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Determining the Spectral Ratio of the Vertical and Horizontal Components of Near-Field Earthquakes

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ABSTRACT: Based on studies conducted in recent decades, it has been determined that the characteristics of earthquakes in the near-field zone are different from those of earthquakes far from faults[1], Among these differences, we can mention the effect of the vertical component of the earthquake. Earthquakes near faults have unique features that neglecting them can increase the damages and human and environmental disasters caused by these types of earthquakes, and their effects on the environment and existing structures can be several times greater. Most of these damages occur in the short distance from the epicenter, especially in the horizontal components of long-span bridges, structures, and buildings[1]. The effects of the vertical component of the earthquake in the past were considered negligible, so in past researches and the old versions of some regulations, the effect of the vertical component of the earthquake was ignored or it was considered as a coefficient (two-thirds) of the horizontal component. Therefore, one of the simple methods to determine the design spectrum of the vertical earthquake component is to use empirical relationships such as the V/H spectral ratio (vertical to horizontal component).

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1- Introduction

Several studies have been done in relation to the vertical component of the earthquake [10-5] [4-2] and relations and coefficients for the V/H spectral ratio have been introduced[13-11]. On the other hand, some international regulations and engineering guidelines in their old and new versions have different recommendations for determining this ratio [18-14] , for example, the fourth edition of the 2800 standard considers the effects of the vertical component of the earthquake as a vertical force[19].

According to the studies conducted in this field, it has been found that the examination of the vertical component and its relationship with the horizontal component of earthquakes in the near-field zone has been neglected in Iran. No action has been taken in this field so far in Iran, even though this coefficient (V/H ratio) is determined in international regulations and researches.

The importance of determining the vertical component of earthquakes as an important parameter that can play a decisive role in designing some structures and vital arteries becomes clear when considering the high seismicity of some areas in Iran and the presence of active faults in the vicinity of some population and urban centers and Also, the existence of the Alpine-Himalayan seismic belt. Therefore, the importance of this parameter can be better understood by focusing more on determining the vertical-to-horizontal ratio, especially in sites near to faults. Therefore, the necessity of studying and determining the vertical earthquake component as an important parameter is emphasized.

The purpose of this research is to determine the ratio of the vertical component to the horizontal component based on the data of the area near the fault of Iran. Therefore, This study, using data from Iran's near-field earthquakes, including 69 (not only the pulse-like data) earthquake records (obtained from the Housing and Urban Development Research Center of Iran[20]) which occurred inside Iran with epicentral distances less than 30 km and Mw≥5 and PHGA≥200 m/s2, the V/H (vertical to the horizontal) ratio was determined.

2- Materials and Methods

The most common value of damping to determine the characteristics of strong ground motion and compare the response spectrum of earthquakes is 5% damping, which is used in the design of engineering structures. In the response spectrum presented in Iran's 2800 regulation, 5% damping is also used, therefore, 5% damping is used to prepare the corrected data response spectrum.

3- Results

The general results and the correlation coefficient of

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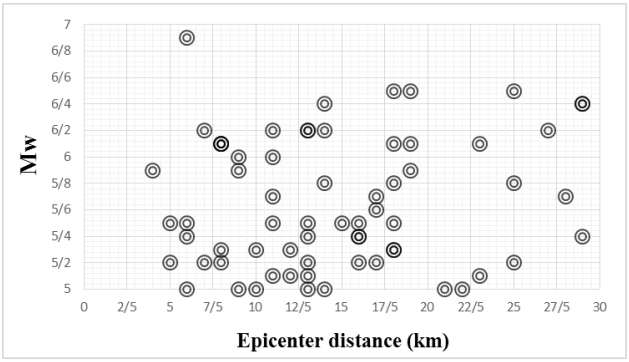

Fig. 1. Epicenter distance distribution of 69 selected data relative to earthquake magnitude

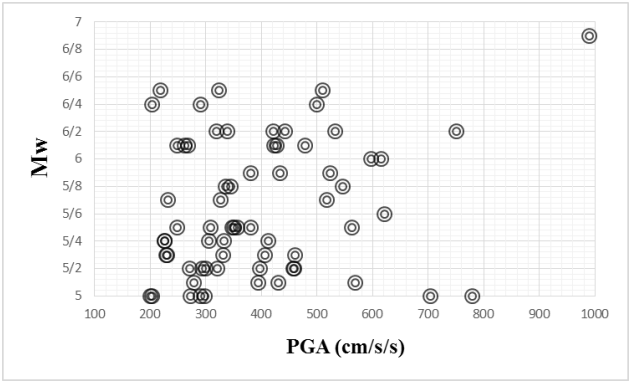

Fig. 2. Peak ground acceleration distribution of 69 selected data relative to earthquake magnitude

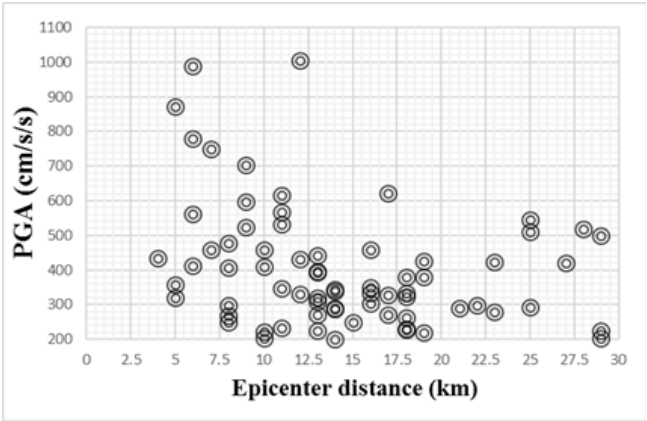

Fig. 3. Epicenter distance distribution of 69 selected data relative to Peak ground acceleration

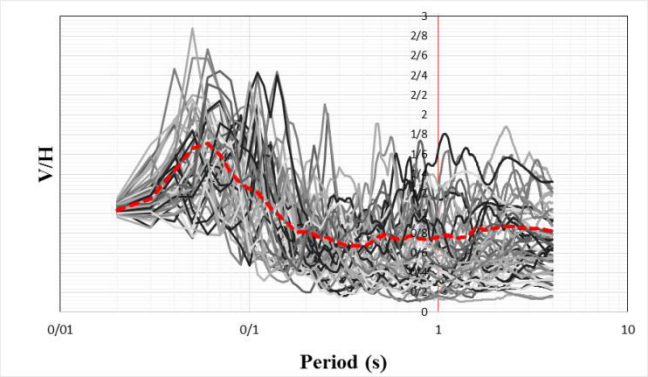

Fig. 4. V/H spectral ratio of the total data (the red graph is the average of the total data and the horizontal axis is logarithmic)

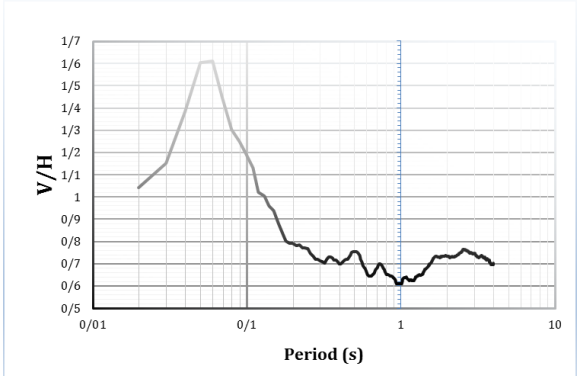

Fig. 5. Average V/H spectral ratio of all data (horizontal axis is logarithmic)

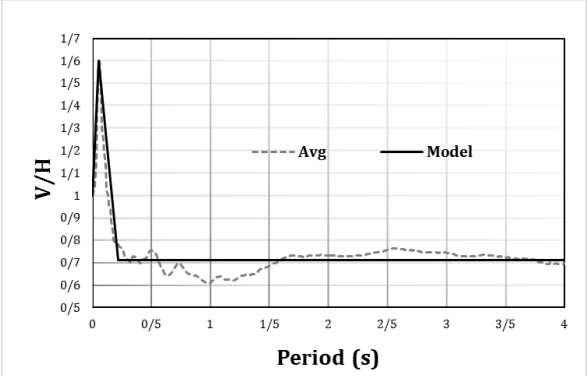

Fig. 6. Average spectral coefficients of all data along with the proposed model

the proposed model for the V/H ratio to compare it with the relative coefficients of the spectrum obtained from all the data are available in Figure (4) and Table (1). The least squares algorithm was used in Matlab software to select the most suitable proposed model obtained from all the data.

V/H spectral ratio for all data in the entire period interval (0-4 seconds) is determined, and then by averaging and using linear regression, the final proposed coefficient obtained is presented. The parameter (T) in the table and graphs represents the period (range 0-4 seconds) and (N) the proposed spectrum correction coefficient.

4- Conclusion

As a result of the study, more emphasis should be placed on determining the vertical component and its ratio with the

Table 1. Proposed V/H model

The correlation coefficient	0.92
N =12 T + 1	T <0.05
N = -5.235 T + 1.862	0.05 < T <0.22
N = 0.71	0.22 < T < 4

horizontal component, especially in sites located in areas near faults, it is recommended that, like other standards, regulations, and studies that have used simple assumptions such as the value of two-thirds for the V/H ratio, a value of 0.71 should be used to convert the horizontal component response spectrum to the vertical component response spectrum for data from the near-fault earthquakes in Iran.

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