THE EFFECTS OF COMPRESSION LOADING ON PERFORATED TWCFS STRUCTURAL MEMBERS OF LIPPED CHANNEL CROSS-SECTION

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1. INTRODUCTION

Cold formed steel exhibits a versatile nature which allows for the forming of a range of widely different products, with a variety of shapes, sizes, and applications [1]. Perforations are used in many cold-formed thin-walled applications to accommodate services such as electrical, plumbing, and heating. There are a number of, but not many, research projects that have been conducted on the analyses of cold-formed thin-walled channel section columns with perforations subjected to compression loading [2].

The main objectives of this study were to investigate the effects that the position of perforations have on buckling behaviour of thin-walled cold formed steel (TWCFS) channel section columns subject to compression and also to attempt to compare these effects using experimental, and theoretical (numerical FE and analytical) investigations, as well as design code predictions (AISI, BS and Eurocode).

2. RESEARCH PROGRAMME AND METHODOLOGY

Two sets of columns (Fig.1) were tested. Both in experiment and theoretical analysis fixed-fixed boundary conditions were applied. FE analysis was carried out using ANSYS numerical code. The non-linear buckling analysis was carried out to study buckling behaviour. Additionally , for some cases, yield line analysis (YLA), based on plastic mechanism model [3] was performed to study ultimate and post-ultimate performance.

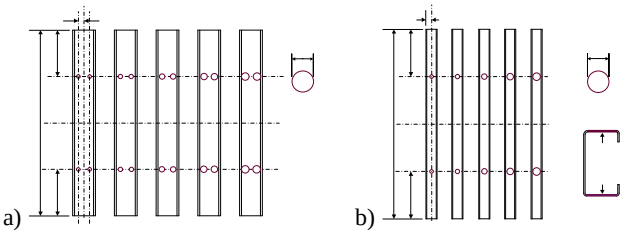

Fig. 1. Perforations shapes and position: a) set 1: perforations located on webs, b) set 2: perforations located on flanges

Numerical results based on FE models that incorporate the column testing parameters were compared with test results. Exemplary comparative deformation patterns are shown in Fig. 2. For selected cases, also YLA results were incorporated into the comparative study.

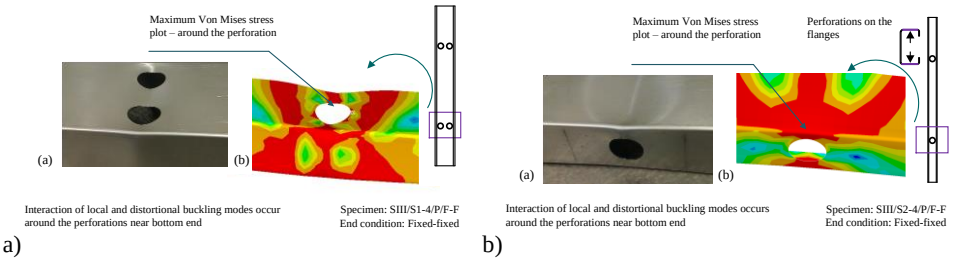

Fig. 2. Comparison of experimental and FE analysis deformed shape: a) - set 1, b set - 2

3. CONCLUSIONS

The comparisons between the test results in Set 1 and Set 2 pointed out, that the reduction in the stiffness associated with the specimen with perforations on the web was found to be lower than that for the specimen with perforations on the flanges.

It was shown that numerical and experimental investigations can be used to obtain a better understanding of failure mechanisms of buckling in lipped channel sections with perforations with a reasonable degree of confidence. Further, the investigation showed that the ultimate load of the structure under compression varied greatly with the position of perforations. Moreover, the results also indicated that current design rules in American Iron and Steel Institute (AISI), British Standards (BS), and European Recommendations are conservative for the load capacity of column members of lipped channel cross-section with perforations subjected to compression loading. In some cases, determination of ultimate loads using YLA analysis might deliver less conservative results.

REFERENCES

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