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EVALUATE THE SEISMIC BEHAVIOR OF THE BASE-ISOLATED BUILDINGS SUBJECTED TO DIFFERENT TYPE OF GROUND MOTIONS WITH DIFFERENT COMPONENTS

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However, several interesting studies have been conducted on base-isolated structures and base isolation systems under different seismic activities (Tavakoli et al., 2014; Choun et al., 2014; Alhan & Sahin, 2011; Alhan & Oncu-Davas, 2016), but the behavior of the base isolation systems and base-isolated buildings under different type of excitations are still questioned. For this reason, one of the investigators' biggest issues is to study the behavior of the base-isolated structures under circumstances of different type of ground motions. The particular aim of this research is to assess the earthquake reaction of multi-story structures with Lead Core Rubber Bearing (LCRBs) subjected to a different type of earthquakes. In this direction, the equations of motion of the base-isolated buildings are obtained, and force-deformation behavior of the LCRB is modeled as bilinear in MATLAB. Then, the behavior of the base-isolated buildings is being evaluated for 45 different ground motions, which are categorized into three different groups with regard to the ratio of Peak Ground Acceleration to Peak Ground Velocity (PGA/PGV<1, 1<PGA/PGV<2, PGA/PGV>2). Finally, the results illustrated and compared both in graphs and tables.

In this paper, in order to assess the probabilistic behavior of the base-isolated buildings, two-factor factorial design was conducted (Montgomery, 2013) considering the “Number of the stories” and the “Ratio of PGA/PGV” as two factors.

For each group of earthquakes (considering PGA/PGV ratio), seven different kinds of buildings varying at height (i.e., 5, 10, 15, 20, 25, 30 and 35) have been considered, and combinations thereof are generated. Thus, there are 15 ground motions for each group based on PGA/PGV ratio, and base-isolated buildings subjected to the ground motions mentioned above. Therefore, overall, 315 time-history analyses were conducted.

For a conventionally fixed base structure following equation of motion has been given (Naeim & Kelly, 1999), the relative displacement u of each degree of freedom with respect to the ground is given by:

$$\mathrm{M}\ddot{\mathrm{u}} + \mathrm{C}\dot{\mathrm{u}} + \mathrm{K}\mathrm{u} = -\mathrm{M}\mathrm{r}\ddot{\mathrm{u}}_{\mathrm{g}} \tag{1}$$

When this structural model is superimposed on a base isolation system with base mass m_b, stiffness k_b, and damping c_b, the above equation changes to:

$$\mathrm{M}\ddot{\mathrm{v}} + \mathrm{C}\dot{\mathrm{v}} + \mathrm{K}\mathrm{v} = -\mathrm{M}\mathrm{r}(\ddot{\mathrm{u}}_{\mathrm{g}} + \ddot{\upsilon}_{\mathrm{b}}) \tag{2}$$

where v is the relative displacement relative to the base is slab and υ_b is the relative displacement of the base slab to the ground. The overall equation of motion for the combined building and base slab is:

$$r^T M \ddot{v} + (m + m_b)\ddot{\upsilon}_b + c_b\dot{\upsilon}_b + k_b\upsilon_b = -(m + m_b)\ddot{u}_g \quad (3)$$

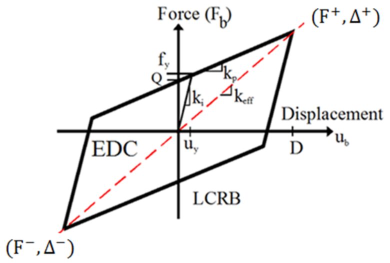

Figure 1. Arrangement for two-factor factorial design.

Table 1. Arrangement for two-factor factorial design.

Run No.	Factors							
	Ratio	Story No.						
15	1>PGA/PGV	5	10	15	20	25	30	35
15	1<PGA/PGV<2	5	10	15	20	25	30	35
15	PGA/PGV>2	5	10	15	20	25	30	35

Finally, it has been concluded that as the intensity of the ground motions whose PGA/PGV is lower than 1 is higher than then the intensity of the other group of the ground motions. In this direction, it has been observed that the base isolated buildings whose fundamental period is higher than the fixed base will be highly in risk of vulnerability when subjected to the ground motions whose PGA/PGV ratio is lower than 1. Especially in high-rise base-isolated building, it has been seen that the bearing displacement is sharply increased under these kinds of ground motions when compared to other ground motions with different ratio of PGA/PGV. Following figures related to Power Spectral Density (PSD) clearly illustrate the above outcomes.

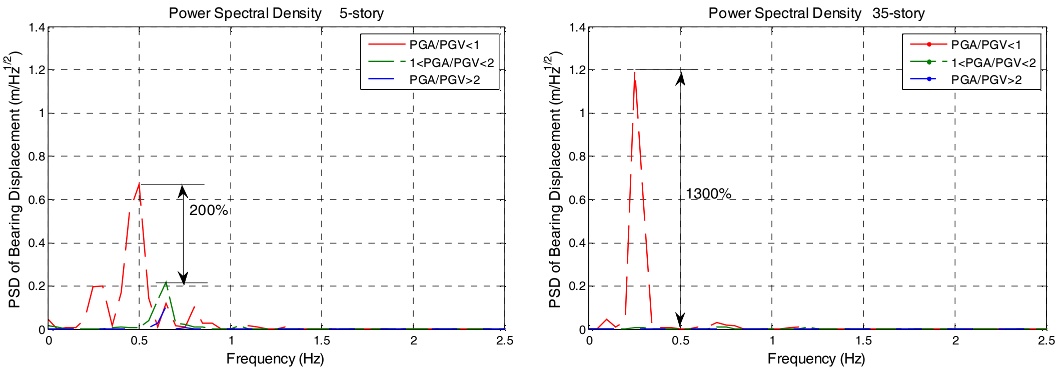

Figure 2. Power spectral density of bearing displacement for both low-rise and high-rise base-isolated buildings.

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