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Introducing an Innovative Structural Fuse for Creation of Repairable Buildings with See-Saw Motion during Earthquake and Investigating It by Nonlinear Finite Element Modeling

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Abstract : Seismic design codes accept structural and nonstructural damages after the sever earthquakes (provided that the building is prevented from collapse), so that in many cases demolishing and reconstruction of the building is inevitable, and this is usually very difficult, costly and time consuming. Therefore, designing and constructing of buildings in such a way that they can be easily repaired after earthquakes, even major ones, is quite desired. For this purpose giving the possibility of rocking or see-saw motion to the building structure, partially or as a whole, has been used by some researchers in recent decade .the central support which has a main role in creating the possibility of see-saw motion in the building's structural system. In this paper, paying more attention to the key role of the central fuse and support, an innovative energy dissipater which can act as the central fuse and support of the building with seesaw motion is introduced, and the process of reaching an optimal geometry for that by using finite element analysis is presented. Several geometric shapes were considered for the proposed central fuse and support. In each case the hysteresis moment rotation behavior of the considered fuse were obtained under simultaneous effect of vertical and horizontal loads, by nonlinear finite element analyses. To find the optimal geometric shape, the maximum plastic strain value in the fuse body was considered as the main parameter. The rotational stiffness of the fuse under the effect of acting moments is another important parameter for finding the optimum shape. The proposed fuse and support can be called Yielding Curved Bars and Clipped Hemisphere Core (YCB&CHC or more briefly YCB) energy dissipater. Based on extensive nonlinear finite element analyses it was found out the using rectangular section for the curved bars gives more reliable results. Then, the YCB energy dissipater with the optimal shape was used in a structural model of a 12 story regular building as its central fuse and support to give it the possibility of seesaw motion, and its seismic responses were compared to those of a the building in the fixed based conditions, subjected to three-components acceleration of several selected earthquakes including Loma Prieta, Northridge, and Park Field. In building with see-saw motion some simple yielding-plate energy dissipaters were also used under circumferential columns.The results indicated that equipping the buildings with central and circumferential fuses result in remarkable reduction of seismic responses of the building, including the base shear, inter story drift, and roof acceleration. In fact by using the proposed technique the plastic deformations are concentrated in the fuses in the lowest story of the building, so that the main body of the building structure remains basically elastic, and therefore, the building can be easily repaired after earthquake.

Keywords : rocking mechanism, see-saw motion, finite element analysis, hysteretic behavior
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