Balasubramaniam Janarthanan*
Mahen Mahendran
Shanmuganathan Gunalan

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Bearing capacity of cold-formed unlipped channels with restrained flanges under EOF and IOF load cases

Bearing failure is a form of localized failure that occurs when thin-walled cold-formed steel sections are subjected to concentrated loads or support reactions. To determine the bearing capacity of cold-formed channel sections, a unified design equation with different bearing coefficients is given in the current North American specification AISI S100 and the Australian/New Zealand standard AS/NZS 4600. However, coefficients are not available for unlipped channel sections that are normally fastened to supports through their flanges. Eurocode 3 Part 1.3 includes bearing capacity equations for different load cases, but does not distinguish between fastened and unfastened support conditions. Therefore, an experimental study was conducted to determine the bearing capacities of these sections as used in floor systems. Twenty-eight web bearing tests on unlipped channel sections with restrained flanges were conducted under End One Flange (EOF) and Interior One Flange (IOF) load cases. Using the results from this study, a new equation was proposed within the AISI S100 and AS/NZS 4600 guidelines to determine the bearing capacities of cold-formed unlipped channels with flanges fastened to supports. A new design rule was also proposed based on the direct strength method.

1 Introduction

Cold-formed steel members have been gaining in popularity over hot-rolled steel members due to their high strength-to-weight ratio, mass production, accurate detailing and ease of fabrication. Among these cold-formed types, channel sections are commonly used as bearers and joists in floor systems for residential, industrial and commercial buildings as shown in Fig. 1. These conventional channel sections are mainly classified as lipped channel sections (with stiffened flanges) and unlipped channel sections (with unstiffened flanges). Such channel sections are used in floor systems with bolted and welded connections. However, these cold-formed steel sections are at risk of localized failures in their slender plate elements, and this should be considered in their design.

Web bearing failure, also known as web crippling failure, is one such failure in thin-walled cold-formed steel beams due to concentrated loads or support reactions. The bearing capacities and failure modes of cold-formed steel channel sections mainly depend on the loading types, locations and connection types. Fig. 2 shows the different web bearing/crippling failures of cold-formed unlipped channel sections under the End One Flange (EOF) load case. In Fig. 2a the flanges have rotated about the web/flange junction. However, in Fig. 2b such rotation has been restrained by the bolted connection. The current North American specification [1], Australian/New Zealand standard [2] and Eurocode 3 Part 1.3 [3] specify four types of load case – End One Flange (EOF), Interior One Flange (IOF), End Two Flange (ETF) and Interior Two Flange (ETF) – by considering load types and failure locations as shown in Fig. 3. The failure type is considered as end loading if the failure region is within $1.5d_1$ from the edge of the specimen. Otherwise, it is considered as an interior loading failure. The one-flange loading condition is considered if the distance between the edges of two opposite bearing plates is greater than $1.5d_1$. Otherwise, it is considered as a two-flange loading.

Since 1940 many experimental studies have been performed on cold-formed steel channel sections with unfastened [4], [5] and fastened [6], [7] support conditions. Current design rules for the bearing capacities of cold-formed steel members in the North American specification AISI

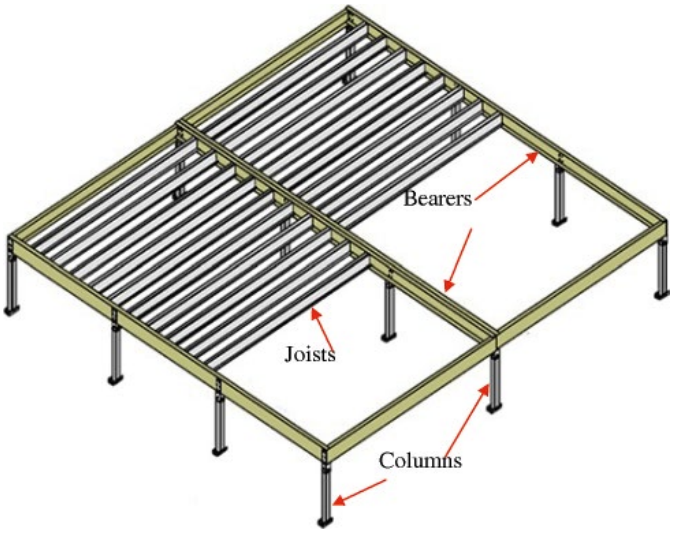

Fig. 1. Cold-formed steel floor systems

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* Corresponding author:
janarthanan.balasubramaniam@hdr.qut.edu.au