# EFFECTS OF INFILL WALL MODELS ON VIBRATION PERIOD AND SEISMIC RESPONSE OF A BUILDING

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## 1. INTRODUCTION

Nonlinear Response History Analysis (NLRHA) is a precise method for analyzing structures subjected to earthquakes. This is achieved by employing simulated models of buildings that accurately replicate the characteristics and attributes of real structures. In general, detailed models only the main components of a building, like columns, beams, or structural walls. To simplify the analysis process and reduce complexity, non-structural elements such as infill walls are represented with a simplified model. These infill walls are modelled as equivalent compression struts, which is a macro-model designed to capture the nonlinear behavior of infill walls under an earthquake. However, during the low-level or the initial stages of an earthquake, both infill walls and buildings tend to exhibit linear behavior. In these situations, equivalent struts may offer stiffness values or lateral force resistance properties that are too low, causing the model to appear less stiff than the actual building. Moreover, the vibration period experienced during these conditions might be longer than the apparent vibration period of the building, leading to inaccuracies in the analysis results.

## 2. METHODOLOGY

In this research, the objective is to investigate the impact of infill wall models on the response of a building model using nonlinear response history analysis methods [1] The research focuses on a 5-story reinforced concrete building shown in Figure 1. and employs a 2D lumped-mass model. The model of the rigid frame is a linear system, while the equivalent strut exhibits nonlinear behavior. Consider the example building. An equivalent strut is required for the 2nd, 3rd, and 4th floors because the first floor is the foundation floor, while the 5th floor is an open space with no walls. The equivalent strut width calculation follows FEMA 273 [2]. Then compare the results of the building model using the elastic modulus of the equivalent strut with two values: (1) the value obtained from previous research [3] called model A and (2) a modified elastic modulus value adjusted to match the building model's vibration period with that obtained from actual building measurements called model B. Two different models, with natural frequencies of 3.17 and 5.07 Hz, respectively. In this study, model B has to use a factor of 8 to multiply the elastic modulus of the struts in model A in order to achieve the fundamental frequency that matches the ambient measurement. The building models are performed with seismic waves that have a base period like the vibration period of the two building models. These include seismic waves with a main frequency of 3 Hz and 5 Hz, divided into 2 intensity levels: (1) a level where an equivalent strut

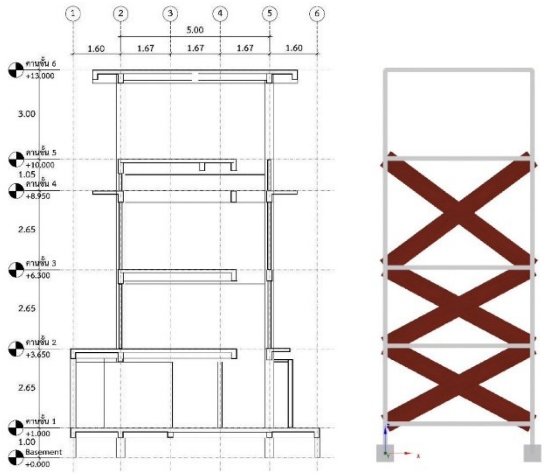

Figure 1. Example building and 2D lumped-mass model

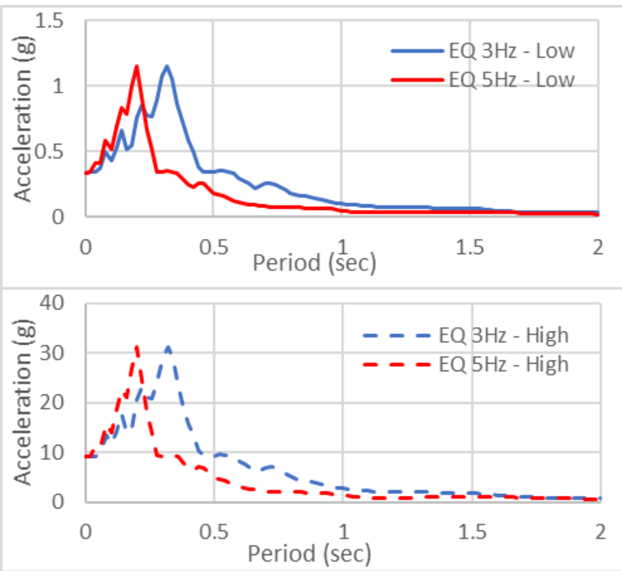


Figure 2. Response spectrum of example seismic waves

behaves a linear response; (2) a level where an equivalent strut behaves Non-linear response that shown in Figure 2.

## 3. RESULTS

Figure 3 illustrates the shear ratios in the columns of Model B in comparison with Model A (B/A). These ratios provide insight into how the structures respond to EQ 3Hz wave. Under low intensity level. Shear force ratios between Model B and Model A are consistently below 1. This is because the dominant frequency of EQ 3Hz is close to the fundamental frequency of model A. However, for high-intensity levels, it was observed that at the onset of inelastic response, some of the equivalent struts began to collapse, leading to a decrease in the fundamental frequency of the building. The fundamental frequency of model B approached the dominant frequency more closely than that of model A. As a result, the shear ratios (B/A) for all floors exceeded 1, especially for floors 1 and 5, which were without struts.

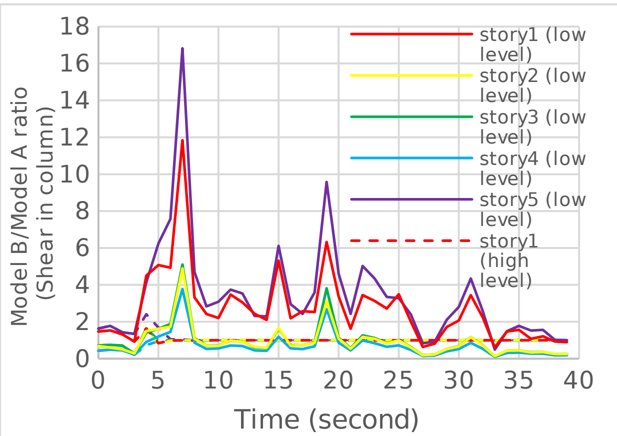


Figure 3. Model B /Model A ratio of column shear subject to EQ 3Hz

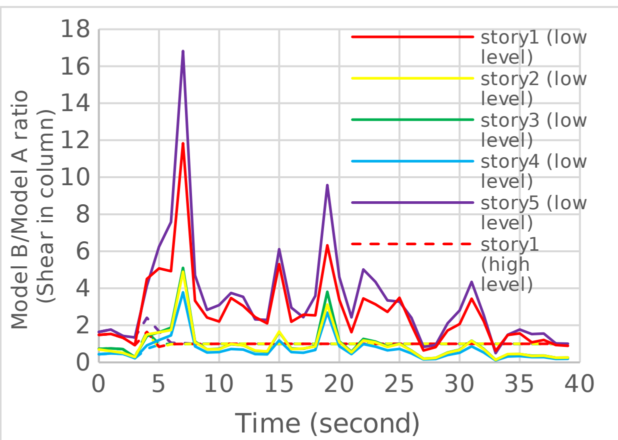


Figure 4. Model B /Model A ratio of column shear subject to EQ 5Hz

Figure 4 presents the shear force ratios in the columns of Model B in comparison with Model A. when subjected to EQ 5Hz. Under low level, shear ratios were mostly higher than 1, especially floors 1 and 5, which do not have equivalent struts. In addition, under high intensity level, it was found that the shear force ratio before the strut collapse of all floors was higher than 1, which means that model B had higher shear than model A and indicates that it is not safe if designed, using model A equivalent strut criteria.

## 4. CONCLUSIONS

This study shows that differences in equivalent strut models affect the vibration period of building models. The building model using the elastic modulus of the strut from the test value (model A) has a longer natural period than the building model that uses a modified elastic modulus (model B), resulting in a different response of the building model under earthquake loads. Furthermore, when considering the shear force in the column, Model A was found to have smaller shear forces than model B, especially when subjected to an earthquake with a dominant frequency close to the fundamental frequency of the model B. This indicates an unsafe condition when considering the use of equivalent strut model without taking into account the actual fundamental frequency.

## 5. REFERENCE

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