Behavior and Design of Low-Ductility Braced Frames

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What is the appropriate balance between strength and ductility for lateral force resisting systems in moderate seismic regions? In most cases, an R = 3 design for a braced frame results in a less expensive structure which not only has simpler details but also is lighter than an ordinary concentrically braced frame designed according to the AISC Seismic Provisions. The inherent lack of ductility and complex post-elastic performance of braced frames has made their design the object of repeated deliberations and changes since the AISC Seismic Provisions were first published in 1992. Furthermore, over the past two decades building codes have specified design forces for moderate seismic regions that vary by as much as a factor of two. The cost effectiveness and simplicity of an R = 3 design, combined with the recent history of changes in recommended braced frame demands and capacities has caused many designers to question the relevance of current seismic design provisions in moderate seismic regions.

This paper presents a simple study of a 9-story R = 3 chevron concentrically braced frame, where the brace connection fracture capacities were varied from the equivalents of R = 2 through R = 7 according to ASCE 7-02. Detailed observation related to the collapse behavior of these frames and their dependence on brace fracture connection capacity exposes useful subtleties regarding the notion of replacing ductility with strength. Based on these observations, the paper discusses the possibility of designing a reserve system to prevent collapse after failure of the wind force resisting system.