POSSIBILITY OF LIQUEFACTION AND DAMAGE ANALYSIS OF THAI PAGODA DUE TO SEISMIC HAZARD IN CHIANG SAEN DISTRICT

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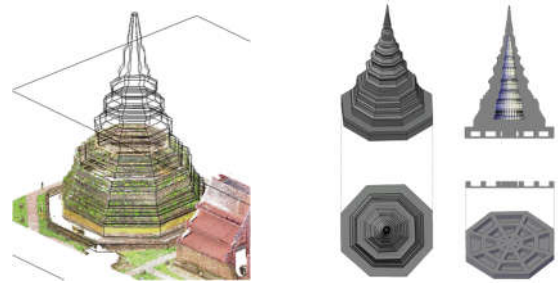
1. INTRODUCTION

Thailand's urban growth has led to large cities with many buildings, but sustainable development must consider the impact of natural disasters like earthquakes. The Mae Chan Fault is a powerful geological fault that spans over 100 kilometers from Mae Ai District in Chiang Mai Province through Mae Chan and Chiang Saen Districts in Chiang Rai Province before extending into Laos. This fault has historically caused significant earthquakes (>7.0 Richter scale) at least five times in the past 940,000 to 1,600 years [1-5].

One event that emphasizes the importance of earthquakes in the Mae Chan Fault region is the legend of Wiang Yonok [6]. The legend describes the demise of Wiang Yonok as it sank into a pond due to an earthquake. Some historians have suggested that this legend could have originated from the area's susceptibility to liquefaction during intense earthquakes. The expansion of the Wiang Nong Lom community makes it an ideal research site to assess the risk of liquefaction-related disasters and raise awareness among the general public.

2. METHODOLOGY

This paper presents the possibility of liquefaction from the seismic in Chiang Saen district, which is Wiang Nong Lom's location. According to the Mae Chan Fault, Chiang Saen has a high potential for seismic hazards. Consequently, probabilistic seismic hazard analysis in the Mae Chan Fault area was investigated. Then, the possibility of liquefaction was evaluated for various seismic hazard levels by using the soil investigation data and laboratory results of the soil in the area. The 3D laser scanning technology was also applied to collect the current geometrical morphology of the ancient pagoda in Chiang Saen. Finally, the nonlinear finite element analysis is used to simulate the damage investigation of a Thai Pagoda due to seismic and liquefaction hazards. The Chedi Luang Pagoda in Chiang Saen was a case study. Figure 1 shows the point cloud data and the finite element model of the pagoda.



a) Point Cloud Data b) Finite Element Model

Figure 1. Point Cloud Data and Finite Element Model of Chedi Luang Pagoda in Chiang Saen

3. RESULTS

The results indicate that the peak ground acceleration in Chiang Saen is in the range of 0.1-0.15g and 0.3-0.35g for the 475-year and 2475-year return periods, respectively. The soil investigation data reported that there is a possibility that liquefaction could occur in the South of Wiang Nong Lom and some areas of Chiang Saen.

The nonlinear finite element analysis reveals that a case study pagoda may have damage according to the seismic for earthquakes with 475-year return periods, and it has a more severe effect for earthquakes with 2,475-year return periods.

The liquefaction increases the pore water pressure and then reduces the soil strength below the foundation, which leads to additional settlement. Figure 2 shows the damage and the total settlement occurring to the pagoda due to the seismic and liquefaction effect.

4. CONCLUSIONS

This research assesses earthquake hazards and liquefaction risks in the Wiang Nong Lom and Chiang Saen districts of Chiang Rai province, focusing on the Mae Chan Fault. The results indicate that the peak ground acceleration in Chieng Saen is in the range of 0.1-0.15g and 0.3-0.35g for the 475-year and 2475-year return periods, respectively. The soil investigation data reported that there is a possibility that liquefaction could occur in the South of Viang Nong Lom and some areas of Chieng Saen. The finite element solutions show that the pagoda may have damage and additional settlement

according to the seismic and liquefaction, especially for the earthquake with 475-year and 2475-year return periods. Recommendations for further assessment and construction preparedness in these areas are advised.

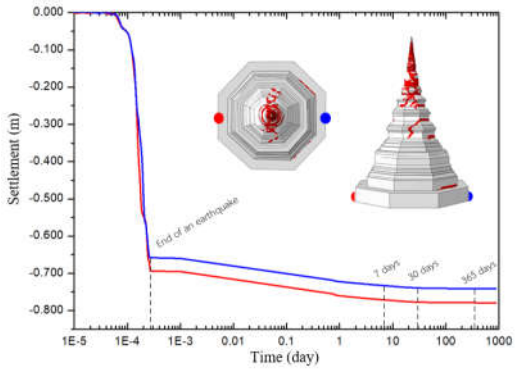


Figure 2. An Effect of Seismic and Liquefaction to the Pagoda

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