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Time-frequency analysis of the 2017 Sarpol-e Zahab earthquake ground motions

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ABSTRACT

A severe earthquake ground motion with moment magnitude Mw=7.3 took place in the western part of Iran on 12th November 2017. The aim of this proposed study is to assess the time evolution of the frequency-intensity content of Sarpol-e Zahab earthquake ground motions records by using of the Wavelet Transform (WT) methodology. For this purpose, the ground motions recorded at Sarpol-e-Zahab, Kerend and javanrod stations that has maximum PGA has been selected. Time–frequency analysis of ground-motions recorded at the Sarpol-e Zahab station shows that the most energy content of the T component is concentrated at time equal to 21 s but is distributed over a range of periods between (0.2 -0.5sec) with a lesser peak in energy at a period of about 0.6 sec, that there may be effect of moving resonance on building with periods between (0.2-0.5 sec). Also, it can be observed that most energy of the L component was highly concentrated at time equal to 21 s and a narrow period band (between 0.2 and 0.3 sec) that is considered as pulse like. This finding is consistent with damage observation in Sarpol-e-Zahab and it's around villages where many dwellings and buildings which collapsed or suffered severe damage during this event had low fundamental period between (0.2-0.5sec).

Keywords: Time evolution; wavelet transform; energy ground motion; low fundamental period.

1. INTRODUCTION

One powerful earthquake with Mw=7.3 occurred on western part of Iran at 21:48 and 18:18 UTC of 12th November 2017. The epicenter was 10 km southwest of Ezgeleh, 33 km northeast of Qasr-e-Shirin and 39 km northwest of Sarpol-e Zahab, at a depth of approximately 18 km. During this earthquake which measured respectively as 7.3 on the moment magnitude scale, more than 1000 villages have completely destroyed and different damage levels were observed in the cities of Sarpol-e Zahab, Qasr-e Shirin and Eslamabade-e gharb. Reported show that more than 600 people were killed and at least 12,000 were injuries, left more than 30,000 homeless [1] and caused widespread damage to the structures. The structural damage has a direct relevancy with important parameters of the ground motion such as frequency content, significant duration and amplitude. Unlike to the amplitude and significant duration parameters the frequency content is not estimable from the ground motion time history and this information is hidden behind the ground motion record that various mathematical tools are required for their extraction. Numerous tools have been developed for the analyses of time-varying frequency content of ground motions, including the Short Time Fourier Transform (STFT), the Wavelet Transform (WT), and the Wigner-Ville Distribution (WVD) [2-4]. WT is a powerful tool adaptive to time-frequency analysis and has good time-frequency discrimination ability. Subsequently, several researchers applied wavelet transform to time- frequency analysis of earthquake strong motion [5-7].

The proposed study aims to assess the time evolution of the frequency-intensity content of earthquake ground motions recorded by using of the Wavelet Transform (WT) methodology. For this purpose, the ground motions recorded at Sarpol-e-Zahab, Kerend and javanrod stations that has maximum PGA has been selected. The time-varying frequency and energy contents of horizontal and vertical components of ground-motions recorded at select station are critically evaluated. As the present work is based on wavelet decomposition, a brief review of wavelet transform used in the paper is given in next section.

2. Wavelet analysis

Wavelet transform as an efficient tool for extract the temporal evolution of the frequency-intensity content of earthquake ground motions. The original signal can be reformed from the details only without any loss of information [8]. The reconstructed signal is illustrated as follows: