Eddy Current Damped Interconnection for Mitigation of Internal Pounding for a Seismically-Isolated Building

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ABSTRACT

Seismic isolation systems are based on the concept of reducing seismic demand in the superstructure at the expense of high base displacements, thereby limiting structural damage but increasing the possibility of pounding of the building with adjacent structures. Moreover, internal pounding effects between closely spaced structural parts (e.g. in the case of an insufficient seismic gap between the elevator and surrounding building) may happen in seismically isolated structures, due to notable displacement at the level of the isolation system under severe earthquakes. To study this poorly investigated issue, a reinforced concrete (r.c.) building located in the Sicilian town of Augusta is considered [1], with a hybrid isolation system including elastomeric (high-damping-rubber bearings, HDRBs) and sliding (low friction flat sliding bearings, LFSBs) bearings. This r.c. framed structure, composed of a basement and three storeys above the ground level, is seismically isolated at the top of rigid columns in the basement, while a steel framed elevator shaft crosses the isolation level. A common structural configuration is presented here, where the elevator shaft is fixed-base and separated from the building by a gap. The highly nonlinear behaviour of HDRBs is described by means of a reliable mathematical model calibrated on experimental results available in the literature, while a bilinear model can be regarded as a reasonable assumption for LFSBs characterized by very low values of the friction coefficient. Four cases are compared considering that the mass of the elevator is added to the basement and upper three levels. Torsional effects induced by the eccentric position of the elevator shaft in the building plan are investigated through three-dimensional nonlinear seismic analysis, by rotating bi-directional earthquakes. Despite the presence of a seismic gap, the occurrence of internal pounding is highlighted at all levels of the superstructure. With the aim of reducing pounding effects, an eddy current damped interconnection (ECDI) between adjacent corners of the elevator and surrounding building at the floor levels is proposed. It takes up less space than traditional passive dampers and produces notably lower forces transmitted when compared to a rigid link configuration [2]. Specifically, an eddy current damper (ECD) consists of an outer cylindrical conductor tube and an inner tube equipped with an array of axially magnetized, ring-shaped permanent magnets separated by iron pole pieces, as mover [3]. The relative motion between conductor and magnets, during seismic loading, induces an eddy current producing electromagnetic damping force. Given that viscoelastic linear behaviour can be hypothesized for the ECDs, a simplified design procedure of the ECDI is presented. Finally, to evaluate the effectiveness of the ECDI, nonlinear seismic analysis is carried out with regard to three structural models of the Augusta building: i.e. i) no connection; ii) rigid links; iii) eddy current dampers.

REFERENCES

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