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Full-scale Cyclic Testing of an R = 3 Chevron and R = 3.25 Split-X Braced Frames

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ABSTRACT
Steel concentrically-braced frames (CBFs) are used extensively as lateral-force-resisting systems for low to mid-rise buildings in moderate seismic regions of the United States, such as the East Coast and Midwest. Although good structural performance of CBFs in moderate seismic regions for typical gravity and wind loading is well-established, there is essentially no data for earthquake loading. As a result of this situation, a research project was initiated to investigate the seismic performance of CBFs in moderate seismic regions. This paper summarizes data from two full-scale cyclic tests: (1) a one-bay two-story CBF designed assuming R=3; and (2) a one-bay two-story ordinary CBF (OCBF). Both tests focused on the sequences of limit states and associated system behavior. Measured and approximated force distribution in both frames in their deformed configuration is presented at the design force level in addition to events corresponding to various limit states encountered during the analyses. Plots of brace force against longitudinal displacement identify a key difference in structural behavior between the two tests; while the braces in the OCBF frame buckled in a ductile manner, the braces in R=3 frame experienced a brittle buckling mechanism with a corresponding sudden drop in force. An additional study on the R=3 frame was performed by inducing weld fracture in the lower story, which created a mechanism driven by brace re-engagement in compression and beam flexural bending at midspan.

KEYWORDS: *low-ductility, steel frames, braced frames, moderate seismic, reserve capacity, R=3, full-scale*