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Enhancement of Lateral Performance of K-braces in Light Steel Frames

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Abstract

Nowadays, the application of cold-formed steel members is well established in light steel framing structures around the world. One of the economical methods of lateral bracing of light steel structures is to utilize sections with the same type of main members in the form of K-bracing. In this paper, the racking behavior of six frames with dimensions of 2.40×2.40m and different arrangement of studs and bracing members was numerically investigated. In Nonlinear finite element model of frames, different failure modes were examined such as distortional buckling of studs, tearing of track flange, buckling of bracing members and bearing of connections. Regarding these failure modes, the structure characteristics such as ductility, lateral strength and lateral stiffness were studied. Finally, through using a novel method has been proposed in this paper, racking performance of K-bracing system is improved.

Keywords: Cold-formed steel, Light steel frame, Finite Element method, Nonlinear analysis, Diagonal brace

1. INTRODUCTION

The novel construction technologies including construction systems with the potential of industrial and prefabricated production have met the demand to construction from the quantitative and qualitative point of view. Light steel frame (LSF) is characterized as one of these systems which as well as having the potential of industrial and prefabricated production, due to its light weight, can minimize the vulnerability of buildings during earthquake in case of appropriate design and construction.

Requirements of hot-rolled steel structures were first established at 1930s. Since this code was not applicable to cold-rolled steel structures, therefore, American Iron and Steel Institute (AISI) found the necessity of developing codes for such structures. George Winter is known as the father of cold-formed steel structures in the United States. He established four research reports during 1940 until 1946 for AISA which was eventually published in a book entitled “Design Specifications of members of light steel structures” [1].

Due to the growing application of light steel frame, these structures have been the focus of many studies and particularly, some experiments have been conducted in relation with wind and earthquake loads. Among numerous studies performed since 1978, it can be mentioned to McCreless and Tarpy [2], Tarpy [3], Tarpy and Girard [4], Tissell [5], Gad et al. [6], Salenikovich et al. [7], Dubina and Fulop [8], Pastor and Rodriguez [9], Martines and Xu [10] , Landolfo et al. [11], Kim et al. [12], Long and Naujoks [13] , Kim and Kuwamura [14], Schafer [15], Hatami et al. [16], Moghimi and Ronagh [17], Yu [18]. In most of the above-mentioned studies, the system behavior was investigated under cyclic or monotonic loads.

Up to now, not too many numerical studies on lateral behavior of light steel frames, which provides examination of different parameters, have been developed. This issue is mainly due to the complex behavior of thin-walled members and connections of light steel frames which makes difficult obtaining reliable numerical results. On the other hand, most of the numerical investigations were conducted in relation to X-shaped braces and wooden or steel shear walls.

Since LSF system was originally substituted for wood in wooden buildings, therefore, conventional methods of bracing in the wooden building such as K-shaped bracing can also be in LSF buildings. In this