SEISMIC PERFORMANCE OF STEEL MOMENT FRAMES UNDER NEAR-FAULT PULSE –TYPE EARTHQUAKES USING U-SHAPED METALLIC-YIELDING DAMPER

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The conception of controlling the vibration of the structure and its response by supplemental elements such as dampers makes fundamental changes in the typical process of retrofitting structures against earthquakes and improves the response of the structure during the earthquakes. Moreover, the use of energy dissipation systems such as dampers in structures is known as an effective and relatively low-cost method to reduce the risk of earthquakes. For instance this energy dissipation can be based on the inelastic metallic deformation in the metallic-yielding damper. Hence, in this paper, the performance of a type of yielding damper called U-shaped metallic-yielding damper has been studied in steel moment frames under near-fault pulse-type earthquakes. For the first time, the idea of using U-shaped damper in structures began with the conceptual and experimental work by Kelly et al. in 1972. Furthermore, U-shaped metallic-yielding damper can be assembled easily and it is the most important property of this damper. The details of U-shaped damper and its configuration in the steel frame has shown in Figure 1 (Bagheri et al., 2015).

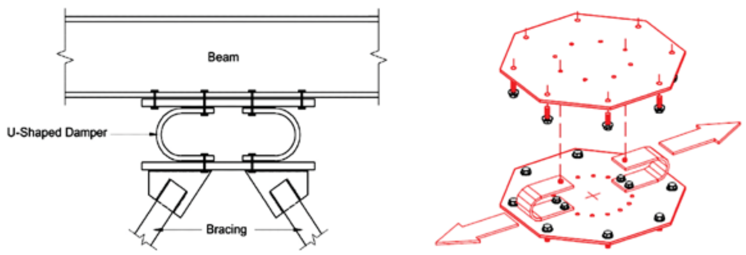
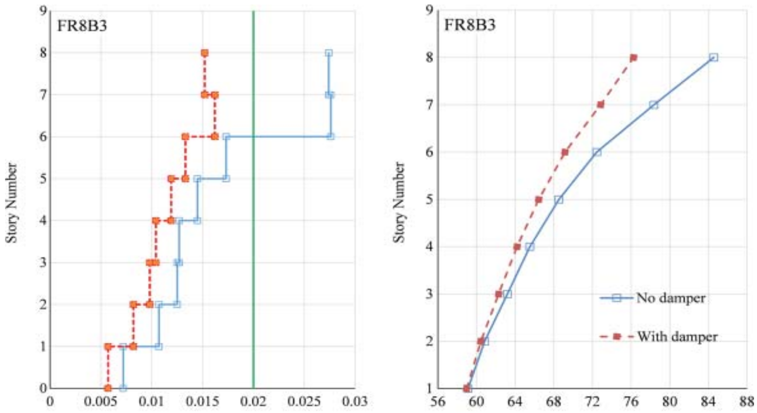


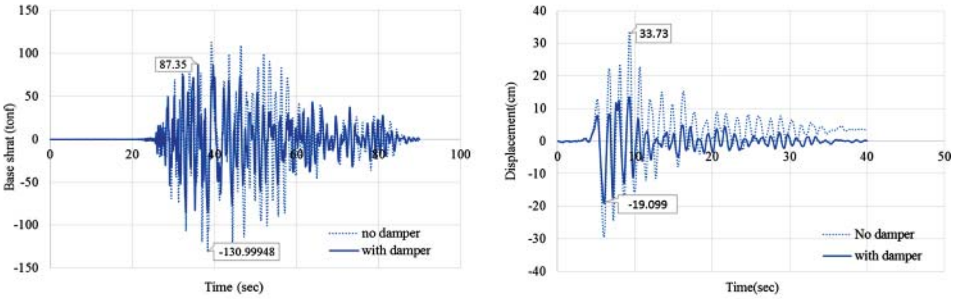
Figure 1. U-shaped metallic -yielding damper (Bagheri et al., 2015).

In order to evaluate the performance of this damper first, the verification study was done according to 5-story steel model by Bagheri et al. (2015). Then, the behavior of 3-span steel moment frames with 3, 8, 12, and 20-story variations reinforced with U-shaped damper was evaluated in SAP2000 (v19.1.1). Nonlinear time history analysis was applied to models under 20 records of pulse-type near-fault ground motion that were scaled according to Iranian Code-2800 (4th Ed.). In both cases (with and without the dampers) the responses such as absolute floors displacement, the drift of the floors, the history of roof displacement, the history of the base shear, and the process of plastic hinges were extracted. The significance of this study to compare with the previous studies was considering the effect of near-fault ground motion, which has been neglected in previous research. Part of the results is shown in Figures 2 to 4. It is worth noting that in this study, the specifications of the dampers presented was used in the study by Bagheri et al. (2015), and the results are valid only for two-dimensional frames at base height in the range of assumptions.



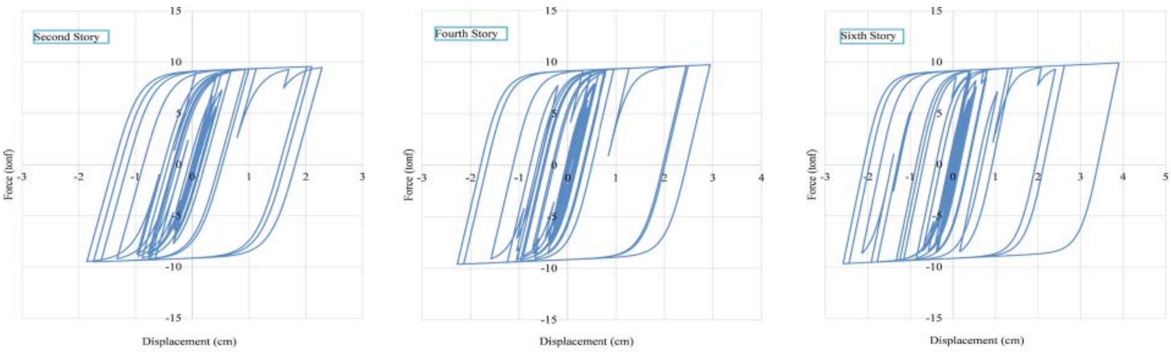
(a) Story drift at maximum displacement (b) Maximum absolute displacement.

Figure 2. 8-story frame with and without U-shaped damper.



(a) The base shear time history response under Chi-Chi earthquake (b) Roof story displacement history under Imperial Valley earthquake

Figure 3. 8-story frame with and without U-shaped damper.



(a) Second story (b) Fourth story (c) The sixth story

Figure 4. U-shaped damper hysteresis loops in the 8-story frame under Imperial Valley-06 earthquake.

The evaluation of the results of nonlinear time history analysis confirms the significant effect of this damper on the reduction of the history of roof displacement, the drift of the floor, the loss of plastic hinges, and good hysteresis curves with approximately equal energy absorption. In reviewing the results of the mean absolute floors displacement, the percentage reduction for 3, 8, 12 and 20-story frames was 7%, 10%, 12%, and 16%, respectively.

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