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OPTIMIZATION OF WEB STIFFENER IN COLD-FORMED STEEL CHANNEL BEAMS SUBJECTED TO PURE BENDING

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ABSTRACT

In this paper; based on previous experimental results, the buckling behavior of CFS channels beams with both edge and intermediate stiffeners in their web subjected to pure bending has been predicted with the aid of advanced numerical modelling. A non-linear finite element model has been developed to investigate the flexural behavior of CFS beams and to improve their moment capacities and observed failure modes at ultimate loads. Based on the analysis and optimization study, a numerical prediction relationship between web stiffeners and beam dimensions is developed.

Keywords: buckling, cold-formed steel, finite element, web stiffeners, flexural enhancement.

INTRODUCTION

Cold-formed steel structures are steel structural products that are made by bending flat sheets of steel at ambient temperature into shapes which will supports more than the flat sheets themselves [1]. They have been produced for more than a century since the first flat sheets of steel were produced by the steel mills. However, in recent years, higher strength materials and wider range of structural applications have caused a significant growth in cold-formed steel relative to the traditional heavier hot-rolled steel structural members [2].

Cold-formed steel channels sections are commonly used in many applications including residential construction [3, 4].These steel sections usually have large width-to-thickness ratio. Hence, the buckling phenomena (local buckling and distortional buckling) are usually the governing failure modes for CFS members [3, 5, 6]. In plate mechanics, the edge stiffeners; such as lips in channel sections, and intermediate stiffeners in the web can enhance the strength of sections by acting as out of plane supports to the flat elements of sections. Thus, the stiffeners improve the efficiency of the utilization of material.

The finite element package ABAQUS [6.14] was used to develop a finite element model and perform nonlinear analysis of channel beam subjected to four-point load. The sample length 1400 mm and the cross-section dimensions were used in FEM and created based on the centerline dimensions and base metal thickness. The developed finite element model was verified against the previous experimental results [6]. The moment capacities and failure modes predicted by the finite element analysis (FEA) were compared with the test results. The moment-curvature curves obtained from the test and FMA are very good agreement for beams as shown in Figure 1 and showed to be accurate in terms of ultimate moment, failure modes and moment-rotations curve.

RESULTS AND CONCLUSIONS

It has been showed that FE model well predicted the moment capacity and failure modes of the test beams. Thus, the verified model was used for extensive parametric study of 160 beams with stiffened channel sections subjected to bure bending.

The most significant enhancement of stiffness behaviour appears between the appearance and varying dimensions of web stiffener as shown briefly in Figure 2.

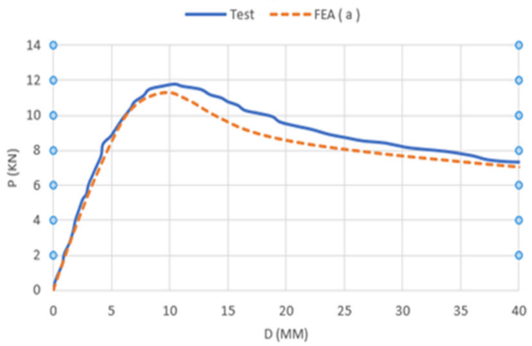

Fig. 1 - Comparison of moment-curvature curve obtained from test and FEA for C-beam

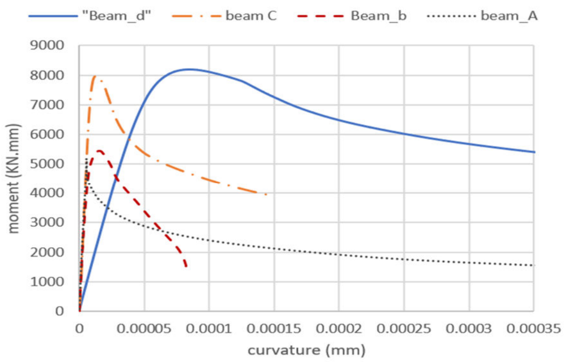

Fig. 2 - Comparison of moment-curvature curve obtained from FEA for C-beam with (a) out stiffeners (b) comp. flange stiffener (c) web stiffener (d) both flange and web

This study shows that, geometric failure may occur before section yielding. So, the presence of buckling phenomena of an element does not necessarily mean that its load capacity has been reached. The intermediate and edge stiffeners can significantly enhance the performance of channel beams in bure bending. This study presents also a numerical prediction relationship between web stiffeners and beam dimensions.

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