

THE GREAT SUMATRA-ANDAMAN ISLANDS EARTHQUAKE ($M_w = 9.0$) OF 26 DECEMBER 2004: FAR-FIELD RESPONSE IN SINGAPORE

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1 Introduction

The massive undersea earthquake (moment magnitude $M_w = 9.0$) of 26 December 2004 occurred off the north-west coast of Sumatra, Indonesia. It caused tsunamis around the Indian Ocean with a global death toll approaching 290,000 (as of 22 March 2005), making it the deadliest tsunami ever recorded. The majority of the death toll (more than 200,000) came from the province of Banda Aceh, Indonesia, which is 250 km north-northwest from the epicenter of the Sumatra-Andaman Islands earthquake. Compared to Banda Aceh, Singapore is 908 km south-southeast from the epicenter of the recent earthquake. Singapore is located in a low seismicity region of Sunda plate, where the Sumatran fault and the Sumatran subduction zone, are located more than 350 km away. While earthquakes have never posed any real problems for Singapore, previous large earthquakes have induced tremors felt in Singapore [1-4]. This report aims to provide the far-field ground motions of the recent Sumatra-Andaman Island earthquake recorded in Singapore.

2 Far-field response due to Sumatra-Andaman Island earthquake

For the Sumatra-Andaman Island earthquake, the main tremors and a series of aftershocks were also reportedly felt in several areas of Singapore, which is 908 km from the epicentre of the earthquake. A local Singapore newspaper reported that the areas where the tremors were felt are Tanjung Rhu, Marine Parade, Toa Payoh, Siglap and Meyer Road (*Today*, December 27, 2004). At these locations, the tremors caused no damage and the locations are shown in Figure 1.

Furthermore, far-field ground motions were recorded by a network of seismic stations in Singapore. The Meteorological Services of Singapore (MSS) installed the network of seismic stations (in 1996), which consists of two down-hole arrays (BES and KAP) of strong-motion stations and five teleseismic stations (BTDF, FTC, NTU, PTK and SJA). The two down-hole arrays are located on the Kallang formation of Quaternary deposits. The main station, located in the Bukit Timah nature reserve and denoted as BTDF, is a Global Seismic Network (GSN) station, which is equipped with a comprehensive set of sensors to record ground tremors continuously. BTDF is located on a rock outcrop site. The Nanyang Technological University (NTU) has also installed two additional seismic stations, one inside the campus (denoted as NYC) and the other in the basement of a high-rise office building in the central business district (denoted as RP). The NYC station is located on a firm residual soil site, and the building in which the RP station is located sits on rigid caissons. The two NTU and seven MSS stations form an array called the Singapore Array for Earthquake Response (SAFER). In Figure 2, the locations of MSS stations are depicted by triangles and those of NTU stations are in circles.

The far-field ground motions due to the main and one main aftershock of the Sumatra-Andaman Islands earthquake were recorded in Singapore. The baseline-corrected time histories of the accelerations, velocities and displacements of the ground motion recorded at the BTDF station due to the main shock and one major aftershock are presented in Figures 3 and 4, respectively. In the figures, the three components of acceleration, velocity and displacement (i.e., E-W, N-S and U-D), are denoted as E, N, Z, respectively.

For the main shock due to the Sumatra-Andaman Islands earthquake, the horizontal components of E-W and N-S had peak ground accelerations (PGAs) of 2.42 mm/s^2 and 3.13 mm/s^2 , respectively. For the major aftershock, the PGAs of the E-W and N-S components are 0.37 mm/s^2 and 0.63 mm/s^2 , respectively.

References

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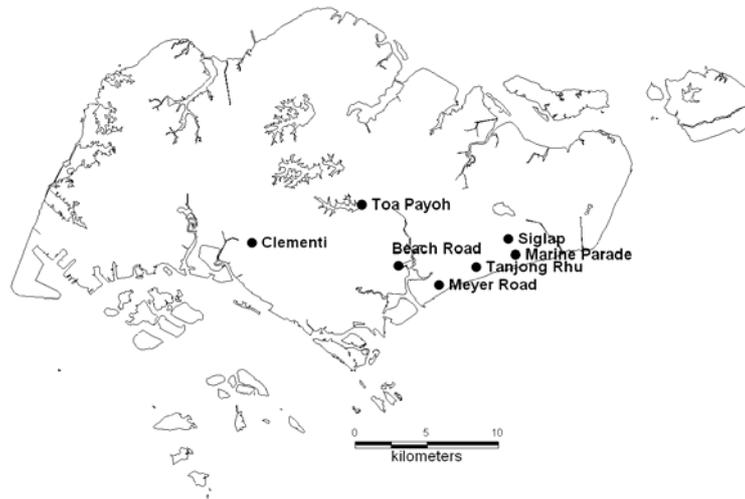


Figure 1. Distribution of locations in Singapore where tremors were felt

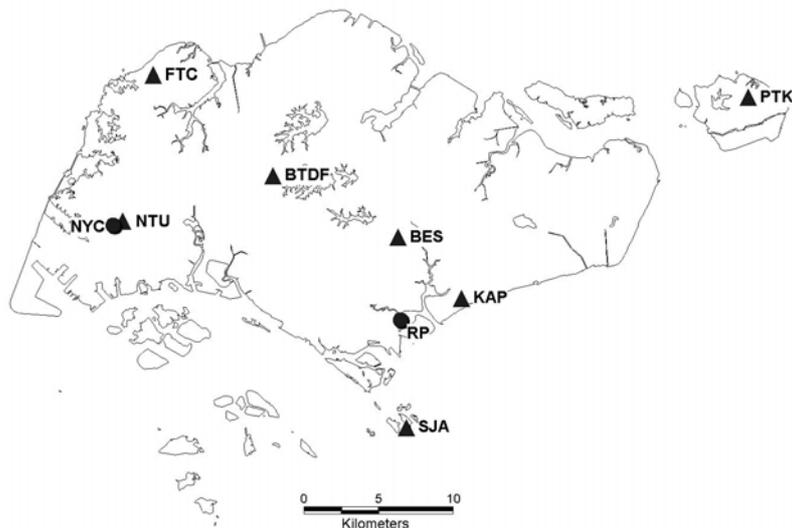


Figure 2. Seismic stations in Singapore (SAFER Array and NTU Array)

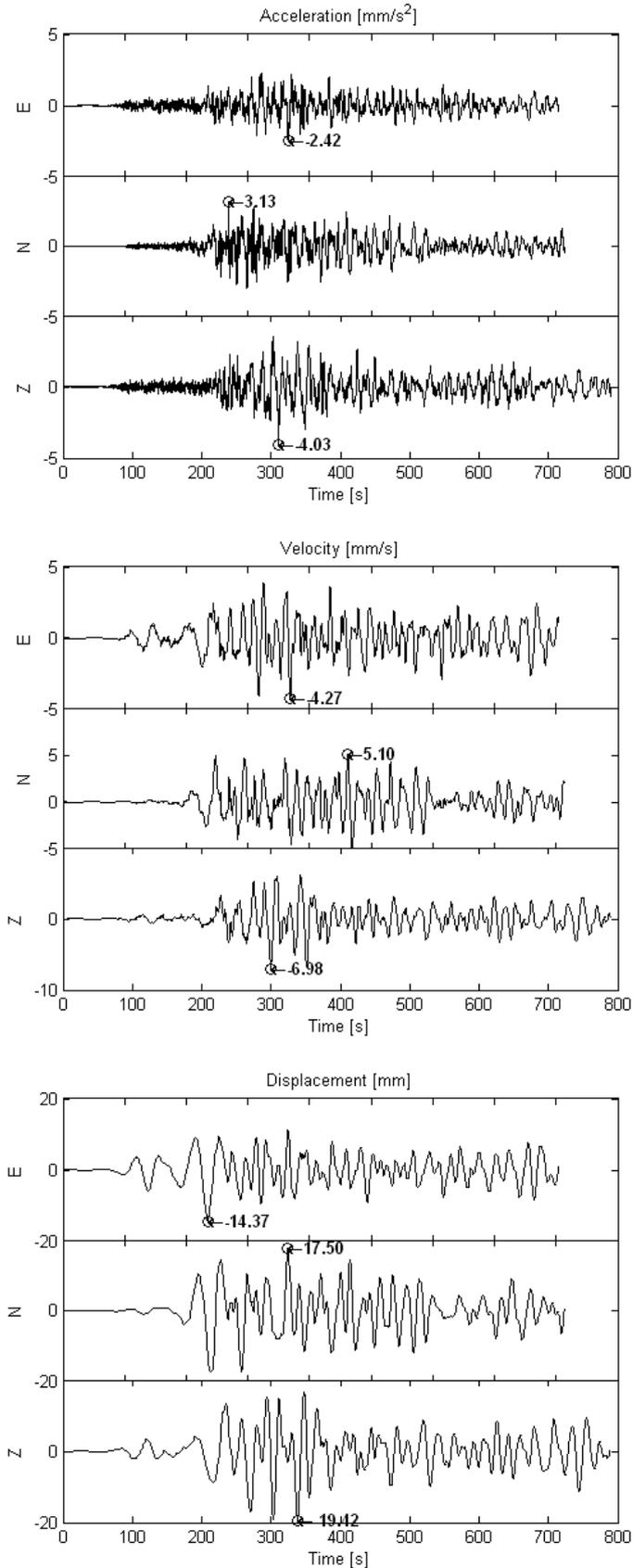


Figure 3. Baseline-corrected acceleration, velocity and displacement of the main shock of the Great Sumatra--Andaman Islands earthquake (2004/12/26 00:58:53 UTC), recorded in Singapore at BTDF seismic station.

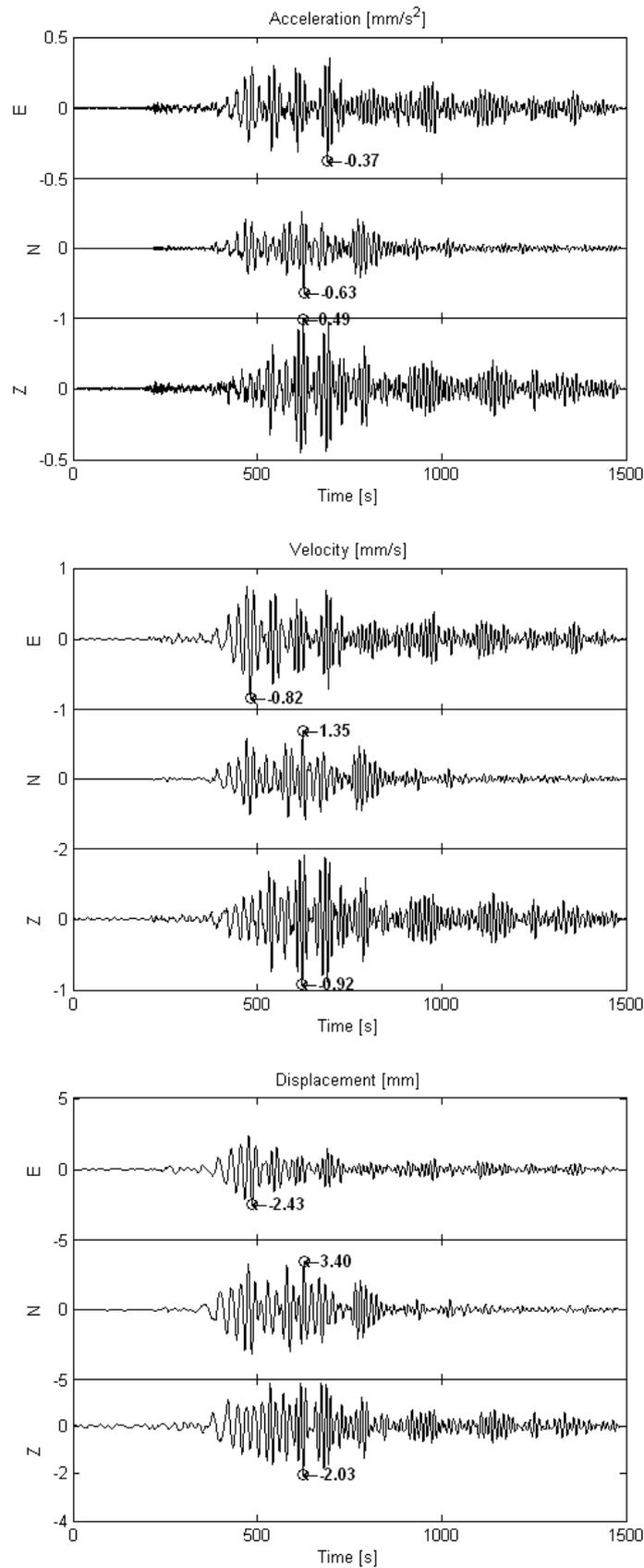


Figure 4. Baseline-corrected acceleration, velocity, and displacement of the major aftershock (2004/12/26 04:21:26 UTC) off the West Coast of the Northern Sumatra earthquake, recorded in Singapore at BTDF seismic station