Effect of steel middle ring on ductility of concentrically X-braceed steel frames

There are various ways to confront with lateral forces of earthquakes. Use of X bracing is one of the economic and simple ways. However, this conventional system does not behave similarly in tension and compression and is weak in ductility and other nonlinear properties in compression. Lack of enough ductility results in the brace having an insufficient capacity for absorption of vibration energy during a severe earthquake. In order to overcome the shortcomings of the mentioned system, different suggestions have been made by researchers to make some kind of modification in the arrangement of the system including use of knee and eccentric braces, rectangular zones at the intersection of the cross braces, and other options.

In this thesis, a new geometry is suggested for the concentric X bracing to convert the axial behavior of the braces to flexural action of intermediate members. The added members are in the shape of concentric rings located at the center of the bracing system. They bend under the axial forces of braces and develop plastic hinges in bending before any nonlinear action in the diagonal braces. Therefore, the concentric rings constitute the seismic fuses of the system and the cross braces are to remain in the elastic range. Using push-over analysis, it is shown that the proposed system possesses the intended nonlinear behavior. It has a lateral stiffness and strength similar to the X-bracing system and a ductility similar to a special moment frame. Also, the plastic hinge formation remains limited to the middle concentric rings.

Through a design process and comparison, it is observed that the seismic resistant system suggested in this thesis can also be an economic alternative for concentric bracing and moment frames.

Keywords:

Concentric brace, moment frame, ring braced frame, pushover analysis, stiffness, strength, ductility.