Journal of Constructional Steel Research 150 (2018) 1–6

Contents lists available at ScienceDirect

Journal of Constructional Steel Research

Effects of different support conditions on experimental bending strength of thin walled cold formed steel storage upright frames

Ali Saleh [a], Harry Far [a,*], Lawrence Mok [b]

[a] Centre for Built Infrastructure Research (CBIR), School of Civil and Environmental Engineering, University of Technology Sydney (UTS), Sydney, Australia
[b] Dexion (Australia) Pty Ltd, Sydney, Australia

ARTICLE INFO

Article history:
Received 1 May 2018
Received in revised form 11 July 2018
Accepted 31 July 2018
Available online xxxx

Keywords:
Four-point bending test
Upright bending strength
Support conditions
Load deformation curves
Free twisting

ABSTRACT

Design computations of industrial storage racks in accordance with current industry standards rely in part on laboratory testing. One of these tests is for determining the bending strength of upright sections. When testing the bending strength about the axis of symmetry of the upright, a four-point bending test of the assembled upright frame is mandated. The test arrangement prescribed by the standard must permit free twisting of the section at the supports, while the applied loads and their reactions for each upright may be applied in the plane of the section's shear centre. A test arrangement that provides free twisting of the upright section at the supports is more complex and difficult to set up compared with a simple support. This paper examines if the condition of free twisting at supports is necessary in the case of shear centre loading, especially that relaxing this particular code requirement would lead to a simpler test arrangement. Laboratory testing of two sets of upright frames, loaded through the upright's shear centre but with each set having a different support condition indicated that free twisting at the supports had no effect on the bending capacity of the upright members tested. The paper outlines the test setup and reports the results in form of characteristic load deformation curves of the tested specimen.

© 2018 Elsevier Ltd. All rights reserved.

1. Introduction and background

Industrial racks are the most common structures for the storage of palletised goods. The behaviour of these structures, which are built-up from thin-walled cold-formed steel profiles, is quite complex [1]. Upright frames are primary structural components in industrial racking systems. They typically consist of two perforated thin-walled members that are linked together by a bracing system [2] as depicted in Fig. 1. The sensitivity of the uprights to buckling, the presence of the perforations on the uprights, the non-linearity of the connections, the frame sensitivity to the second-order effects and the influence of the imperfections are the main sources of complexity [3, 4].

Several numerical and experimental studies (e.g. Michael et al. [5]; Crisan et al. [6]; Bertoccia et al. [7]; Zhao et al. [8]) have been carried out on bending capacity and different buckling modes of perforated thin-walled cold-formed steel upright frames in order to understand the complex structural behaviour of those steel members. The large variability in terms of geometry of the profiles, of the joints and of the perforations, and the complexity of the phenomena which affects the member behaviour, do not yet allow performing a pure numerical design, but call for tests aimed at the characterisation of the structural components [9]. One of the important tests, which is the subject of this study, is focused on determining the bending strength of upright sections. When testing the moment resistance about the axis of symmetry of the upright, EN 15512 [10] and Australian Standard AS 4084 [11] both require a four-point bending test of the assembled upright frame with a test arrangement as depicted in Fig. 2.

Bernuzzi & Maxenti [12] have employed the mentioned four-point test setup to study the performance of uprights under axial load and gradient moment. They pointed out that when investigating the flexural member behavior about the axis of symmetry, a complete upright frame has to be tested instead of an isolated upright. In this case, four-point tests allow for the prediction of the upright flexural performance about major and minor axes of bending properly [12]. Trouncer & Rasmussen [13] tested 16 nominally concentrically loaded upright frames in order to capture the interactive buckling effects of local, distortional and overall buckling. A comparison of the experimental ultimate loads with strength determinations by the AS/NZS 4084 [11], EN15512 [10] and RMI [14] steel storage rack specifications was also conducted, highlighting the differences between each. The comparison indicated that EN 15512 [10] specification is more accurate in establishing the ultimate capacities of upright sections than the other two examined specifications. Therefore, it can be concluded that for experimental investigation, four-point bending test of the assembled upright frames based on EN 15512 [10] can render the most accurate outcomes.

* Corresponding author.
E-mail address: harry.far@uts.edu.au (H. Far).

https://doi.org/10.1016/j.jcsr.2018.07.031
0143-974X/© 2018 Elsevier Ltd. All rights reserved.

Fig. 1. Typical upright frames.

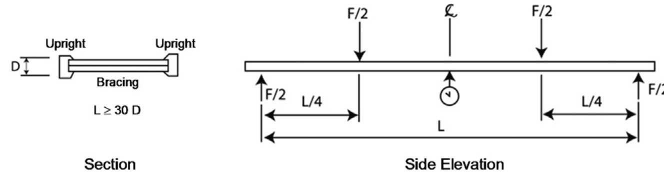

Fig. 2. Test arrangement for the major axis bending test on upright sections [10].

Fig. 3. General view of the test rig.

2. Test configurations

The four-point bending test arrangement in EN 15512 [10] stipulates that "the applied loads and their reactions for each upright shall always be in the same vertical plane and that this plane may be defined by the shear centre or the centroid of the section". Furthermore, EN 15512 prescribes free twisting of the section at the supports in order to allow the lateral torsional buckling effects to be developed by the uprights in their normal mode of use. An experimental setup in which the web of the upright section is used to apply the loads and their reactions will inevitably lead to twisting of the upright axis due to the eccentricity between the planes of loading and corresponding upright shear centre. As a result, the twisting action that will develop during the test may undesirably influence the bending strength of the specimen and therefore the code requirement of free twisting of supports is justified. However, if in the experimental setup loads and support reactions were to be applied through the shear centre of the upright section then, twisting of

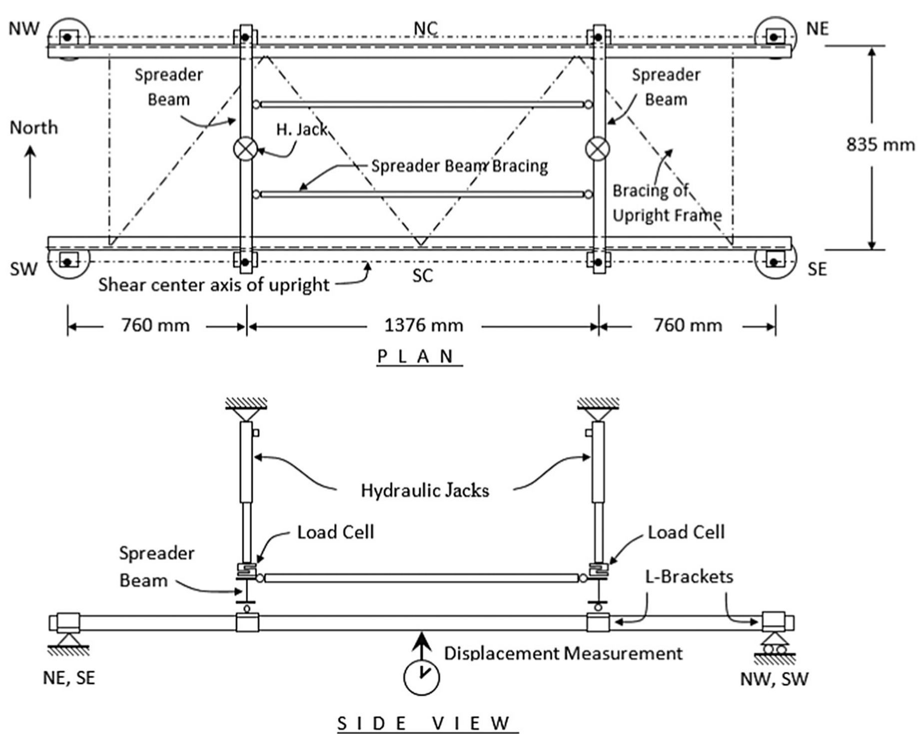

Fig. 4. Test arrangement.

Download English Version:

https://daneshyari.com/en/article/8947125

Download Persian Version:

https://daneshyari.com/article/8947125

Daneshyari.com