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Improved Simulation Method of the Conventional Buckling Brace and Gusset-plate Connection

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Special Concentrically Braced Frames (SCBFs) are commonly used as the seismic resisting system in buildings. Their inherent strength and stiffness assure serviceable performance and therefore have been widely used in the United States. Inelastic tensile yield and post-buckling compressive deformations of the brace dominate performance during large seismic events. Inelastic deformations of the brace place secondary yet significant inelastic deformation demands on the surrounding frames and connections, which significantly affect the seismic performance of the system. To accurately capture the responses, these response modes must be included in an analytical model of the system.

The research was undertaken to develop a modeling approach for SCBFs to more accurately predict their seismic performance. Beam-column elements combined with fiber sections (Fig. 1) are used for the braces, beams and columns, and the brace elements include nonlinear geometric effects to simulate brace buckling. A new connection model (Fig. 2) is proposed to simulate the behavior of the gusset plate which significantly influences the post-buckling behavior of the frame system. The model parameters are based upon the member sizes, properties and connection designs.

Simulated results are compared with experimental results (Fig. 3) and predictions from approaches more commonly used in practice including pinned and fixed connection models. The proposed is verified to reasonably represent the global hysteretic behavior of the frame (Fig. 3a) and also the brace out-of-plane displacement at the mid-span of the brace (Fig. 3b). Although the proposed model is a step beyond currently used in design practice, it remains simple in its implementation and is suitable for a wide range of practical applications. The proposed model provides accurate simulation of global behavior, while retaining simplicity and providing reasonable predictions for various local behaviors.

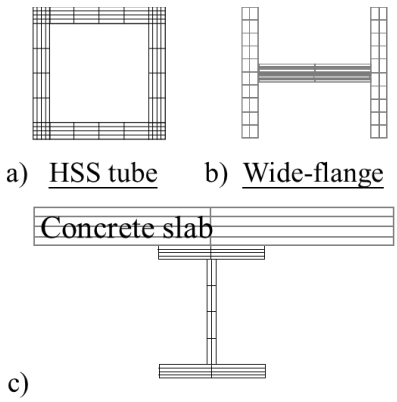

Figure 1. Fiber Discretization used for (a) HSS and (b) Wide-flange Brace Members and (c) the Composite Beam Members.

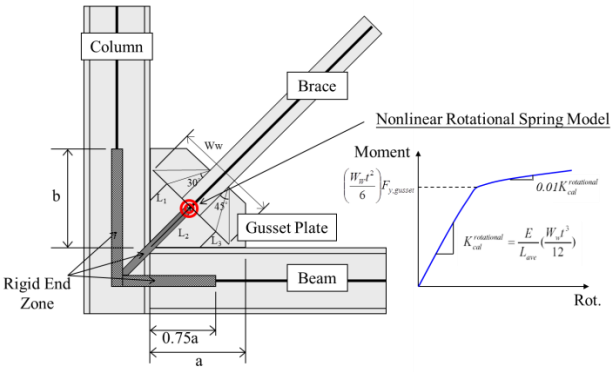

Figure 2. Illustration of the Proposed Connection Model

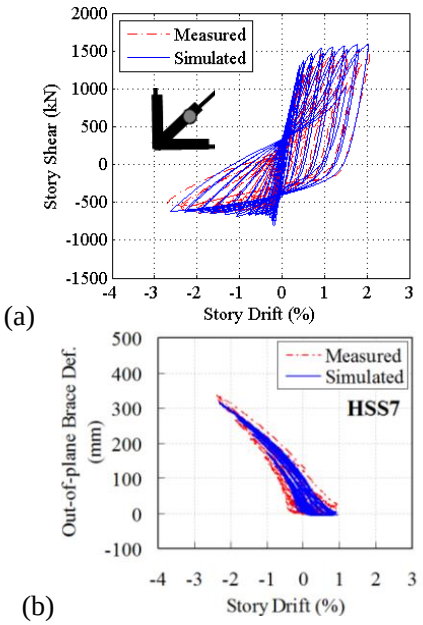

Figure 3. Simulation of the Single-story Frames (HSS7) (a) Hysteretic Behavior of the Frame, (b) Out-of-plane Displacement of the Brace.