INTRODUCTION

Thin-walled cold-formed steel (TWCFS) structures are usually made of members of Class 4 cross-sections. Since these sections are prematurely prone to local or distortional buckling and they do not have a real post-elastic capacity [1]. Thus, the failure at ultimate stage of those members, either in compression or bending, always occurs by forming a local plastic mechanism. The objective of the study was the experimental testing of TWCFS lipped channel section columns subjected to eccentric compression about the minor axis and experimental validation of theoretical models of local plastic mechanisms, developed on the basis of preliminary FE simulations and used in the yield-line analysis, leading to the determination of post-failure capacity [2].

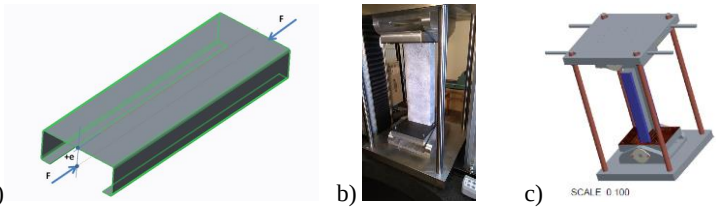


Fig. 1. Object of the study: a) lipped channel section column, b) test rig, c) special grip

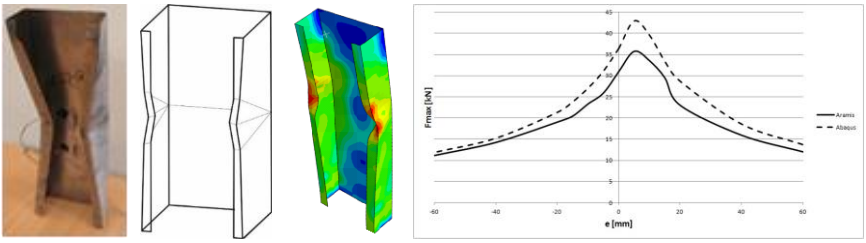
2. OBJECT OF THE STUDY

The object of the study is shown in Fig. 1a. The dimensions of the cross-section are $a \times b \times c \times t$ = 150×60×20×1. The length of the columns was L = 450 mm. The specimens were tested at positive and negative eccentricities of 5, 10 15, 20, 40 and 60 mm, respectively, and for axial compression.

3. METHODOLOGY AND RESULTS OF EXPERIMENTS

Experimental tests were performed on the testing machine Instron (Fig. 1b). The short columns were installed in the grip (Fig. 1c) with the bottom and top plates with grooves,

each groove corresponding to certain eccentricity. The loading velocity was 1 mm/min. Load and shortening of the specimens were measured using integrated measurement system of the testing machine. Additionally, the Aramis Digital Image Correlation system was used to measure deformations.



a) b) c) d)

Fig. 2. Exemplary experimental results for eccentricity e= +15 mm: a) plastic deformation pattern, c) plastic mechanism model [2], d) FE simulation, d) ultimate load versus eccentricity

Exemplary experimental results are shown in Fig. 2. Ultimate loads decrease significantly with an increase of positive eccentricity and absolute value of negative eccentricity. However, for very small positive eccentricities an increase is observed (with the maximum for ca e = +10 mm). Two theoretical models of plastic mechanisms were developed for positive eccentricities [1]. The first one (for small eccentricities is shown in Fig. 2a. It coincides with the theoretical model (Fig. 2b). For negative eccentricities, the mechanisms recorded experimentally and confirmed by FE simulations, were a combination of flip-disc mechanism in the web and a local one, similar to the local mechanism in flanges of box-section beam subject to pure bending [3].

4. FINAL REMARKS

The paper presents the results of an experimental program into the ultimate and post-failure performance of TWCFS lipped channel members subjected to eccentric compression about minor axis, with a wide range of both positive and negative eccentricities, so that recorded different failure and post-failure performance allow one to develop a general relation of load-capacity and post-failure behaviour in terms of the eccentricity of applied load.

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