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SEISMIC PERFORMANCE ASSESSMENT OF OPTIMALLY DESIGNED BASE ISOLATION SYSTEM UNDER MAINSHOCK-AFTERSHOCK SEQUENCES

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Earthquake as one of the most important catastrophic events in the world is still causing major losses for the people, governments, and societies. During the last decades, the building design codes have been improved well for seismic design of buildings. However, some major shortcoming still exists. One of the most important issues is the ignorance of the effects of aftershocks. It is very important to see how the structure, which is probably damaged during the mainshock, can withstand the aftershocks. In many cases, aftershocks start to occur right after the mainshock which means that no one has the time to repair the damaged structure. Therefore, it is very important to evaluate the performance of building designed only for resisting the mainshock, and see how they will behave during the next aftershocks. One of the applicable solutions for this problem is to use new seismic protection systems like base isolations and/or supplemental damping devices that reduce the damages of buildings considerably under mainshocks and their corresponding aftershocks.

There are several research dealing with the applicability of the vibration control systems for the improvement of the building responses due to the earthquakes (Soong and Constantinou 1994, Buckle 2000, Christopoulos and Filiatrault 2006, Khansefid and Ahmadizadeh 2016). However, a limited number of works have focused on the performance of these devices and buildings equipped with them under aftershocks. In one of these studies, Zhai et al. (2017) evaluated aftershocks effects on the performance of seismically isolated reinforced concrete containment structure. Castaldo et al. (2016) probabilistically analyzed and evaluated the life-cycle cost of three dimensional reinforced concrete structures equipped with friction-based isolation system. Rinaldin et al. (2017) assessed the capability of viscous dampers in responses enhancement of nonlinear structure under seismic sequences. Han et al. (2018) used the base isolation system for retrofitting an existing non-ductile RC building under mainshock and corresponding aftershocks. Recently, Khansefid and Bakhshi (2019) proposed an advanced two-step optimization methodology considering the life-cycle cost of buildings equipped with active vibration control systems under mainshock-aftershock sequences to evaluate its performance.

Here, in this research, the performance of three seismically isolated 4-, 8-, and 12-story buildings with the intermediate moment resisting frame system of superstructures was evaluated under mainshock-aftershock sequences. These superstructures were located on the lead rubber bearing system capable of both isolating the superstructure and absorbing the seismic input energy in the isolation level. At the first step of this research, buildings were designed based on the procedure introduced by the international design codes for the seismically isolated buildings. To obtain the best design properties of the isolation system as well as the superstructure beams and columns dimensions, a multi-objective optimization procedure was applied (Figure 1). The objectives of this optimization were the base isolation level deformation and the design seismic base shear of the superstructure which behave oppositely. In the next pace, fully detailed three dimensions' models of these buildings were built by considering the effects of soil-structure interaction, and their performances were evaluated under six mainshock-aftershock sequences of the Iranian plateau. These sequences contain week, moderate, and strong ground motions. Therefore, they are a good representative of real condition. The results show that the base isolation system is well capable of mitigating sequential earthquake excitation. In addition, it is shown that the residual deformation of lead rubber bearing remains in an acceptable range. However, by increase in the superstructure height, it is getting an increase. Moreover, on average by considering the aftershocks effect, the final residual deformation is estimated about 25% less than the real conditions.

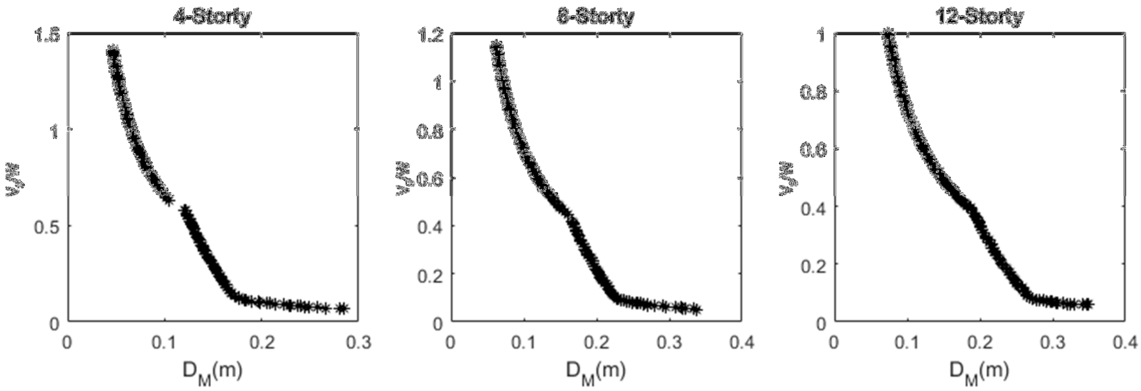

Figure 1. Optimal Pareto fronts of the optimization objectives of the seismically isolated structure.

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