

## Enhancing Ductility of Cross- Braced Frames Using Steel Tube Rings as Seismic Fuses

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Concentric braced frames cannot absorb enough energy in severe earthquakes due to their low ductility. To compensate for this weakness, ductile segments have been used within the concentric braces to improve the ductility capacity of the system. The proposed system in this study includes concentric X-bracing elements added with two steel rings composed of bent pipes around the center of the braced bay. First, the proposed system is studied analytically to develop the governing equations conditioned such that a maximum number of plastic hinges form in the rings concurrently. The second ring enhances the stiffness and ductility of the system. Increasing the diameter of the interior ring with regard to the exterior, results in higher stiffness and ductility values. When using a single ring, use of larger diameters reduces the system performance regarding the mentioned characteristics. Development of bending plastic hinges in several locations in the rings, controlled sequence of forming of plastic hinges by changing the dimensions of the rings, considerable increase of the number of hinges required before instability, increase of the ductility and stiffness with regard to the braced and moment frames, respectively, distinguishes this system from its counterparts. In this thesis, nonlinear behavior of the suggested system is compared with the braced and moment frames using nonlinear static analysis using OpenSEES.

Keywords:

Cross brace, special moment frame, annular bracing, ductility, stiffness.