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PREDICTION EQUATION FOR ARRIVAL TIMES OF NEAR-SOURCE STRONG GROUND MOTIONS VELOCITY PULSES USING PULSE-LIKE RECORDS

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In this study, an equation is represented to predict arrival time of strong ground motion pulse. The arrival time of a velocity pulse with respect to the strong ground motion duration has been defined through a parameter, normalized arrival time (NAT). The functional form of the model was an additive natural logarithm of four predictor variables, namely moment magnitude (M_w), rupture distance (R_{rup}), time-averaged shear-wave velocity in the top 30 m (V_{S30}), and the style of faulting effect (F_m), which has been considered for the first time as an indicator directly in the functional form. The equation could estimate NAT of velocity pulses of earthquakes with moment magnitudes from 5.5 to 7.9 and rupture distances of up to 95 km. The results shown that the NAT generally increased with increase in magnitude and rupture distance. As a case study, the NAT of Sarpol-e Zahab 2017 earthquake of Iran is reproduced with the proposed equation and compared with the recorded data.

The effects of arrival time of the dominant velocity pulse on the response of structures are studied in Goswami and Chaudhuri (2012). They investigated the effects of normalized arrival time (say NAT hereafter) on the ductility demand and the response spectrum of the SDOF oscillator. The normalized arrival time is the ratio of the occurrence time (a) of peak ground velocity (PGV) from the starting of the strong motion duration to the total duration (b) considering an acceleration time-history by definition by Trifunac-Brady (Trifunac and Brady, 1975). NAT definition is shown in Figure 1.

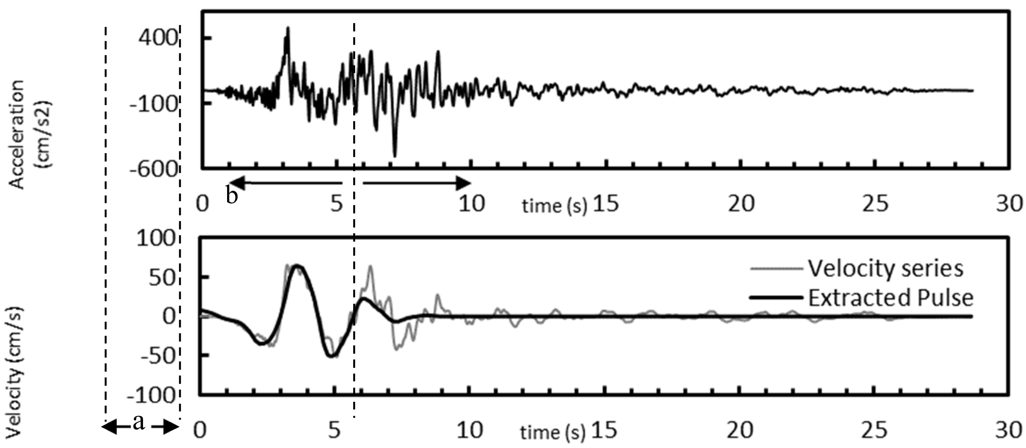

Figure 1. Normalized arrival time for a strong ground motion is defined as a/b that a is the occurrence time of PGV and b is the total duration of the time history.

In this study, we propose an equation to predict NAT of dominant velocity pulse using NGA-West2 pulse-like records that are classified by Shahi and Baker (2014) quantitative classification method. A mixed-effects nonlinear regression procedure is used to achieve regression coefficients. The equation functional form is an additive natural logarithm of four predictor as Equation 1:

$$Ln(NAT) = C_1 + f(M_w, R_{rup}) + C_2 \ln V_{S30} + C_3 F_m \quad (1)$$

where $C1$ to $C3$ are regressed model coefficients and M_w, R_{rup}, V_{S30} and F_m denote on moment magnitude, rupture distance, shear velocity of soil in top 30 m and focal mechanism indicator respectively.

The results show that in a general manner NAT increases with increase in moment magnitude and rupture distance. Figure 2 illustrates the distribution of arrival time of velocity pulse peak against the moment magnitude. Two black lines show the linear trend of the distribution.

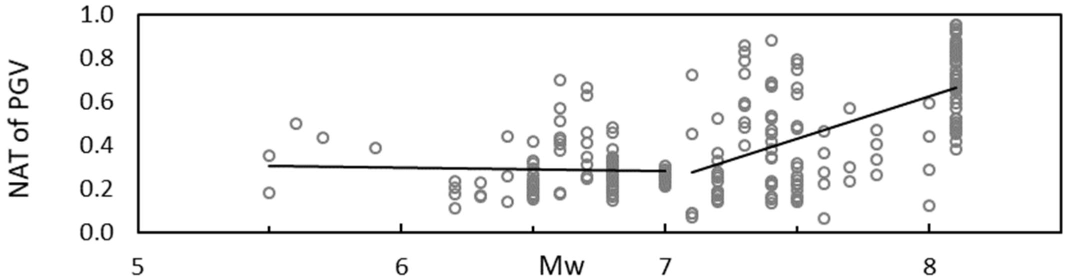

Figure 2. Velocity pulse normalized arrival time distribution against moment magnitude.

The arrival time increases at the moment magnitudes greater than 7 obviously. It can be said that the NAT has an increasing trend If the records with magnitudes smaller than 6 are ignored. The scattering appears in the NAT for such records may be affected by insufficiency of recorded data.

As an instance, we reproduce the NAT of Sarpol-e Zahab 2017 earthquake of Iran and show that the model is capable to predict the NAT with an appropriate accuracy.

REFERENCES

Baker J.W. (2007). Quantitative classification of near-fault ground motions using wavelet analysis. *Bulletin of the Seismological Society of America, 97*(5), 1486-1501.

Boore, D.M. (1983). Stochastic simulation of high-frequency ground motions based on seismological models of the radiated spectra. *Bulletin of the Seismological Society of America*, 73(6A), 1865-1894.

Goswami, K., and Chaudhuri, S.R. (2012). *Effect of Arrival Time of Velocity Pulse on Seismic Response of Structures.*

Shahi, S.K. and Baker, J.W. (2014). An efficient algorithm to identify strong velocity pulses in multi-component ground motions. *Bulletin of the Seismological Society of America, 104*(5), 2456–2466.

Trifunac, M.D. and Brady, A.G. (1975). A study on the duration of strong earthquake ground motion. *Bulletin of the Seismological Society of America, 65*, 3, 581-626.