Using curved steel plates in braced frame as a seismic fuse

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Abstract

Inelastic deformations Due to intense stimulations like earthquakes, will cause the local plastic hinges to form in different areas of the structure. In case that these plastic hinges experience the mentioned deformations without considerable decrease of strength, the amount of energy absorbtion and ductility will increase in the structure. Different studies showed that with the increase of appeared inelastic deformations during earthquake, the considerable damages will happen in main members of structures such as beams and columns. In recent decades the use of vibration control systems and especially passive controls was considered an effective way to reduce the expenses caused by mentioned damages. In this study, a new steel yielding damper is being introduced and tested in chevron braced frames. The mentioned damper is made by placing two curved steel plates in front of each other and will be used in the middle of braces in chevron frame. In this damper the potential of energy dissipation will mainly depends on the hysteretic behaviour of inelastic deformations in steel plates due to axial force of the brace. Involved geometric parameters in energy absorption such as the number of curves, curve depth, thickness and width of the cross section for reaching the optimum energy dissipation is fully studied. The chevron frame equipped with chosen samples of studied damper will be modeled and its hysteretic behaviour due to ATC-24 displacement-control protocol will be obtained. With the increase of sample’s depth, initial strength and frame’s stiffness will decrease. Decreasing the sample’s width will reduce the amount of initial and ultimate strength, frame stiffness and hysteresis loop area. Also with the decrease of length, the amount of initial strength and frame stiffness will slightly increase; even though there would be no considerable change in hysteresis loop area. Beams in chevron braced frames has to be designed for considerable amount of unbalanced brace forces due to post-buckling compressive strength reduction and tensile yielding of the braces. With providing a symmetrical nonlinear behaviour for chevron frame, using the recommended yielding damper will omit the mentioned unbalanced forces applied to beam. Applying the mentioned damper in chevron frames will provide a required stiffness for the frame. With postponing the both compressive buckling and strength reduction, using this system can increase the energy dissipation to 50 percent; It also causes the similar hysteretic behaviour in tension and compression. Samples with more than one curve will also be modeled and the test results were that due to non-uniform stiffness and change in boundary conditions along multi-curve sample’s length after a few hysteretic cycles, early buckling and intense strength reduction will accure in connection zones of curves along compression force path. As a result, plastic strain will only develop in one of the curves. In the mentioned case the amount of frame strength will be lower than the identical sample with one curve. Consequently in order to reach the optimum results, using samples with one curve is preferred to multi-curve samples. Capability of being easily performed and replaced, similar behaviour in tension and compression, replacement of most welding connections with bolts to reduce tension concentration and avoiding fragile behaviour are the most noteworthy advantages of the studied damper.

Key Words: passive control, yielding damper, curved steel plates, hysteretic behaviour, finite element analysis