NUMERICAL ANALYSIS OF THE BEHAVIOR OF CONCENTRICALLY BRACED FRAMES UNDER CYCLIC LOADING CONSIDERING COLUMN ORIENTATION

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ABSTRACT

Concentrically braced frames (CBFs) are widely used as lateral-load resisting system in steel structures. They are economical, and their strength and stiffness may satisfy seismic demand of structures in seismic regions. During severe, infrequent earthquakes, brace yielding and buckling occurs, and this behavior provides the ductility and the energy dissipation capacities for structures. In recent years, a number of studies have examined different factors, which influence the performance of SCBFs; in particular, the gusset plate and the brace member details.
This study is carried out to investigate the effect of column orientation and the resulting flexibility of the connection region on the overall behavior and performance of the system. Nonlinear analyses using a detailed inelastic finite element model (FEM) and the concept of plastic equivalent strainare carried out to study the behavior of frames subjected to cyclic loading.The results showed that the flexibility of the connection region caused by column orientation affects the overall response of the system including lateral load and ductility capacity.

INTRODUCTION

Steel braced frames are commonly used lateral-load resisting systems in design codes. Special concentrically braced frames (SCBFs) are increasingly used in seismic regions in recent years due to their satisfactory behavior and uncertainty as to the performance of special moment resisting frames after the 1994 Northridge earthquake. In SCBFs, the braces are connected to the beams and columns by gusset plate connections, and energy dissipation is provided by the tensile yielding and post buckling deformation of the brace. There are some requirements in design codes for braces to ascertain the nonlinear behavior of them. Out of plane buckling of the braces along with the expected tensile and compressive capacities of them has to be accounted in designing the gusset plate. The current design practice recommends a "$2t_p$" linear geometric offset to be used, where $t_p$is the plate thickness, in order to provide free end rotation resulting from out-of-plane brace buckling. However, relatively large and uneconomical gusset plates resulting from linear geometric offset encouraged researchers to develop substitution for that. In response to this demand, the elliptical geometric offset has been proposed by Lehman et al. (2008) at the University of Washington.
Many studies in the past examined the performance of the brace and the gusset plate connection. Nevertheless the beam and column as main members of the frame play important role in overall performance of the system. The common practice of the columns is I-shaped sections which provides a favorable seismic