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Short Communication

Quantifying the Influence of the Horizontal Slab Systems on the Building Resisting Performance against Earthquake

Moustafa Moufid Kassem*

School of Civil Engineering, Universiti Sains Malaysia, Malaysia

***Corresponding author:** Moustafa Moufid Kassem, School of Civil Engineering, Universiti Sains Malaysia, Engineering Campus, 14300 Nibong Tebal, Penang, Malaysia.

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Floor systems play an integral part with the vertical components in resisting the lateral as well as the gravity loading. The purpose from this study is to identify the effect of the horizontal slab systems on the building resisting performance against ground motion excitations. Floors act as horizontal diaphragm with very large stiffness in the horizontal direction, and as apart from their traditional function to resist vertical load and help to distribute lateral loads into vertical structure elements such as walls and columns. Reinforced concrete floor system is classified into two categories; (a) One-way slab when the slab is supported on two sides only, the load will be transferred to these sides, while (b) Two-way slab when the slab supported on all four sides, and the load transferred in two orthogonal directions [1] .By definition, the types of slabs are, flat plates are the slabs that do not have beams, drop panel, column head between columns, and directly supported to columns. However, flat slabs are the slabs that do not have beams but are supported on drop cap or column capitals, in contrast for the two-way slab and beam. Flat slab systems one of the unique reinforced concrete structural systems forms that have poor structural efficiency, and insufficient lateral resistance performance under earthquake loading [2]. This becomes necessary to investigate and evaluate the vulnerability of this special slab system. The flat slab can easily construct, but unfortunately, it is poor resistance under earthquake experience which causes a vulnerable and failure [3]. Erberik & Elnashai [4] monitored the performance limit state for moment resisting frame system and flat-slab system using fragility curves. The developed fragility curves provide that the structural losses in the flat slab are in the same range with the moment resisting frame. Apostolska et al. [5] noted that the flat slab structural system under lateral load is flexible and more vulnerable against seismic loading. In order to improve its seismic behavior, certain modifications are needed to achieve in constructing the flat slab system. Hueste and Bai evaluated the structural response of RC-flat slab office building located in the U.S using nonlinear static analysis and nonlinear dynamic analysis, which do not meet the basic safety criteria of FEMA 356 [6,7]. Gowda & Tata [8] prepared two models to analyze the seismic behavior of the building using Response Spectrum method. In the first model is a commercial building consist of the flat slab with drop panel that generates the better seismic performance rather than the second model without drop panel.

Khan & Mundhada [9] studied the dynamic analysis for three multi-story building in four distinct seismic zones. From the analysis, they concluded that the choice of the slab is important for the lateral displacement and time period. Mohana & Kavan [10] compared the flat slab building and conventional slab building for all earthquake zones, they found that the lateral displacement for the flat slab building is much higher than the conventional building. Navyashree K et al. [11] analyzed the seismic performance and the vulnerability of the conventional RC frame and Flat slab building in seismic zone IV. The result showed that column moments are more in a flat plate, and the base shear is of the flat plate building is less, with more time period than the conventional building. Boonyapinyo et al. [12] used the pushover analysis to analyze the seismic performance of the post-tensioned concrete slab-column structural building. The capacity curves evaluation showed that the post-tensioned concrete slab-column frame building has a low lateral strength capacity and insufficient inelastic response. An experimental study has done by Prawatwong et al. [13] to perform the seismic performance for a scaled post-tensioned interior slab-column connection model. Model one without drop panel, and model two with drop panel. These models were tested under gravity load, with conventional displacement cyclic loading. They concluded that the drop panel experience more lateral load prior punching shear failure. Post-tensioning cables were used as a strengthening option for different types of building and structures to resist earthquake loading. The post-tensioned high strength cable connection to moment resisting frame (MRF) provide to pre-compress the beams to columns (self-centering) and close the gap that developed during earthquake loading [14].

Bahoria et al. [15] has done a comparison between RC flat plate and PT under the earthquake loading. By using STRUDS software, the result showed that the moment for the post-tensioned slab is less than the RC flat plate, and due to the post-tensioning effect, there is an increase in the moment and shear forces on columns. Aiswaraya & Mohan [16] studied the fragility curves for a five-story flat slab building. Based on the analysis they concluded that the flat slab systems are more vulnerable due to insufficient resistance under high seismic zone. Ramteke [17] studied the effect of different plan configuration, where the behavior of flat slab building depends critically on building configuration during earthquake motion. Alam & Paul [18] evaluated the seismic performance of an existing flat plate structural building in Bangladesh. The evaluation based on Pushover analysis and the performance point that deals with the flat plate is more flexible under lateral load and need to be retrofit related to FEMA356 guideline. Pramod et al. [19] analyzed three types of floor diaphragms such as; flexible diaphragm, semi-rigid diaphragm, and rigid diaphragm. From the analysis, it has been noticed that the rigid diaphragm is the best assumption for multi-story building compared to the other types. Janardanachar & Prakash [20] have been compared the seismic response of flat plate and flat slab structures with the conventional beam-slab structure located in seismic zone IV. Based on the result, the displacement of the flat plate and flat slab structure are higher than the conventional beam-slab structure, and the natural frequency for the flat plate and flat slab are lower than the conventional beam which is related to the stiffness of conventional beam-slab system. Based on the previous literature, it is noticed that there is rarely of usage the incremental dynamic analysis and fragility curves in evaluating the seismic analysis of the floor structural systems. The scope of this short communication article is to highlight on evaluating performance of different types of structural slabs systems based on nonlinear time history analysis (NTHA), in order to develop the IDA and fragility curves (Figure 1).

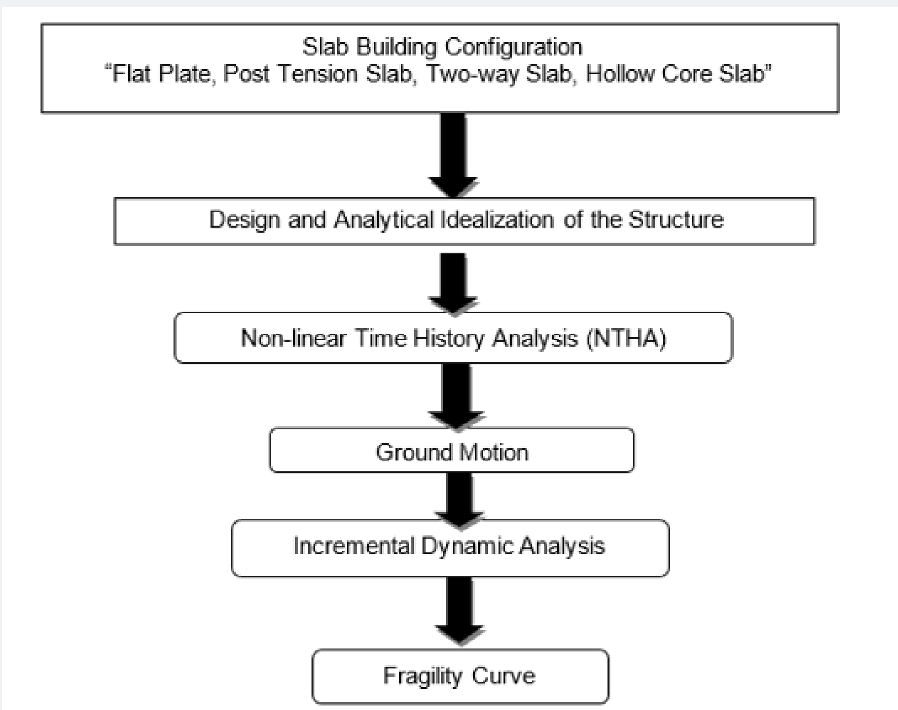

Figure 1: Flowchart for assessing the structural slab system.

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Conflict of Interest

No conflict of interest.

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