

STOCHASTIC GROUND MOTION PREDICTION IN THE NORTH OF VIETNAM REGION

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1. INTRODUCTION

Vietnam is located in the South East of Eurasian Plate, bordered by Philippine plate in the East and India – Australia plate in the West and South, is situated between two greatest seismic belts of Planet: the Mediterranean – Himalayan and Pacific tectonic belts. The maximum earthquake ($M_{\max}$) in Vietnam is only rising 6.5 to 7.0 of Richter; the Northeast occurs $M_{\max} = 6.5 - 7.0$; $M_{\max} = 6.0 - 6.5$ almost distributes in the Ca River – Rao Nay and Nam Con Son faults. The Dien Bien earthquake (1935, $M = 6.8$) and Tuan Giao earthquake (1983, $M = 6.7$) are the two largest ones that happened in Vietnam main land territory in the 20th century. Some parameters of Tuan Giao earthquake source have been recorded by Vietnam researcher such as Cao Dinh Trieu (2002), Pham Van Thuc (2007). However, the first accelograms within Vietnam were obtained only since the year 2000, among which the most valuable is the ground acceleration data recorded from the Dien Bien earthquake of 19 February, 2001 ($M_S = 5.3$) and five other events ($M_S = 4.0 \div 4.9$).

Ground motions are simulated by the point source simulation using the D-Wave software developed by Japanese based on stochastic method developed by Boore in this study.

2. GROUND MOTION SIMULATION BASED ON STOCHASTIC METHOD

Most of difficulties in predicting ground motion are to characterize the source models of future earthquakes. Most of ground motion predictions in earthquake hazard analysis have been made using empirical attenuation-distance curve for PGA (peak ground acceleration) and PGV (peak ground velocity) based on the outer fault parameters. However, from source inversion studies mentioned above we have realized that such parameters are not enough to estimate strong ground motions.

2.1. Methodology

According to Boore (1983, 2003), the ground-motion predictions are based on the stochastic model, in which ground motion is modeled as band limited finite-duration Gaussian noise through a number of filters; the radiated energy is assumed to be evenly distributed over a specified duration. The method is quite general and can be used to predict many amplitude and instrument-response parameters. The general spectrum of the motion as a function of seismic moment and distance, $Y(M_0, R, f)$, which can be represented by

$$Y(M_0, R, f) = E(M_0, f) \cdot P(R, f) \cdot G(f) \cdot I(f) \quad (1)$$

Where $E(M_0, f)$ represents the source spectrum, $P(R, f)$ represents the spectral amplitudes attenuation with the closest distance from rupture surface, $G(f)$ represents the effect of site condition, $I(f)$ is the type of motion.

2.2. Data source in the Tuan Giao earthquake, 1983

According to Pham Van Thuc (2007), the parameters for the Tuan Giao earthquake (1983) as follow: Magnitude $M_S = 6.7$; the fault-source is stretching in Northwest-Southeast direction, with a normal, right lateral strike slip mechanism with direction of dip is Northeast with a dip angle of $\gamma = 75^\circ$; epicenter coordinates are latitude of $21^\circ 71' N$, longitude of $103^\circ 43' E$ and seismic moment $M_0 = 3.5 \times 10^{25}$ dyne•cm, length of fault $L = 23$ km, wide of fault $W = 22$ km, time duration $t_0 = 12$ s, average displacement $D_0 = 28$ cm, seismic energy $E_S = 1.1 \times 10^{20}$ erg, rupture velocity $V_R = 2$ km/s, density 2.7 g/cm^3 , velocity of S wave $V_S = 3.4$ km/s.

Keywords: Ground motion, stochastic method, seismic design

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2.3. Observed record in the Dien Bien earthquake, 2001

The first accelograms within Vietnam were obtained only since the year 2000, among which the most valuable is the ground acceleration data recorded from the Dien Bien earthquake of February 19th, 2001 ($M_S = 5.3$) and four other events ($M_S = 4.2 - 4.8$). The analysis shows the structure of the variation frequency has the same shape, peak spectrum at period about 0.1 sec, cut down from 0.1 to 0.3 sec and quickly reduce from 0.3 to 1.0 sec. The energy of earthquake of the main shock and the aftershock with the same arising mechanism as Dien Bien earthquake mainly concentrates in the short period 0.1 to 0.3 sec (Le Tu Son et al., 2003).

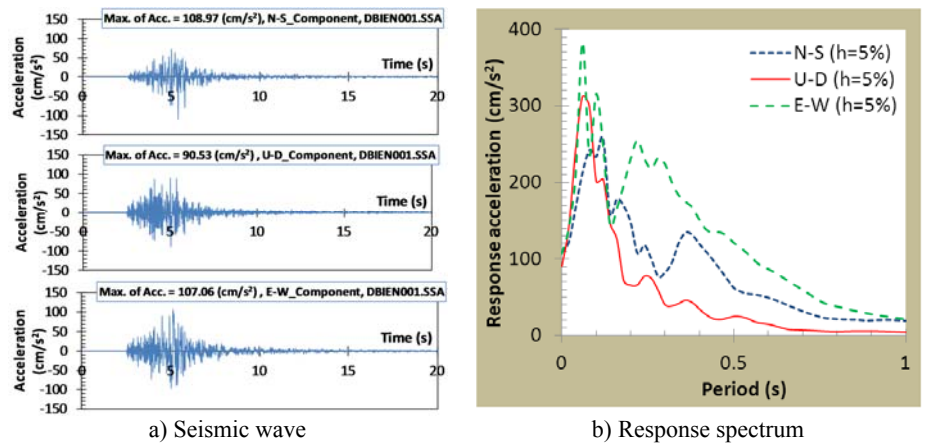


Fig. 1. The main shock of the Dien Bien earthquake of February 19th, 2001 (21.34N 103.85E, $M_S = 5.3$) at Dien Bien station (R=19km)

2.4. Result

Figure 2 show predicted acceleration waveform and response spectrum for Tuan Giao earthquake (1983). The predicted ground motions at Tuan Giao are greater than the observed record at Dien Bien earthquake (2001). The comparison of response spectrum between predicted motions, observed record motions and occurrence specifications in Vietnam are discussed (shown in

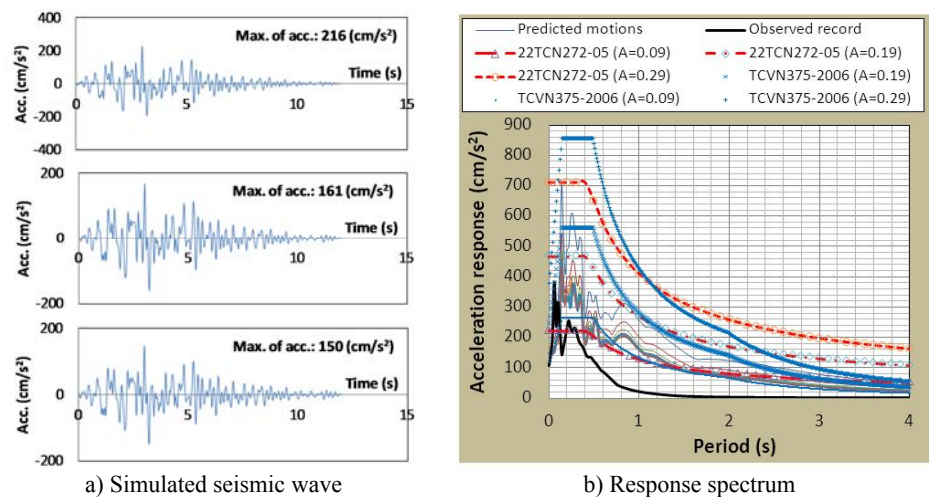


Fig. 2. Simulated results Tuan Giao, 1983 (21.71N 103.43E, $M_S = 6.7$)

Fig. 2 (b). The response spectrum of predicted motions and observed record are within the limits of the specifications for bridge design (22TCN272-05, with soil profile type II) and design of structures for earthquake resistance (TCVN 375-2006, with soil profile type B).

3. CONCLUSION

This study simulates histories earthquake in north of Vietnam based on observed record and some parameters assumed by D-wave software developed by Japanese based on stochastic method developed by David M. Boore. The response spectrum was also compared with current specifications in Vietnam.

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