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

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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 two different types of concentrically braced frame are recognized in design codes, special concentrically braced frames (SCBF) and ordinary concentrically braced frames (OCBF). SCBFs are increasingly used in recent years, because of the mentioned advantages and uncertainty regarding the performance of moment resisting frames after the 1994 Northridge Earthquake (Roader, 2002). The seismic behavior of SCBFs has been evaluated in different aspects in the past. Most experiments focused on, gusset plate and brace member behaviors and their effects on the overall behavior of the frame.

This study examines the effect of column orientation on the behavior and performance of SCBFs. A single bay, single story frame is used to evaluate the interaction of members. Nonlinear analyses using a detailed inelastic finite element model (FEM) are carried out to study the behavior of frames subjected to cyclic loading. Models are adopted from recent studies in University of Washington. The equivalent plastic strain concept is used to determine the ductility capacity and to predict fractures and failure in these models.

Initially a detailed comparison between the analytical prediction and the experimental observation was used to verify the FE modelling and to ascertain the accuracy and the reliability of inelastic behavior prediction. For this purpose experimental results of (Fooladvand, 2009) were used. The test specimen is depicted in Figure 1. In FEM modelling, all members were tied together and modelled using the four node quadrilateral shell elements, which has six degrees of freedom in each node. Nonlinear-Geometric formulation was used to simulate buckling, and bilinear kinematic hardening material model was employed to simulate cyclic inelastic behavior. The FEM modelling and experimental results were in the agreement (Figure 2).

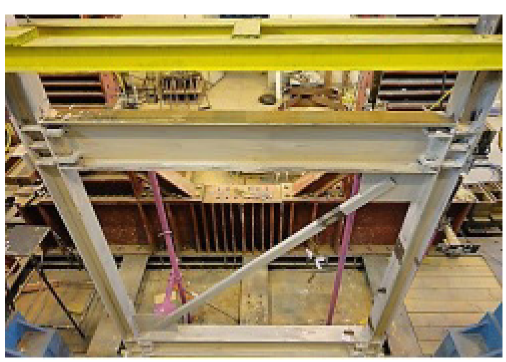

Figure 1. Test specimen of the experiment (Fooladvand and Aghakouchak, 2009)

The column in the lateral bracing system may be oriented so that the gusset plate is connected either to the flange or to the web. Unless the web is stiffened, a connection to the column web is more flexible than common one in which the gusset is connected to the flange. For evaluating the effect of column orientation on the behavior of the frame, the frame was modelled with rotated column and the results were compared to the common frame. The results show that the effect of flexibility in the connection region is more pronounced on the ductility compared to the lateral load capacity.

Figure 2. Experimental and analytical Force-Displacement Plot

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