WEB CRIPPLING BEHAVIOUR OF CURVED COLD-FORMED STEEL UNLIPPED CHANNEL BEAMS

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Cold-formed steel (CFS) sections are increasingly utilized in various building applications such as purlins, decks, wall studs, and floor joists, due to their inherent characteristics over hot roll sections. With the increasing popularity of curved structures in architectural and structural designs, understanding the structural performance of curved CFS elements is important. CFS channel sections are prone to localized bearing failures known as web crippling under concentrated forces due to their higher web slenderness. Although numerous studies have been undertaken to investigate web crippling behaviour of straight CFS channel beams, the response of curved CFS beams to web crippling has not been explored yet. Therefore, this study investigates the web crippling behaviour of curved CFS unlipped channel beams.

Through a series of experimental tests conducted on curved CFS unlipped channel beams with different curvatures, including both flanges inward and outward curved, subjected to interior-two-flange (ITF) loading conditions, the study evaluated the resistance of these curved beams to web crippling. The experimental results indicate that the initial curvature has a significant impact on the web crippling capacity. Notably, the flange inward curvature enhances the web crippling capacity, whereas the flange outward curvature diminishes it compared to straight, unlipped channel sections. Furthermore, the design guidelines commonly used for predicting web crippling capacity were evaluated for consistency and reliability compared to the experimental results. It was found that outlining the inconsistencies of using the guidelines developed for straight beams in evaluating the web crippling capacities of curved CFS unlipped channel sections.

In order to further investigate the web crippling response of curved channel beams, finite element models were developed. Finite element models developed for straight beams were validated against experimental results done in this study and available in the literature, demonstrating good agreement in terms of failure modes, capacity, and load-deflection curves. A parametric study was carried out to evaluate the key parameters influencing the web crippling behaviour of curved beams.

In summary, this research carried out experimental and associated numerical studies on curved CFS channel sections subjected to web crippling under the ITF load case. It was found that the curvature of the beam is significant, considerably improving the knowledge and understanding of the web crippling behaviour of curved channel beams.

Keywords: Cold-formed steel, Curved beams, Finite element modelling, Interior two-flange loading, Web crippling, Unlipped channel

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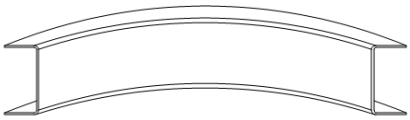
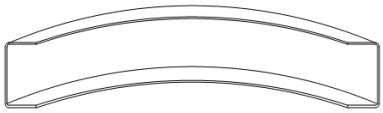


Flange-outward curved beam



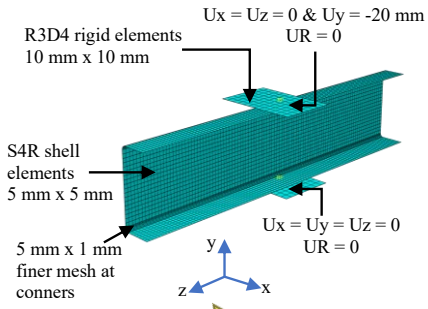
Flange-inward curved beam

Experimental Test Setup

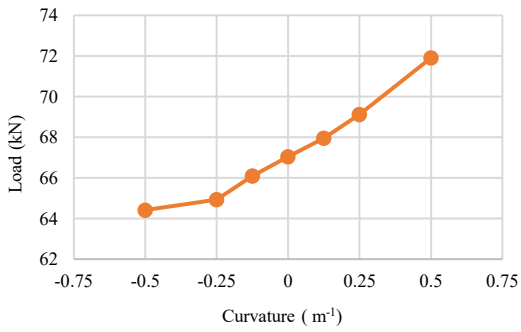
Web Crippling (ITF) Test

Tensile Coupon Test

Finite Element Modelling



Web crippling strength vs Beam curvature



"–" Outward Curvature, "+" Inward Curvature