Earthquake Engineering, Tenth World Conference © 1992 Balkema, Rotterdam. ISBN 90 5410 060 5

Microseismic noise investigation on the site of sensor factory

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ABSTRACT: Through the collected microseismic records from natural and artifical microseisms have been determined by FFT the spectral characteristics for points with different geological conditions and ground water level. The results manifested a high diurnal seismic noise level and this showes his antropogenic origin. The purpose of the analysis of both general sources was to obtain some parameters used for microzonation. The applications of microseisms to solve the engineering seismology problems are discused.

1. INTRODUCTION

The main parameter of the seismological maps is the intensity of the region, where will be the construction built. These maps are usually compiled on the base of the data of the felt earthquakes, which are incomplete and unreliable. Intensities given in the seismological maps are usualy related to the "average soil conditions" of the region and without other important for the design parameters.

The Upper Thracian Valley is situated in an area with high seismic risk and the intensity according to seismological maps is VIII. There were taken into account a few destructive earthquakes (M = 6,9 - 7,0) in Plovdiv, 1928. The practical significance of the field seismological investigation was increased in connection with the building of the unique equipments in the town district that is situated in region with seismic activity. These equipments should be resistant enough and economically expedient (1). The instrumental methods of the seismological microzonation by which the ground seismic differenciation is made on real records and spectra of the soil vibrations, have the greatest contribution to the realisation of the first condition mentioned above. The economical expedient of some of the equipment for high technologies, lasers, microscopes, precise optimal systems etc. was defined also by the microseismic level on the place where the equipment works. One of the methods of instrumental microzonation is based of measurement of the microseisms (which exist everyvhere and ever) in observation points and their statistical processing (2, 3).
The main purpose of this paper was to evaluate the character, level and regime of the highfrequency seismic noise on the site for building of factory for electronic elements (sensors). The collected data were used and for additional statistic evaluations of the soil filter properties and intensity changes on the site that helped the design of the construction.

2. RECORDING TECHNIQUE AND OBSERVATION METHOD

The aparatus for seismic noise registration was portacorder seismograph type RV-320 Teledayn Geotech with frequency band 0,2 - 50 Hz, amplification till 10^6, dynamical range 96 db and separate additional power. The testing and overall characteristics of the instrument was made by generator method.

For evaluation of the level and the time variations, the seismic noise was recorded during 2 minutes every hour as the registration was made in points along a certain profile at day and night. The experiment was from

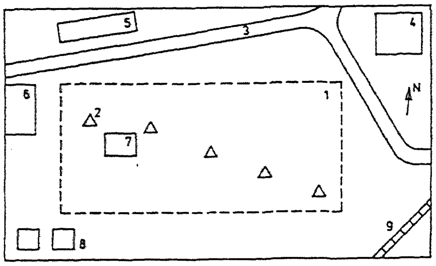

Figure 1. Plan of the investigated site: 1) site, 2) observation points, 3) roads, 4) industrial zone, 5)housing estate, 6) concrete corporation, 7) small building, 8) electro-mechanical workshop, 9) stand-by railway line

Table 1. Seismic noise components

Source of vibrations	Distance fromthe sources	Displac. ampl. [μ]	Freq. [Hz]	Prop. seism. waves
Transport (groundroad)	50m	0,5-3,0	1,5-3,0	P,S,surf. waves
Transport (asph. road)	20m	till 5,0	3-25	"
Industrial sets	10-300m	1-4	2-50	"
Microseisms (technogen.)	—	0,02-1,2	2-8	P-waves
Natural microseisms	—	0,2-0,6	0,1-0,3	surface waves
Industr. blasts	100km	1-2	2-4	S-waves
Earthquakes	5-100km	2-3	1-6	"
	upon 100	till 1	1-4	"

February till July 1986, and in all cases the seismometer was protected against direct wind effects. The plan of meašurements and the site is shown on Fig. 1.

The spectral analysis (FFT) was used and the results were represented in Tabl. 1 and on Fig. 2. The processing method was selected according to the type of the investigated seismic signals. For instance, for the constant microseismic background the spectra were calculated every 3 hours, for the signals from blasts, transport, earthquakes during the recording time for the industrial equipment signals when the signal was changed but not reare than 3 hours (6).

3. OBSERVATION, RESULT AND INTERPRETATION

All kinds seismic disturbances depend

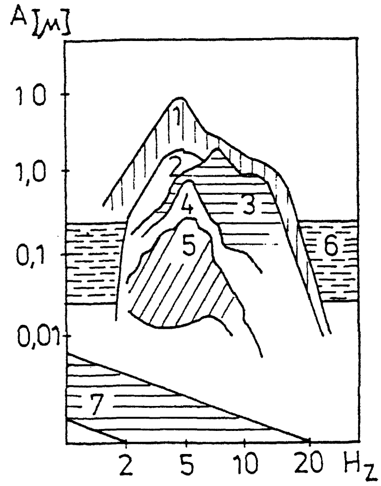

Figure 2. Spectral curves of the seismic vibrations from: 1. concrete corporation, 2 and 3. transport (20, 50 m), 4. blasts, 5. technogenic background (night, day), 6. average town noise (bibl.), 7. continental noise (bibliography)

very much on the observation point (geological deposits, remoteness of the transport, factories and seismogenetic zones), because of on every point of the definite region the seismic conditions are necessary to investigate (5).

The site of the electronic factory was with an orthogonal shape and was situated on alluvial quarternary deposits in the industrial part of the town. The 15 m depth boreholes, that were made, showed the general availability of loam deposit (0,3 - 12 m) with almost the same lift and a level of ground water 1,5 - 6,0 m (Fig. 3). To investigate the dependance between the microseisms amplitudes and geological-engineering condicions were made measurements along the profile (Fig. 1) in the night hours (Fig. 4).

The comparatevelly uniform geological borehole profile allowed to be evaluated the absorbtion properties of the surface soils according to the predominant microseismic periods and the changes of the intensity ΔI for the site according the described methodology (7).

Behaviour of the average and maximal values of the seismic noise for the hole investigation period along all the points of the profile are demonstrated on Fig. 5. The records of the similar grounds had almost

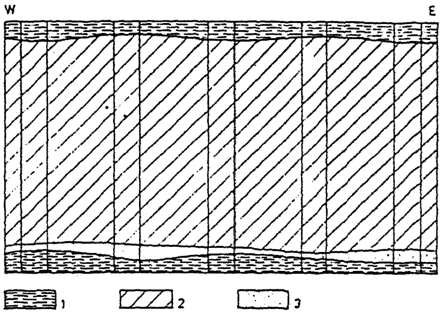

Figure 3. Geological data from boreholes: alluvial quaternery deposits: 1. loamy sandy ground (0,6–1,2 m), 2. watersaturated loamy ground (11,6–14 m), 3. sandy-gravel ground (0,4–1 m).

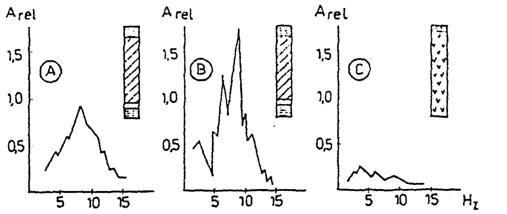

Figure 4. Geological cross-sections and spectral curves obtained in different ground conditions: a) deep ground water level (12–15 m), b)high ground water level (1,5–6 m), c) dry siennits.

uniform behaviour (differences 3–5 %) of the average and maximal amplitudes.

4. DISCUSSION

Industrial and transport seismic noises were the most intensice and their amplitude level got to 20 microns, as the most stable was 2 Hz peak. The spectrum of the background was composed from different type seismic waves and was influenced by the construction peculiarities of the buildings where the sources of the seismic disturbances worked. For the predominant frequencies 2–6 Hz the microseismic level changed night and day (0,02–4 μ), but the average level for the investigated period was 1–2 μ (Fig. 2 and Fig. 6). The

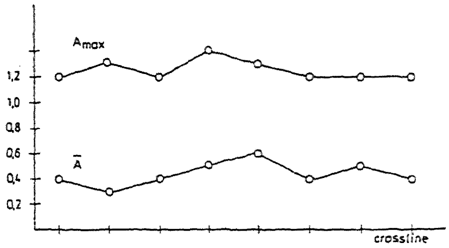

Figure 5. Amplitude curves of microseismic recorded on the profile.

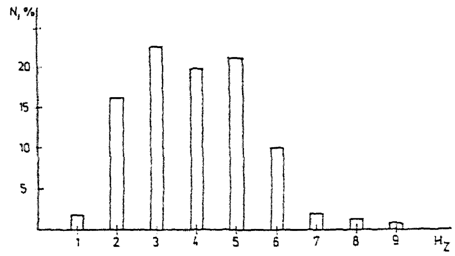

Figure 6. Distribution of predominant frequencies.

wind effects didn't influence the seismic noise spectrum which confirmed the technogenical origin of the high frequencies disturbances, their source was the industrial zone near the site. It was shown by the analysis that the microseismc were closely associated with the geological – engineering characteristics of the ground, which defined the increasing of the seismic effect with $\Delta I = +1$. This trend was filled out by the fact that the ground water hadn't a high level and the amplitudinal spectra on water-saturated loamy grounds were sometimes 2–3 times higher and according the Student criterion (8) the differences between the extracts on the standard and damp soil was not random (Fig. 7). The charts of amplitude distribution for different periods for water-saturated layers (sandy, loamy) are characterized by large number of pronounced peaks in wide range from 2–3 till 10 Hz.

The fact that the longitudinal waves from earthquakes and blasts could cause seismic disturbances with amplitudes up 1 μ was established, but those events were with short time duration for the technolo-

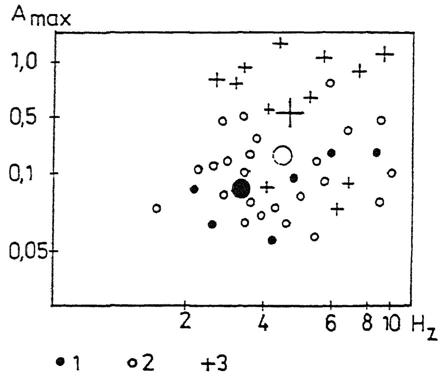

Figure 7. Correlation between the maximal microseismic amplitude and their frequency on: 1. dry grounds, 2. average geological site condition ($\Delta I = 0$), 3. water-saturated ground ($\Delta I = +1$).

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The transport noises are almost constantly high daytime, and their spectra depended from the vehicle and the quality of the road. The displacement amplitudes of the ground reached to 3-4 microns and their spectra were well recognized (3-25 Hz).

The described site as a place for manufacturing of electronic sensors and chips wasn't chosen successfully from the point of view of the seismic disturbances. Taking into account the technological requirements for the amplitudes of the seismic noise (till 1 micron) it is necessary to take additional steps for damping and resistant design.

5. CONCLUDING REMARKS

According to the microseismic investigation and the results can be drawn the following conclusions:

1. The microseismic noise amplitudes were high with values in daytime 0,1-3,0 microns, in range 0,2-5 Hz in this part of the Plovdiv town. The reasons for the increasing of the noise level (2-2,5 times) are the changes in the underground water level.

2. The results of the seismic disturbance investigations in the range 0,2-25 Hz showed comparetively high amplitudes 1,5-3,0 microns, in the range 2-5 Hz and in the cases with high level of the underground water the increase was 2-2,5 times.

3. Additional special steps for damping of seismic signals penetrating in the fundaments and the equipments of super precise technologies are necessary.

4. The general part of the energy of the microseisms is in the range 2-5 Hz, which defined the filtering properties of the soil and the microseismic activity reach IXth degree.

The investigation was sponsored through an agreement No. 236/1985 with the Department "Investment building" of the Sensor Factory in Plovdiv.

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