Seismic Performance Evaluation of an Existing Vertical Irregularity Reinforced Concrete Building using Nonlinear Time-history Analysis

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Abstract

On 5th May 2014, the Mw 6,1 Mae Lao earthquake occurred at a depth of approximately 6 km in the northern Thai province of Chiang Rai, which caused extensive damage to the community, and spread to Bangkok, an epicentral distance of 670 km, where tall buildings swayed. This paper evaluates the seismic performance of an existing 26-storey reinforced concrete (RC) building with vertical irregularity located in Bangkok, Thailand. The understanding gained from this evaluation can be used to propose effective control measures for similar existing high-rise RC buildings. As the building was constructed in 1990, the structure no longer meets the new Thai regulation. As a result, the building may have sustained significant damage, and an assessment had to be conducted according to the Thai Ministerial Regulation B.E. 2564 (2021). A seismic safety evaluation was applied by using the nonlinear time-history analysis (NLTHA) which was performed by the software ETABS 18.1.1.

Keywords: seismic performance evaluation; nonlinear time-history analysis; high-rise building.

1 Introduction

On 5th May 2014, the Mw 6,1 Mae Lao earthquake (EQ) [1] occurred at a depth of approximately 6 km in the northern Thailand (TH) province of Chiang Rai (Figure 1a), which caused extensive damage to the community, and spread to Bangkok (BKK) where tall buildings (BLDG) swayed. BKK is built on deep and soft alluvial soil, which can amplify incoming ground motion even from events occurring hundreds of kilometers away. Figure (Fig.) 1b shows how ground motion experienced at locations on deep alluvial basins can be further amplified above and beyond what would be expected using the near-surface soil stiffness parameter only. An example EQ was observed in 1985, the Mw 8,1 Michoacan EQ in Mexico City [2], a city which has geological conditions particularly well aligned to yield destruction from distant subduction EQs, and serves as a warning for BKK. Due to its surficial geologic setting, and the ability of regional sources to cause a major EQ, BKK is susceptible [3,4]. Fig. 2 shows major historical EQs in Thailand (1920-2020). The Thai Meteorological Department (TMD) seismic station is located in the BKK basin (Fig. 3) [5,6]. Fig. 4 shows acceleration time history, Fourier spectra and horizontal-to-vertical (HV) ratio of Fourier spectrum of the EQ.

2 Aim of the Study

This paper evaluates the seismic performance [7] of an existing 26-storey RC BLDG with vertical irregularity using NLTHA. The BLDG is located in BKK and was constructed in 1990. The structure no longer meets new regulations. As a result, the BLDG may have sustained significant damage, and an assessment had to be conducted according to the Thai Ministerial Regulation B.E. 2564 (2021).

https://doi.org/10.2749/nanjing.2022.1387
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