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SEISMIC ASSESSMENT AND RETROFIT OF BUILDINGS THROUGH BASE ISOLATION AND ENERGY DISSIPATION: EXAMPLES IN ITALY AND IN IRAN

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The paper, based on the authors' direct experience, reports on seismic assessment, design and implementation issues related to the application of base isolation and energy dissipation in the seismic retrofit of buildings.

As far as base isolation is concerned, some recent significant examples of application in Italy are presented and discussed. The use of seismic isolation in buildings in Italy is actually continuously increasing since 2003, when a new seismic code including a specific provision on seismic isolation was issued, and even more since 2009, after the April 6 L'Aquila earthquake (Mw=6.3). Some years ago most of the base isolated buildings were strategic or public buildings, e.g. hospitals, civil protection buildings, schools, while in last years seismic isolation has often been used in private residential buildings. Recently seismic isolation is being applied not only to new constructions, but for retrofit of existing buildings as well. Most of said applications are reinforced concrete framed buildings, but some of them are also in masonry buildings (Mezzi et al., 2012). Most of the buildings under retrofit in Italy through seismic isolation were damaged by the 2009 L'Aquila earthquake and consequently declared unfit for use, even though most of the damages were to non-structural elements and often limited to the first two storeys. The use of seismic isolation allows to respect the increase in seismic safety required by the law for reconstruction of L'Aquila while limiting the intervention on the superstructure and associated costs.

Curved surface sliders (CSS), also known as friction isolation pendula (Castellano and Infanti, 2010), are the type of isolators most frequently used in retrofit of existing buildings. The reason is that with these isolators it is easy to reach high values of the fundamental period (i.e. about 3 s or even higher) of the isolated building, because the fundamental period does not depend on the supported mass but mainly depends on the radius of curvature. Consequently, the accelerations transmitted to the superstructure and the strengthening interventions on existing structural elements are reduced. Furthermore the use of CSS allows to minimize the eccentricity between the centre of mass of the structure and the centre of stiffness of the isolation system, regardless of plan location of devices; this is very important in existing reinforced concrete buildings that often are very irregular in plan. In some applications the seismic isolation system is based on elastomeric isolators (high damping rubber bearings or lead rubber bearings), usually combined with free sliding bearings, in order to increase the fundamental period as much as possible.

In the paper, the design procedure adopted for the retrofit is presented, along with the typical phases of the intervention for the installation of isolators in existing buildings (see for example Figure 1).

Figure 1. One of the phases of the intervention for installation of an isolator in a R.C. Column (left); a curved surface slider as installed in a R.C. Column of an existing building in L'Aquila, Italy (right)

The second part of the paper reports on the use of energy dissipation as a technique for seismic protection of existing building. Applications to tall buildings (see for example Figure 2) are presented. Particular attention is devoted to nonlinear Finite Element modelling and to the comparison, either in terms of performance and cost, between conventional upgrading techniques and energy dissipation.

Figure 2. Parsian Azadi Hotel in the northern part of Tehran, Iran (Motavalli, 2006)

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