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Improvement of Seismic Performance of Zipper Braced Frames by Using a New Distribution of Lateral Load Pattern

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Abstract

This paper proposes a new distribution of lateral loading pattern for designing zipper-braced frames using the uniform distribution of damage over the height of structures. Evaluation of the seismic behavior of zipper -braced frames shows that these structures have acceptable performance when compared with Inverted V-braced frames Although pervious studies showed that utulizing these types of structures the formation of the soft-storey mechanism can be prevented, the structural capacity are not entirely exploited over the height of buildings. . Based on the theory of uniform distribution of deformations, lateral- resistant properties of a structure can be distributed over the height in such a way that they can exhibit more uniform deformation. In this study, two zipper- braced frames of 5 and 7 stories have been designed subjected to several ground motions. Using the theory of uniform damage distribution an optimization technique leading to more uniform damage distribution over the height of the structure is developed.

Keywords: Zipper braced frames, Uniform distribution of deformations, Lateral load pattern

1. INTRODUCTION

Concentrically braced frame (CBF) in chevron configuration is a cost-effective system for resisting lateral loads. This structural system is usually employed for low- and mid-rise steel framed buildings. The behavior of such a system is controlled by the buckling of the first story braces in compression, resulting in a localization of the failure and loss of lateral resistance. For instance, extensive damage was found in CBF buildings during Tohoku earthquake on March 2011 (Lignoset al, 2011), Christ-church earthquake on 2010 (Bruneauet al, 2010), Loma Prieta earthquake (1989), Northridge earthquake (1994), Kobe earthquake in 1995 (Tremblay, Bruneau, & Wilson, 1996) and other events. However, Inverted V-braced frames still exhibit a suitable seismic behavior but upon continued lateral displacement, the compression brace buckles and its axial capacity decreases while that of the tension brace continues to increase. This creates an unbalanced vertical force on the intersecting beam, resulting in a structural system that tends to concentrate inter-story drift in a single story, as shown in Figure 1. In order to prevent undesirable deterioration of lateral strength of the frame, the provisions require that the beam shall possess adequate strength to resist this potentially significant post-buckling force redistribution in combination with appropriate gravity loads (AISC 2002). This results in very strong beams, much stronger than would be required for ordinary loads.

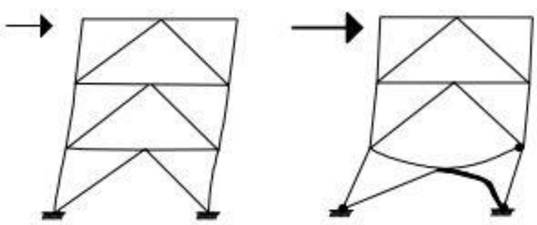

Figure 1. Chevron braced frame behavior under lateral load

To overcome the above design difficulty and mitigate the adverse effect of this unbalanced force, Khatib et al, 1988 [1] proposed to link all beam-to-brace intersection points of adjacent floors and to transfer the