Far-Field Ground Motion Characteristics of Bangkok Basin, Thailand, in the 2025 Mw 7.7 Mandalay Earthquake: Initial Insight

Teraphan Ornthammarath[1,*], Pennung Warnitchai[2], Yoshihisa Maruyamac[3], Patinya Pornsopin[4], and Fumio Yamazaki[2]

[1] Mahidol University, Nakhon Pathom, Thailand, [2] Asian Institute of Technology, Pathum Thani, Thailand, [3]Graduate School of Engineering, Chiba University, Chiba, Japan [4] Earthquake Observation Division, Thai Meteorological Department, Bangkok, Thailand [5] Ohsaki Research Institute, Inc., Tokyo, Japan

*Corresponding author: teraphan.orn@mahidol.ac.th

1. INTRODUCTION

On 28 March 2025, a major earthquake of Mw 7.7 occurred along Sagaing fault with its epicenter located 15 km northwest of Mandalay with focal depth of 10 km at 06:20:52 UTC (USGS 2025). Based on the finite fault model, the rupture plane spreading from Mandalay to Naypyidaw with the total rupture length about 500 km. This earthquake was reported strongly felt in Myanmar, Thailand, southern part of China, and tall buildings in Ho Chi Minh City, Vietnam. In addition to heavy damage to structures along the rupture zone in Myanmar, large structural and non-structural vibrations for high rise buildings in Bangkok at 1,000 km epicentral distance were also reported due to ground motion amplification of thick soft soil alluvial deposit (Poovardom and Plalinyot, 2013, Jirasakjamroonsri et al. 2018, Subedi et al., 2021). This results in a collapse of one 33-story building under construction in Bangkok, and at least two tall buildings reported to have severe damage to their structural parts including major cracks in shear walls (The Nation 2025). Several other high-rise buildings with moderate damage also reported considerable nonstructural damage including fallen ceilings, cracking infill walls, etc. People in Bangkok were mostly felt this earthquake including those situated on the ground (MMI V). Forty-four fatalities and fifty missing people reported in Bangkok due to the collapse of the under construction 33-story skyscraper alone (The Nation 2025).

The strong ground motion of this event had been recorded at 27 seismic stations in Myanmar and Thailand including five digital strong motion sensors located in Bangkok basin maintained by Thai Metrological Department (TMD). In this study, all recorded ground motion characteristic in Thailand is investigated with available ground motion models (GMMs). Moreover, a comparison between stations located inside and outside Bangkok basin are assessed. Most strong motion sensors in Bangkok reported PGA from this event of 0.02g, which is the largest ground motion ever recorded in Thailand capital city. This article provides background on seismotectonic settings of the 2025 Mandalay earthquake, the seismic design code in Bangkok, and the vulnerability of the city due to soft soil layers. Previous large regional earthquakes and their effects to Bangkok are provided. Moreover, observed strong motion in Thailand and observed damage to tall buildings particularly in Bangkok are discussed.

2. The 2025 Mandalay Earthquake and seismotectonic settings

The epicentral location and the focal mechanism of the 2025 mainshock has been determined near Mandalay city showing a north-south right lateral strike slip on the dip angle of 82 degrees, USGS (2025). The largest aftershock of Mw 6.7 occurred 12 minutes later at 30 km from the epicenter of mainshock. While the Global CMT focal mechanism also provides a similar fault plane solution (Ekström et al. 2012) based on a long period waveform simulation, the centroid of the mainshock is located 90 km southward from Mandalay. Due to estimated location uncertainties between Global CMT and USGS-NEIC, this pattern could suggest the rupture began near Mandalay and propagated to the southward direction. The 2025 earthquake ruptured several segments of the Sagaing Fault, encompassing the Meiktila, Naypyidaw, and Pyu segments, and partially affecting the Sagaing segment to the north (figure?). Satellite data also confirmed the inferred observations of an exceptionally long surface rupture extending from Kyaukmyaung, Sagaing to Penwegon, Bago. The length of the surface rupture from satellite data was 500 km. Throughout most of the rupture, the slip at the surface exceeded 3 m while around the epicenter area, reached 4–5 m, USGS (2025). Due to several major cities located along the 2025 rupture zone, the affected cities experienced severe damage in Myanmar, with over 3,800 fatalities and more than 5,100 injuries reported (UNHCR, 2025). This earthquake highlights the seismic hazards associated with one of the major active faults with potential destructive and large earthquakes in the Southeast Asia, that have not shown recent major seismic activity. It highlights the importance of continuous implementation of appropriated seismic design codes and retrofitting local infrastructures in seismically active regions.

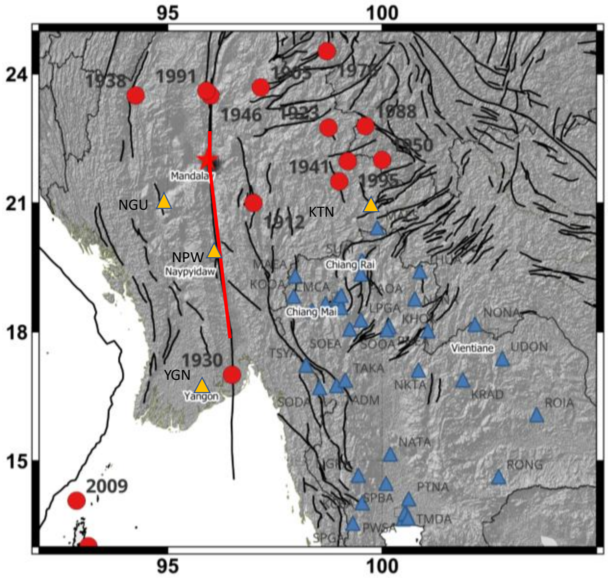

Figure 1.) Myanmar and surrounding region with instrumented earthquake magnitude greater than 7.0 since 1902. The black lines show major active faults in this region. The red line shows the rupture plane of the 2025 Mandalay earthquake with its epicentral shown as red star, USGS (2025). Seismic stations considered in this study are shown in blue and orange triangles for stations operated by Thailand Meteorological Department (TMD) and Department of Meteorology and Hydrology (DMH), Myanmar are, respectively.

3. The 2025 Mandalay Strong Motion

For PGA, CY14 GMM generally underestimate recorded short period ground motion for the distance range from 200 to 600 km for both soil types. However, CY14 provides marginally better aligned between recorded PGA and median curves for stiff and soft soils than those of BSSA14. The underestimation of both GMMs might also be due to the fact that all stations in Thailand are situated in the southward direction along the rupture propagation path. The underestimation effect becomes very clear for the Bangkok stations, where observed PGA mostly outside the median plus five standard deviations. The positive residual at large distance indicating a lower attenuation rate for observed data than those estimated ones by the GMMs. Moreover, it should be noted that these GMMs are developed just up to 400 km so the underestimation could still be expected. In addition, the mean residual for CY14 is 2.33.

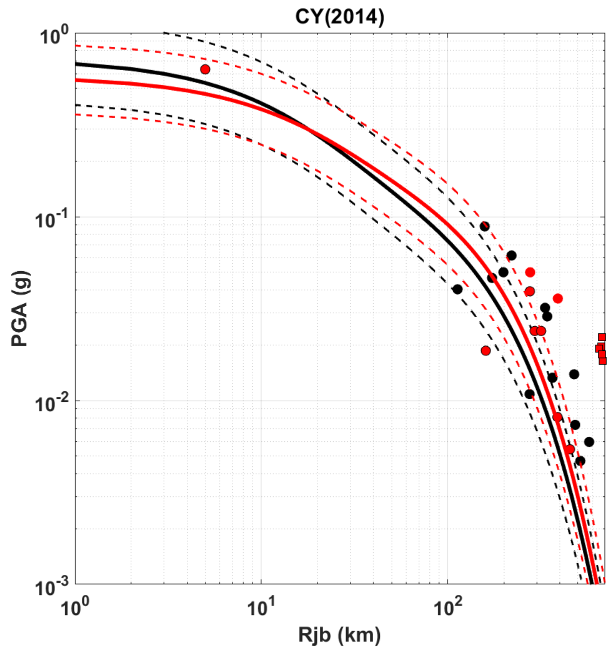

Figure 2. Interior view of the auditorium

3. REFERENCE

[1] The Nation (2025) "SAO Building Collapse Victim Count Rises to 109" www.nationthailand.com/thailand/bangkok/40049643

[2] Poovarodom N, Plalinyot N (2013) Site characterization in the greater Bangkok area by microtremor observations. J Earthq Eng 17(2):209–226

[3] Jirasakjamroonsri A, Poovarodom N, Warnitchai P (2018) Seismic site characteristics of shallow sediments in the Bangkok Metropolitan Region, and their inherent relations. Bull Eng Geol Environ 78:1327–1343

doi:10.1193/072813EQS219M

[4] United States Geological Survey (USGS) (2025) M7.7 - 2025 Mandalay, Burma (Myanmar) Earthquake https://earthquake.usgs.gov/earthquakes/eventpage/us7000pn9s/executive Accessed 12 June 2025

[5] UNHCR (2025) The UN Refugee Agency Myanmar Earthquake Flash Update #5 https://www.unhcr.org/media/myanmar-earthquake-flash-update-5 Accessed 12 June 2025

[6] Chiou BS-J, Youngs RR. Update of the Chiou and Youngs NGA Model for the Average Horizontal Component of Peak Ground Motion and Response Spectra. Earthquake Spectra. 2014;30(3):1117-1153.