DETERMINATION OF LATERAL CAPACITY OF TWO-STORY X-BRACED FRAMES CONSIDERING HYSTERESIS BEHAVIOU OF CONNECTIONS

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ABSTRACT

Special concentrically braced frames (SCBF) are stiff, strong and economical lateral load resisting systems which can sustain large inelastic deformation if properly detailed. The failures observed during recent earthquakes, such as bracing failures or deterioration of different types of connections, make it necessary to investigate these structural resisting systems more accurately. The main objective of this paper is to determine seismic lateral capacity of special concentrically two-story x-braced frame systems for responses in roof drift, interstory drift, base shear, frame fracture-index and failure contribution of each story in overall deterioration using nonlinear static cyclic analysis in OpenSEES software. Therefore, in this study, in order to have a thorough investigation of frame regularity, eight SCBFs were designed based on AISC seismic provision to represent different values for response reduction factor, R with identical plans and elevations. For performing analysis, recommended FEMA461 loading history was applied. In addition to modeling hysteresis behavior of gusset plate connections, shear tab connections were also considered. Therefore, for validating of this, a three-story one-bay tested in NCREE in Taiwan was particularly used. To identify the bracing fracture developements, the maximum strain range has been monitored. Due to the lack of the fracture expression implementation in the OpenSEES framework based on maximum strain range limit, fracture material model was imported in the program with the ability of being open-source in OpenSEES. Moreover, for validation of hysteresis behaviour of brace failure beyond brace fracture, a one-story one-bay tested in University of Washington was used.

INTRODUCTION

Special concentrically braced frames (SCBFs) are one of the economical systems providing high strength and stiffness against lateral earthquake loads for low-rise buildings in high seismicity regions. SCBFs are a special class of CBFs which complies with specific details of gusset plate connections and maximizes inelastic lateral capacity and ductility of buildings. Given the importance of seismic behavior of gusset plate connection to improve the seismic performance of SCBF (Lehman and Roeder, 2008), new restrictions are currently proposed on the design of gusset plate connections, resulting in creating a new balanced design procedure (BDP), maintaining elliptical clearance for corner gusset plate connections (NEHRP, 2013). Nowadays, an issue that has been the new concern of building engineers is to obtain the ultimate strength of a structure designed against earthquake lateral forces. The most precise seismic analyses are nonlinear time history analyses which are not only complex but also highly costly and require highly complex calculations and suffer from the lack of ground motion data and researchers have been trying to find an alternative way to be secure, accurate and yet simple. In this regard, the main activities are in line with nonlinear static analyses techniques. The first study in this regard belongs to Han and Chopra (2006) and