LONG-PERIOD GROUND MOTION IN BANGKOK FROM THE 2025 MANDALAY EARTHQUAKE: JMA SCALE APPLICATION

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1. INTRODUCTION

On March 28, 2025, at 12:50 local time, a moment magnitude (Mw) 7.7 earthquake struck near Mandalay in central Myanmar [1]. This earthquake was caused by right-lateral strike-slip crustal movement along the Sagaing Fault. According to an analysis conducted by the Geospatial Information Authority of Japan using satellite imagery, crustal deformation was observed along more than 400 km of the Sagaing Fault [2]. It is one of the largest earthquakes to occur in Myanmar, second only to the 1912 Maymyo earthquake (Mw 7.9), and is estimated to have caused over 10,000 fatalities within the country [3].

The shaking from the earthquake was felt outside Myanmar as well. In Yunnan Province, southern China, 800 houses were reported damaged, and tremors were felt in high-rise apartment buildings in Ho Chi Minh City, Vietnam. In Bangkok, approximately 1,000 km from the epicenter, a 33-story building under construction collapsed, resulting in the deaths of over 90 people. In Bangkok, the local geological structure amplified long-period ground motions, which affected structures with long natural periods, such as high-rise buildings and long-span bridges.

This study analyzes the characteristics of the long-period ground motions observed in Bangkok based on the Japan Meteorological Agency's (JMA) long-period ground motion intensity scale.

2. JMA INTENSITY SCALE FOR LONG-PERIOD GROUND MOTION

The JMA Intensity Scale for Long-Period Ground Motion (I_{JMA} for LPGM) was introduced on February 1, 2023 [4]. This new seismic index was developed based on lessons learned from the 2011 Tohoku Earthquake. During that event, high-rise buildings in Tokyo and Osaka experienced larger displacements than low-rise buildings—which caused furniture to topple and induced fear among occupants.

In Japan, the JMA Seismic Intensity (I_{JMA}) Scale is widely used to indicate the severity of ground shaking. However, it is based on filtered frequency bands that emphasize the 0.4–1.0 Hz range [5], which does not adequately reflect the seismic response of long-period structures, such as high-rise buildings. To address this limitation, the I_{JMA} for LPGM was introduced.

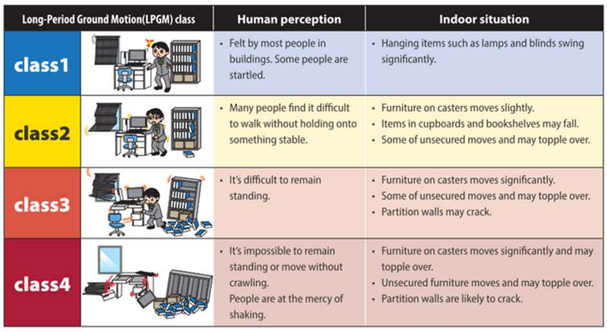


Figure 1. Definition of the JMA Intensity Scale for Long-Period Ground Motion [4]

Table 1. Relationship between the JMA Intensity Scale for Long-Period Ground Motion and the absolute velocity response spectrum (*Sva*) with 5% damping

I_{JMA} for LPGM	Value of Sva (cm/s)
class 1	$5 \leq Sva < 15$
class 2	$15 \leq Sva < 50$
class 3	$50 \leq Sva < 100$
class 4	$100 \leq Sva$

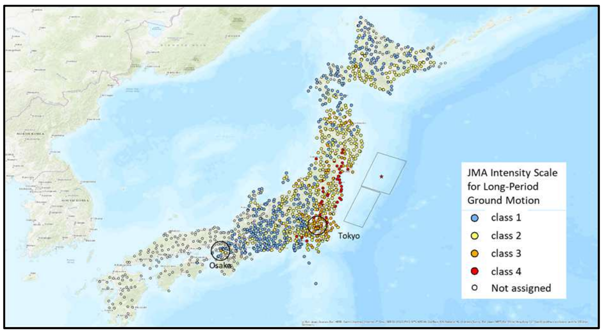
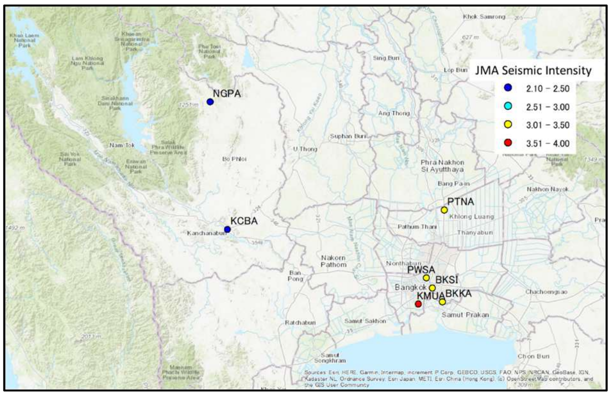


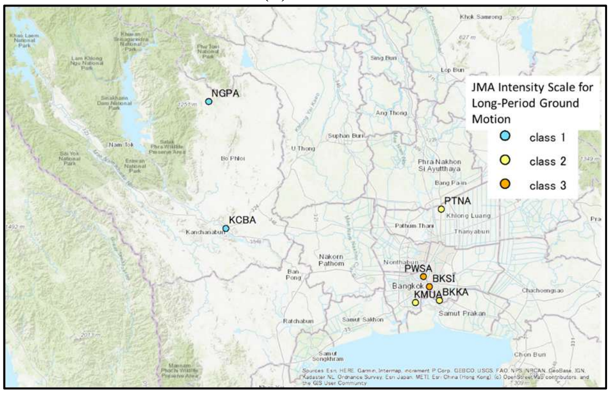
Figure 2. Distribution of the JMA Intensity Scale for Long-Period Ground Motion after the 2011 Tohoku Earthquake

This scale reflects human perception and indoor conditions in high-rise buildings. It consists of four classes (Figure 1), defined using the absolute velocity response spectrum (*Sva*) with a damping ratio of 5% (Table 1). The *Sva* is calculated for each ground motion component (EW, NS, and UD) over a period range of 1.6 to 7.8 seconds at 0.2-second intervals.

Figure 2 presents the distribution of the I_{JMA} for LPGM following the 2011 Tohoku Earthquake, based on ground



(a) I_{JMA}



(b) I_{JMA} for LPGM

Figure 3. Distributions of (a) JMA Seismic Intensity and (b) the JMA Intensity Scale for Long-Period Ground Motion in Thailand

motion records from K-NET and KiK-net stations operated by the National Research Institute for Earth Science and Disaster Resilience (NIED). Even at epicentral distances of approximately 380 km and 800 km, Class 3 long-period ground motion was observed in both Tokyo and Osaka.

3. I_{JMA} FOR LPGM OF THE GROUND MOTION RECORDS IN BANGKOK

The I_{JMA} and I_{JMA} for LPGM were also used to evaluate ground motion records at seven seismic observation stations in Thailand during the 2025 Mandalay Earthquake. Figure 3 shows their spatial distributions. The I_{JMA} for LPGM of Class 1 and Class 2 motions were observed outside of Bangkok, while Class 3 long period ground motion was observed in the center of Bangkok.

Figure 4 shows the *Sva* (5% damping) along with the threshold values for Classes 1 through 4 for the ground motion records at the four seismic observation stations in Bangkok. At BKSI and PWSA, the *Sva* exceeded the Class 3 threshold around a 6-second period. At KMUA and BKKA, the *Sva* surpassed the Class 2 threshold across the entire period range. According to the Figure 4, the ground motion with a period of approximately 6 seconds was observed in Bangkok. These results indicate that the long-period ground motions in

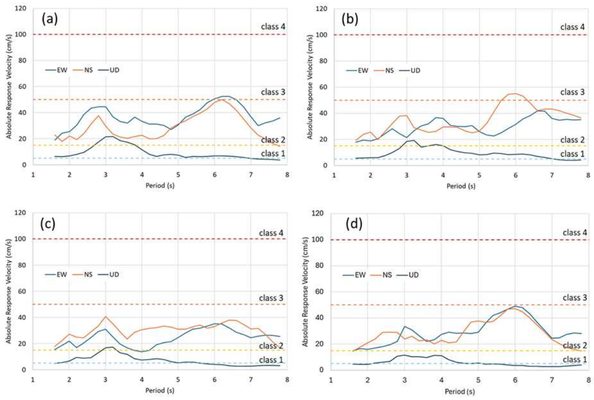


Figure 4. Absolute velocity response spectra with 5% damping at (a) PWSA, (b) BKSI, (c) KMUA, and (d) BKKA, with threshold values for the JMA Intensity Scale for Long-Period Ground Motion

Bangkok were similar to those observed in Tokyo and Osaka during the 2011 Tohoku Earthquake.

4. CONCLUSION

The 2025 Mandalay Earthquake caused long-period ground motions that significantly affected Bangkok, despite its distance from the epicenter. Using the JMA Intensity Scale for Long-Period Ground Motion, Class 3 motions were identified in central Bangkok, with a dominant period around 6 seconds. These results highlight the need to consider long-period ground motion in seismic assessments for high-rise buildings, even in distant urban areas.

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