THE EFFECT OF VERTICAL EXCITATIONS ON THE COLLAPSE RISK ASSESSMENT OF RC FRAME-CORE WALL STRUCTURES

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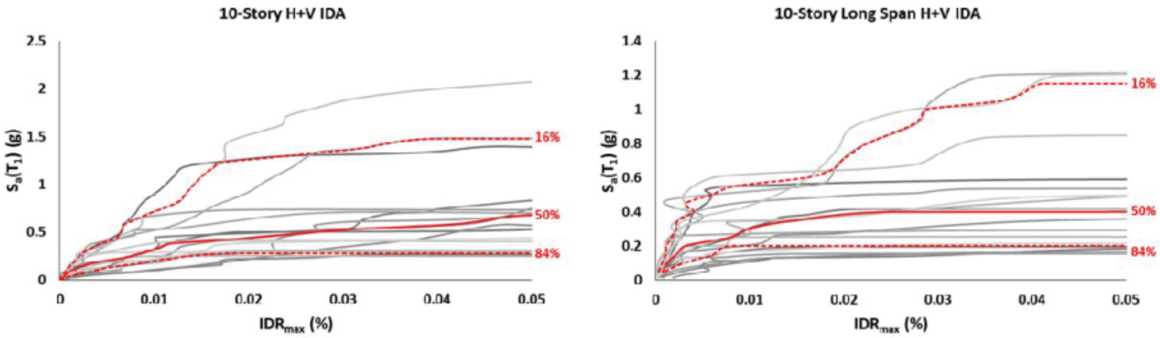
The occurrence of recent earthquakes with a considerable vertical component has drawn both engineers and researchers attention to the effect of vertical excitations more than the past. Based on the investigation into these earthquakes, the vertical acceleration found to be exceeding the horizontal accelerations, especially in near-source distances, which may induce disastrous damages to structures (Shrestha, 2009). Nevertheless, in the majority of the studies on the seismic performance and risk assessment of buildings, the effect of vertical ground motions has been neglected. RC columns may severely be affected by vertical excitations and their susceptibility is usually higher in low-rise buildings (Gerami et al., 1391). The vulnerability of large span RC beams to the vertical component of earthquakes has also been estimated, and the need for the application of the vertical component has been clarified (Varevac et al., 2010).

This study is an attempt to reveal some of the destructive consequences of the vertical component of earthquakes on buildings with different height and beam span. This study is an attempt to reveal some of the destructive consequences of the vertical component of earthquakes on buildings with different height and beam span length. To this aim, 10 and 30-story RC frame-Core wall buildings with 6 and 12-meter beam span are designed, and the nonlinear models of them are developed in the platform of OpenSEES. It is worth mentioning that the concentrated hinges based on IMK hysteretic model (Ibarra et al., 2005) and ShellNLDKGQ element (Lu et al., 2018) have been employed for nonlinear modeling of frames and shear walls, respectively. The influence of vertical ground motions is investigated through conducting Incremental Dynamic Analysis (IDA) in two states, once only under horizontal acceleration (H) and the other under both vertical and horizontal accelerations (H+V). The near-field ground motion records have been selected using the provisions of Lee and Mosalam (2014) so that the vertical-to-horizontal ratio (V/H ratio) of all records is greater than 1.

Results obtained from IDA for both analysis states and the fragility curves of 10-story buildings are illustrated in Figures 1 and 2, respectively. According to these figures, consideration of the vertical component of earthquakes has a greater influence on the building with longer span which means that the collapse of this structure occurs for a lower amount of intensity measures (IMs). In addition, the probability of failure due to the combined effect of vertical and horizontal ground motions (H+V) for the same IM is significantly lower than that of the horizontal ground motion (H).

Moreover, the probability of collapse of the buildings in 50 years has been calculated through the integration of seismic hazard and fragility curves in which the derivative of fragility curve is combined with hazard curve using the risk integral (Judd and Charney, 2014). The results indicated that the collapse risk of the building with longer beam spans under simultaneous horizontal and vertical excitations is noticeably greater than that of the building with 6-meter spans. More specifically, the increase in the collapse risk due to the effects of vertical ground motion is 35.5% for 10-story 6-meter span building while this value is approximately doubled (75%) for the building with 12-meter spans.



(a) (b)

Figure 1. IDA Curves for 10-story buildings with: a) 6-meter beam span, b) 12-meter beam span.

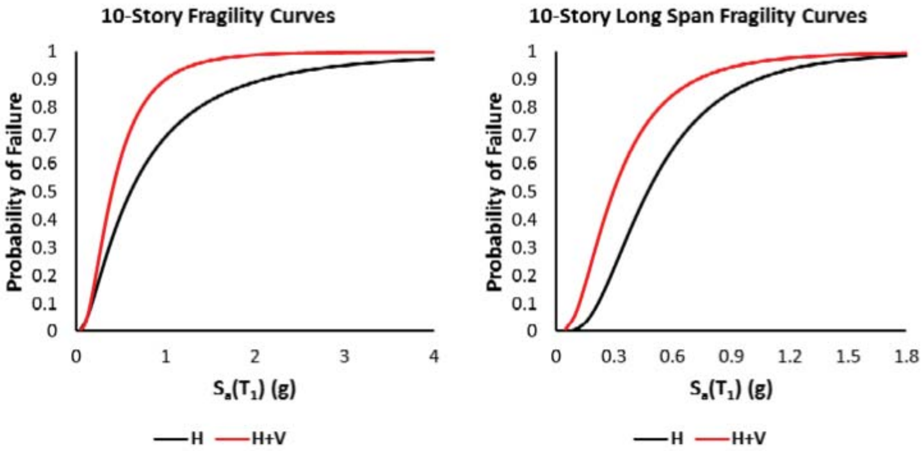


Figure 2. Fragility curve for 10-story buildings.

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