USING THE H/V SPECTRAL RATIO FOR ESTIMATING THE VULNERABILITY INDEX OF AN URBAN AREA

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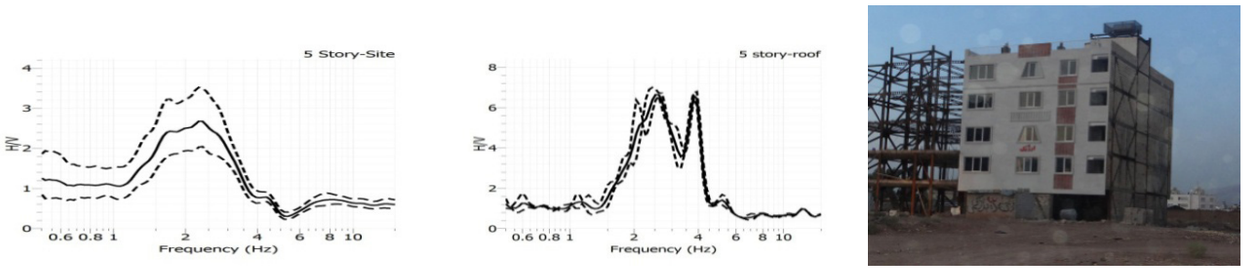
Dynamic soil characteristics and subsurface geological topography have important effect in the vibration of structures. During the several times of building construction, the structures have built by different materials, techniques and standard codes. The studies have shown that the existing buildings have different response to earthquake- induced, related of their materials and design rules. The H/V spectral ratio method which introduced by Nakamura (Nakamura, 1989) can calculate the dynamic characteristics of soils. In addition, as another approach he suggested the vulnerability index of soil and building (Nakamura 1997). Using the later method, in a vulnerability study in the city of Shiraz, the predominant frequencies are derived for the different parts of the city. These data have used to define a coefficient of vulnerability for the earth. In this paper, it has presented a method for estimating the degree of vulnerability of structures using the H/V spectral ratio. For this purpose, 10 different building such masonry, steel or concrete structures were selected. The main frequency and amplification factor of microtremor H/V spectral ratio for building has been obtained. Furthermore, using the H/V spectral ratio, the resonant frequency and amplification of the ground have been calculated. The vulnerability index of soil Kg and vulnerability of building Kb were defined. As an example figure 1 shows a 5 story building, its related H/V spectral ratio on the earth and on the roof. Tables 1 and 2 illustrates the resonance frequencies, amplification factors, ground vulnerability indexes, Kg and vulnerability index of buildings, Kb for different old and new constructed buildings respectively. Comparison of these coefficients recognizes the damage potential of building during the earthquake which nominated as η. Table 3 shows the damage rate of buildings as a function of vulnerability factor η.



(a) (b) (c)

Figure 1. The H/V spectral ratio on the ground (a) and building (b) for a 5 story building (c) at Shiraz city

This paper introduces a fast and inexpensive method to investigate the vulnerability of urban building during an earthquake. This method can use for preparing a vulnerability zonation map of a city. The vulnerability map for the area of a municipality in Shiraz City was evaluated. This result can be generalized to all areas of a city.

Table 1. The calculated vulnerability index of ground Kg, building Kb and vulnerability factor η of old buildings

Building type	No of story	Natural frequency on the roof	Amplification factor on the roof	$_{av}K_b=A^2/F$	f_g	A_g	K_g	η
Masonry building	1	-	-	-	0.7	1.5	3.2	Unknown
Masonry building	2	8	4	2	0.8	2	5	0.8
Old 4 story framed structure	4	7	7	7	0.7	1.9	5.16	1.36
Old 5 story framed structure	5	5	7	10	0.6	1.4	3.3	3

Table 2. The calculated vulnerability index of ground Kg, building Kb and vulnerability factor η of new constructed or retrofitted buildings

Building type	No of story	Natural frequency on the roof	Amplification factor on the roof	$_{av}K_b=A^2/F$	f_g	A_g	K_g	η
Reinforced masonry	2	12	1.7	0.36	0.64	1.8	1.5	0.2
3 story new constructed	3	8	1.7	0.36	0.7	1.7	4.12	0.09
4 story retrofitted building	4	7	1.7	0.41	0.54	1.4	3.6	0.11
5 story new constructed	5	4	2	1	0.52	1.2	8.5	0.12
7 story new constructed	7	3	3	3	0.28	1.7	3.1	0.3
10 story new constructed	10	2	4	8	0.65	2.4	1.3	0.3

Table 3. the suggested damage degree of buildings related to vulnerability factor

Vulnerability factor	A	B	C	D
$\eta = \frac{k_b}{K_g}$	η≤1	2>η>1	3>η>2	η>3

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