SEISMIC RETROFIT OF REINFORCED CONCRETE BUILDINGS WITH T-SHAPE PLAN USING EXTERNAL STIFF STRUCTURES

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There are thousands of buildings around the world, including hospitals, hotels, and commercial complexes which have a T-shape plan due to the architectural requirements. T-shape plan buildings have shown high vulnerability in past earthquakes, and therefore, the existing buildings of this type need to be seismically retrofitted. In many cases, such as hospitals, because of the high importance of the building's function a retrofit technique which does not require the interruption of the building's performance is quite desired. Retrofit by using external structures is such a technique. This technique was used by Furukawa and his colleagues (2004) for seismic retrofit of RC buildings by using external steel portal frames. Hosseini and Ajam (2012) used external mega frames for building casketing as a new seismic retrofit technique for existing RC buildings. Building casketing was also used as a technique for seismic retrofit of existing RC buildings (Dindar et al., 2012). Recently, Roia and his colleagues (2014) have performed a series of ambient vibration tests on a reinforced concrete school building before and after retrofitting works with external steel dissipative towers.

In this paper, a method is introduced for seismic retrofit of existing reinforced concrete (RC) building with T-shape plan by using two external stiff structures which are connected to the building by some link beams as shown in Figure 1.

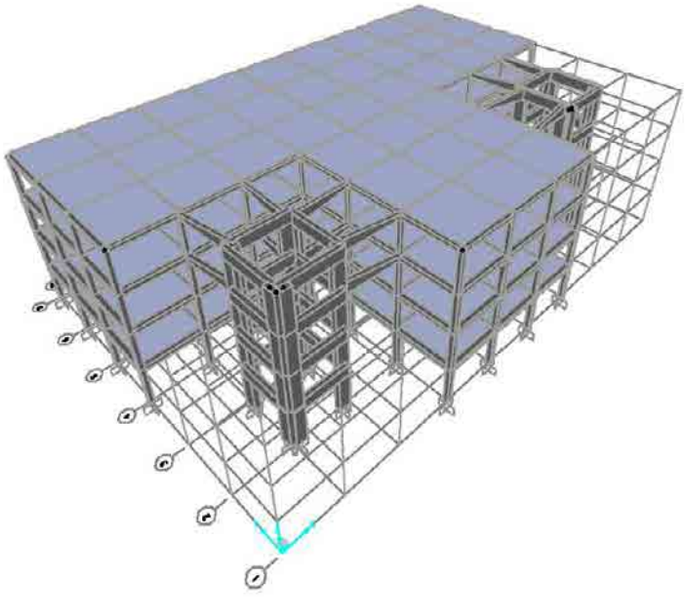

Figure 1. General view of the T-shape plan building retrofitted by using two external stiff structures

To investigate the efficiency of the proposed retrofit technique a set of multi-story RC buildings with T-shape plan, having 4, 7, and 10 stories, designed based on an old version of the seismic design code (ACI 318M-99), were considered. At first, the seismic vulnerability of the considered buildings, based on the formation of plastic hinges, was investigated by performing push over as well as nonlinear time history analysis (NLTHA) by using the accelerograms of some selected earthquake compatible with the assumed site conditions. Then, two relatively stiff frames, as shown in Figure 1, were added to the structural system, and their sufficiency for upgrading was investigated by push over analysis and after reaching an appropriate design, and for making sure on their proper design seismic performance of the retrofitted structure was investigated again by a series of NLTHA. Figure 2 shows the plastic hinges created in one of the buildings' structure in both original and retrofitted cases as samples of the numerical results.

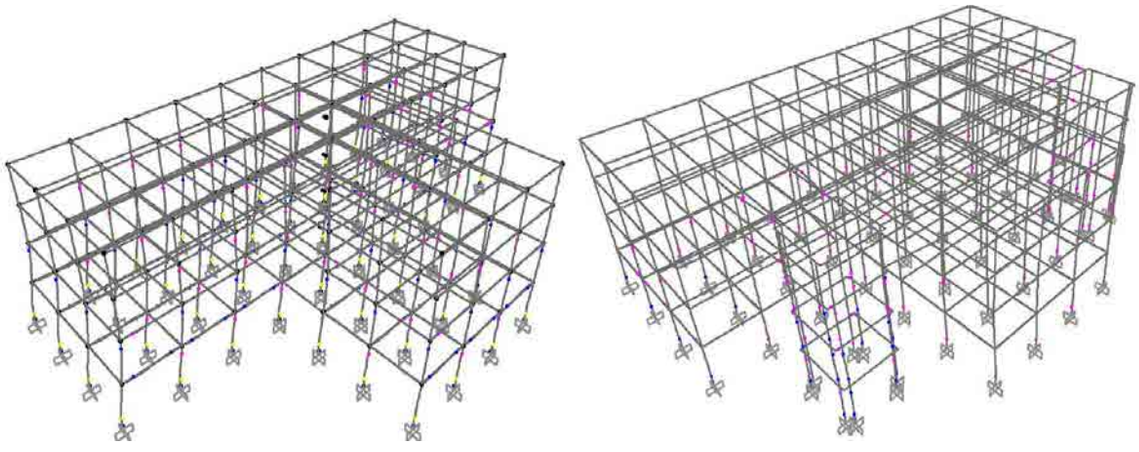

Figure 2. Plastic hinges formation in one of the buildings' structure obtained by NLTHA

It can be seen in Figure 2 that some plastic hinges beyond the life safety (LS) performance level (PL) have been created in the original building's structure (the yellow dots in the figure), while in the retrofitted building's structure, only a few hinges in the immediate occupancy PL have been created in both main and added structures.

Based on the numerical results, similar to those shown in Figure 2, it can be concluded that using the external stiff structures is a high efficiency technique for seismic retrofit of the considered RC buildings with T-shape plan. By the way, regarding the simple and regular form of the added external structures they can have some architectural usage, such as adding one or two lift(s) to an existing building.

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