Simulation study of high-rise structure model on earthquake movement

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ABSTRACT – This paper represents a simulation study of high-rise structure model by exerting horizontal vibration. Three-level of high-rise structure is chosen by referring to Ranau earthquake in 2015. Three analyses were conducted namely stress analysis, strain analysis, and displacement analysis. These analyses were selected as important criteria of horizontal vibration effect on the structure, and finally illustrates the structural behavior of the model. Maximum concentrated stress, maximum strain, and extreme displacement have been recorded. Finally, the conclusion was made, in which all the important criteria were positively proportional to the amount of horizontal vibration energy.

1. INTRODUCTION

Nowadays, modern technologies in seismic and earthquake engineering are very important because many ASEAN countries are affected by recurring events of earthquake. Improvement of material quality, control systems, boundary conditions and many more become mandatory requirements to damp unwanted vibration on high-rise building.

Theoretically, both vertical and horizontal forces appear in high-rise structure. These forces cause the building to sway in multiple directions, from left to the right, and also from top to bottom [1-4]. Many researchers and scientists agreed that new concept and new method of developing high-rise structure are necessary to prevent unwanted behaviors that happened in the past [1-2,5-7].

For instance, this study concentrated in developing new test-rig of high-rise building due to horizontal vibration. It consisted of vertical and horizontal structures. Scatter horizontal forces were applied at every levels, and the response was analyzed by using finite element method.

According to the simulation, three analyses were recorded which were stress analysis, strain analysis, and displacement analysis. Based on these analyses, there were three modes involved to represent the behaviors of the high-rise structure due to horizontal vibration.

2. RESEARCH METHODOLOGY

This section describes the methodology that had been used to analyze the three-level high-rise structure in laboratory scale experiments. The number of levels of high-rise structures chose in this study was based on the type of structure that were mostly affected during Ranau earthquake [8]. Because of that, this type of structure was selected and referred as baseline model in this study (Berita Harian, 2015).

Initially, this high-rise structure was modeled with horizontal forces exerted at every levels. Three parameters were involved namely height, width, and length with dimension of 800mm, 40mm, and 400mm, respectively.

Additionally, there were five values of forces applied which were 10 newton, 20 newton, 30 newton, 40 newton, and 50 newton. Three modes were involved to demonstrate mechanical behaviors of the high-rise structure when the forces applied to the pillars.

3. RESULTS AND DISCUSSION

Three analyses were recorded which are stress, strain and displacement analysis. Detail discussion of these analyses are necessary because it represents the structural behavior of high-rise structure when horizontal vibration was applied at every levels.

In stress analysis, Figure 1 showed the results in three-dimensional view. According to the results, the concentrated maximum stress occurred when 50 newton of force was applied to the structure. This structure bent at maximum deflection, and it represented in red color. Furthermore, the minimum concentrated stress was recorded when small force was applied. According to this analysis, the concentrated stress of the high-rise structure is positively proportional with the value of the force exerted to the structure.

Figure 2 illustrated the strain analysis for high-rise structure. This analysis was carried out by exerting forces on the structure gradually. Maximum strain occurred when 50 newton of force was applied. Additionally, energy used to expand the material had been applied to develop the high-rise structure model. By using huge amount of forces, it allowed the structure to properly expand. However, this approach can create problem due to huge vibration energy. The structure can easily sway from left to the right, or vice versa because of the huge strain. It increases the potential of the high-rise structure to collapse.

Displacement analysis was the third analysis that was recorded in this study. Three-dimensional results showed in Figure 3. Based on the result, maximum

displacement occurred when 50 newton of horizontal force applied, and located at the top of the high-rise structure. It happened because top of the structure was in free boundary condition, and the structure was free to move at any angles and directions. However, at the bottom of the structure, the displacement was recorded at minimum value because the high-rise structure was embedded into rigid foundation. It can be illustrated as fixed boundary condition, and the structure cannot move easily. Additionally, displacement analysis is an important criterion that needs to be fully understood. Based on this analysis, researchers able to make better judgement on material selection for high-rise structure.

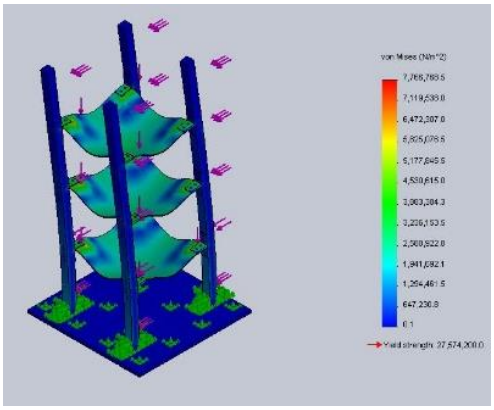

Figure 1 Result of concentrated stress for high-rise structure.

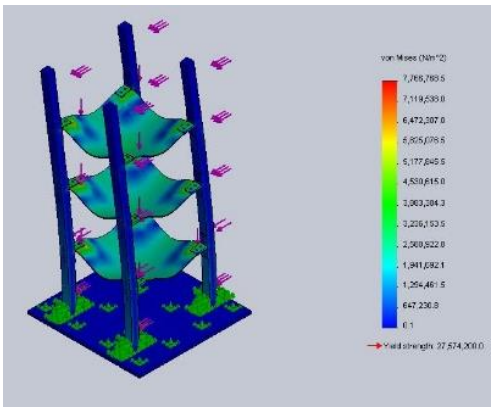

Figure 2 Result of strain expanding for high-rise structure.

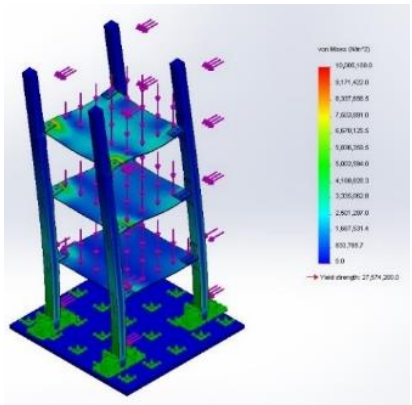

Figure 3 Result of maximum displacement for high-rise structure.

4. SUMMARY

At the end of the study, the simulation on high-rise structure model has been done. On the other hand, three analyses are accomplished which are stress, strain and displacement analysis to represent the structural behavior of the model. All of these analyses were executed by implementing five fractions of force values which are 10 newton up to 50 newton. One summary can be concluded from all these three analyses. All the studied parameters show positive reaction to the force values, and also proportional to the increasing values of force. According to these analyses, the criteria of the high-rise structure have been examined.

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