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MOMENT MAGNITUDE ESTIMATION BASED ON ANDREWS (1986) METHOD IN FREQUENCY DOMAIN

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INTRODUCTION

Earthquake magnitude scales are related measurements of an earthquake. The most commonly used magnitude scales such as local magnitude or body wave magnitude are dependent on the frequency of the recorded waves and above a certain size will saturate. To overcome the saturation problem, moment magnitude **M** was introduced (Hanks and Kanamori, 1979) that is calculated from the seismic moment, $M_{0,}$ which can be estimated from spectral methods (Brune, 1970), the moment tensor inversion, or the waveform inversion. The spectral method, which is generally based on the Brune source model, is a simple yet very efficient method. In this study, the source parameters of the earthquake including M_0, **M** and corners frequency (f_c) were estimated using the Andrews (1986) method based on the Brune source model in the frequency domain using Iran strong motion data.

DATA

In this study, 4373 three-component accelerograms recorded by stations of Iran Strong Motion Network (ISMN) across the country are used. All data were inspected with eye and the P-arrival, S- waves arrival and the S wave window, were determined. Then, the records were filtered using a band-pass filter and their correctted velocity and displacement time histories were estimated as well (Figure 1).

METHOD

Moment magnitude (**M**) is calculated from the following equation (Hanks and Kanamuri, 1979):

$$\mathbf{M} = 2/3\log10\ (M_0) - 6.03, \quad (1)$$

where the scalar moment, M_0, is the seismic moment in N.m. M_0 is calculated from the following equation based on the low-frequency plateau in displacement spectra (Ω_0).

$$M_0 = \frac{4\pi\rho\beta^3}{R_{\theta\varphi}FP} G(R)\Omega_o \quad (2)$$

where, ρ is the density, β is the shear wave velocity, and F is the free surface magnification correction factor. $R_{\theta\varphi}$ is the mean value of the radiation pattern and G(R) is the geometrical spreading function.

RESULTS

The final M_0 of the earthquakes with at least three records was calculated by averaging the values obtained at all stations and using this mean values, the final **M** of the earthquakes were determined. The results are in good agreement with the reported magnitude with mean residuals close to zero and standard deviations (σ) about 0.2 (Table 1, Figure 2). The obtained values from the two selected windows do not differ significantly, but the S window yields less σ. Using this method **M** can be estimated rapidly after the earthquake occurrences for earthquake early warning and rapid response systems.

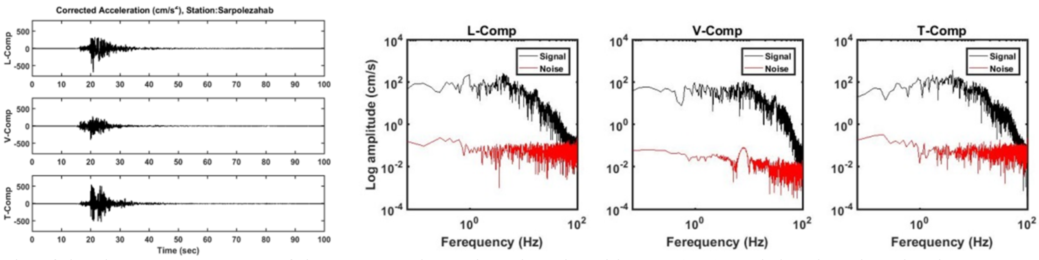

Figure 1. An example of the three components of the corrected acceleration time history (top) and the signal and noise spectra (bottom) related to the 2017 Sarpol-e Zahab earthquake, recorded at the Sarpol-e Zahab station.

Table 1. Mean and σ values for earthquakes with reported M, with at least three recorded accelerograms, based on S-wave window (S) and whole signal widow (W).

Earthquake with at least 3 records	Mean	σ
M_W	0.08	0.20
M_S	0.10	0.18

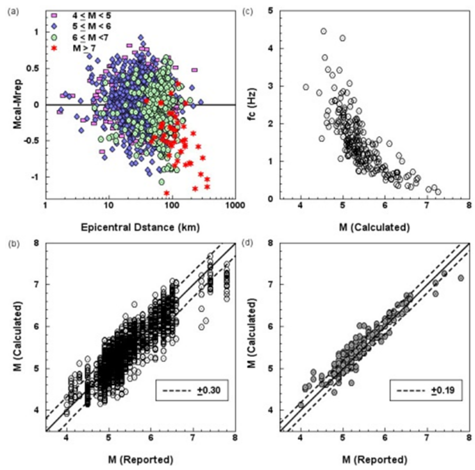

Figure 2. The results based on the S-wave window: a) Residuals for all accelerograms versus distance. b) The calculated magnitude (M (Calculated)) versus the reported magnitudes (M (Reported)) for all accelerograms along with the obtained standard deviations (σ). c) Corner frequency values calculated for all earthquakes versus the M (Calculated). d) M (Calculated) for each earthquake versus the M (Reported) along with the obtained σ.

REFERENCES

Andrews, D.J. (1986). Objective Determination of Source Parameters and Similarity of Earthquakes of Different Size. in *Earthquake Source Mechanics*, Das, S., Boatwright, J., and Scholz, C.H., (Editor), American Geophysical Union, Washington, D.C., 259-267.

Brune, J.N. (1970). Tectonics stress and the spectra of seismic shear waves from earthquakes. *J. Geophys. Res., 75*, 4997-5009.

Hanks, T.C. and Kanamori, H. (1979). A moment magnitude scale. *J. Geophys. Res., 84*, 2,348-2,350.