

30 Mar 2001, 10:30 am - 12:30 pm

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Recommended Citation

Iddir, Rabah and Laradi, Nadir, "Evaluating the Response of Soils to Seismic Tremors by Recording Background Noise" (2001). *International Conferences on Recent Advances in Geotechnical Earthquake Engineering and Soil Dynamics*. 23.

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EVALUATING THE RESPONSE OF SOILS TO SEISMIC TREMORS BY RECORDING BACKGROUND NOISE

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ABSTRACT

At 29/10/1989, Tipaza's region situate in the west of Algiers, was vibrated below a Chenoua earthquake. A distance between the centre of this earthquake and Algiers the capital, wasn't a to make a damage for the constructions (Casbah, Bab El Oued, Hamma, Tagara...). Because this one is dating for the colonial era, and haven't a para-seismic structures. Then determination of zonal effects is one of the essential components of para-seismic prevention, having recourse to macro-zoning. The conventional method of measuring zonal effects experimentally is based on seismic recording. It is admittedly reliable, but it is laborious. We suggest in this paper an original method evaluated, here consists of recording a few minutes of seismic background noise on a site and establishing the spectral ratio of the horizontal path to the vertical one. It is thus an economical method of mapping resonant frequencies and thereby gaining a better knowledge of seismic risk in sedimentation basins.

Key words: Soil – Background noise – microzoning – Frequencies – Ratio H/V spectra – Geomorphology.

INTRODUCTION

Earthquakes are all demonstrations of the geodynamic of the planet, probably; those that marked the popular conscience so much their destructive aspects are big.

The geological nature of the Maghreb region, that is located in the limit of two plates the African and Eurasian, is tectonically unsteady.

This natural phenomenon of plate instability, has been confirmed these last years by the activity of earthquakes, in cities of Chlef, Tipaza, Constantine (Algeria), Agadir (Morocco), permits to say that a lot of our cities are not shelter to the seismic risk. It is therefore, necessary, to protect them, while leading studies, in order to warn seismic risk.

THE SITE ALGERIA

Algeria is submitted to intense seismic activities with as

prejudicial important human and material loss results not only to individualities and local administration, also put in country all whole.

This seismic activity is owed to the geological nature of the Maghreb region and its tectonic features mainly to the African plate border and Eurasian, in permanent movement,

GEOLOGICAL CONTEXT AND TECTONIC OF THE NORTH OF ALGERIA

With studies established notably by Durand-Delga (1969,1980), and Wildi (1983), De Coutelle-Duée (1984) and Belhi (1987), defined principals features of certain geological structures of the North of Algeria and that, with regard to the tectonic alpine. These structures called from the Maghreb are only elongation dynamic of the alpine chain and are constituted of the internal zones, the external zones and flyschs.

PRINCIPLE METHOD

The observation of earthquakes often showed that the seismic aggressiveness can be amplified by the local geomorphology conditions. These effects of site can be bound to phenomena of wave resonance between formations of cover pieces of furniture surmounting some rigid lands (the most famous case is the one of the centre of the Mexico City, constructs on a clayey basin). Other morphological profiles can provoke amplifications of vibrations, as of reliefs very accentuated in which the sudden seismic signal of fortes modifications. Whatever is the reason, these amplifications appear in the own frequency ranges to every site.

This frequency as well as the level of the amplification (or the attenuation) with regard to the substratum is some very important elements to know in the setting of prevention para-seismic. Their knowledge permits a better definition of the movement waited on a site and therefore a better adaptation of the structures resistance. Therefore the seismic site effect translated the amplification (or the attenuation) according to the frequency that sudden a seismic wave at the time of crossing of the last ten of meters of its propagation, of by the nature and the structure of soil.

In this mind of reflection an original and faster technique that the existing usual methods:

- Numeric Modelisation
- Classic method by registration of the seismically

Used for the determination of site effects has been proposed by Nogoshi and Igarashi (1970 and 1971), justify and stake in evidence by Nakamura (1989), validate experimentally by Duval (1994), and lately to apply on the site of Tunis in view to raise its map of microzonage (Bouden-Romdhane and Mechler, 1998).

PRESENTATION OF THE NEW METHOD H/V BACKGROUND NOISE

The principle of this method is to put in value features of the modification of the seismic signal for a site, the strip of frequency concerned and, of more hypothetical way, the level reached by the amplification.

- The nature of the seismic bottom noise is an ask question since a long time. The atmospheric disruptions on oceans propagate itself on the surface of the terrestrial crust are to the origin of the long periods that composes the noise about until 5 seconds presumably,
- While vibrations owed to the human and industrial activity form the part higher frequency, called Microtremor. The tape-recording of noise in network showed that these vibration higher frequencies were composed of surface waves (Rayleigh and Love).

Historically, the first method consisted in interpreting the spectre of Fourier of the noise directly records on a site and to achieve a classification. The signal of entrance is considered white noise modified by surface lands. The second type of utilisation of the noise got on any site by the one reached on a station or the rock.

In this case, the signal to the rock is considered like signal of entrance.

The Justification of the method by Nakamura, and the recent numeric models that they come closer explanations given by Nogoshi and Igarashi conclude that the noise of bottom used in this method is composed of surface waves.

SIGNAL TREATMENT

The "H/V method background noise" requires the count of the spectre of the different composantes of the background noise recorded. These spectres must be inevitably middle and must smooth. The sequence of treatment is therefore the following:

- Restoration of the real signal by deconvolution of traces,
- Automatic Selection of windows to treat from an adjustable doorstep,
- Application of a function of apodition of Hannings to adjustable rate,
- Adjustable Recovery of windows in functions of the rate of the apodition,
- Count of the three-trace spectre and pass-low smoothing of these,
- Count of the average spectre.

Then results are represented by methods of interpolation and the graphic representations adopted for zoning geotechnic (frequency and amplitude of pick).

STABILITY STUDY OF THE BOTTOM NOISE

The first condition of validation of the "H/V method background noise" concerns its stability in the time and in the space (studies have been made by Duval, Meneroud, Vidal and Bard, 1996, BLPC, in Nice, Monaco,...).

TIME STABILITY

The background noise is records to the means of speed three-directional sensors, during 40 Seconds regularly, simultaneously by all stations of study, on one same site, to different moments of the day or the night. The frequency of sampling of the acquirement was 125Hz (for the site to study). Stations were spaced of about ten meters in one same site. The period of working of the whole of the network varied between 1 to 3 days by site.

The spectral amplitude has been calculated for every registration by Fourier transformed. The middle level of the spectre varies the simple to the triple between the two periods. Yet, no noise was generated unless 50m for this site.

On the other hand, the H/VS reports (average vertical spectre) done from these spectres give results that can be considered as particularly steady, until 10-15 Hz. A pick especially detaches itself to 1,7Hz in the ratio descended H/VS of this site (the frequency to which distinguishes itself this pick varies with sites).

The difference between results of day and night disappears.

- This result has the tendency to show that "the H/V report background noise" is relatively steady in

the time, even when the spectre itself varies (that is the level of noise).

Space Stability

To study the spatial stability, several stations have been arranged, to increasing interval of 5 to 15 ms since the central station. Report middle H/V is calculated by station of registration from numerous registrations. The H/V reports give some similar picks, to the same frequency precisely, except for a station that points a frequency a little higher (2,1Hz). It is interesting to notice that this station was most distant of others in the alignment: common geotechnic conditions for the other stations are maybe slightly different for the one there.

- For the other studied sedimentary sites, when geotechnic conditions of surface are homogeneous, the H/V curve background noise proved out to be steady in the space on distances of the order of 100m.

SPATIAL INTERPOLATION

Examples to study show the adaptation of the method to needs of para seismic engineering, at less to define the frequency of resonance. What brought to pull left of its advantages to put in room a new technique of microzonage.

These advantages are:

- Not expensive cost
- Speed of execution
- Establishment of an important number of measures (as dense as wished);
- The precision in frequency of the definition of the resonance picks.

CONCLUSION

The experimental evaluation of "the H/V method background noise" brought to do numerous studies. Comparisons between the descended different method results permit to conclude:

PARTICAL CASES

FOR CASES OF NICE AND MONACO (SITUATED ON PLATE EURASIAN)

The spectre of the bottom noise can vary very extensively in the time on a site. On the other hand, the report spectral "H/V background noise" gives, on sites of sedimentary type, a steady curve in the time and own has every site, if on top of it is the result of the average several measures and that one avoids the too near noises.

For sites to strong mechanical contrast (sediment pieces of furniture on rigid substratum), the report spectral "H/V background noise" delivers a clean pick, centred to an own frequency to every site.

Modelisation and/or functions of transfer established by

seismically registration permit to identify this frequency to the frequency of resonance of the site.

When for no modification of the signal is not waited on a site, the report spectral "H/V background noise" remains in near general of the unit.

For the whole of sites to study, we can practically still to bring closer the main features of "the H/V background noise" curve a site of its frequency answer to earthquakes.

FOR THE CASE OF TUNIS (SITUATED ON THE NORTH AFRICAN PLATE: THE MAGHREB)

This first approach of seismic site effects for sites to study has confirms the interest of the method. It is important to already underline the very good stability in the space of results as well as interrelationships with geotechnical models existing or get up for needs of the survey, as geotechnical and the "H/V background noise" maps.

- The good stability in the time of measures,
- The good stability of the spectral report, even though the previous experiences could have dispensed us to verify them this points;
- Measures on the land have can be achieved in one very short time, (some weeks), with a relatively light equipment (piloting of the countryside by microcomputer) permitting a big reliability of measures and a first fast interpretation.
- This experience shows that it is possible, even with the limited materials, to acquire the necessary data to a serious microzonage.

In conclusion we will note that our colleagues French and Tunisians agree all two that this method is:

- Very reliable in the development of macrozonage maps,
- Little expensive,
- Not requiring a higher technology nor heavy materials,
- And besides it takes place in one record time.

RECOMMENDATIONS

No scientific or other method does permit to foresee the imminence of an important earthquake, in a place data with a sufficient probability.

But for Algeria, a country in way of development, and a sensible economy to all change, new natural disasters don't pass without sometimes indenting the development for a certain number of years. That makes that, the "H/V method background noise" is more adequate (seen advantages that its presents) for studies of its seismic regions while raising maps of microzonage and considerate the seismic risks by:

1. Determination of zones exposed to the superior magnitude earthquake to 5 (ladder of Richter);
2. Reinforcement and calculus of constructions and existing and future facilities against fragility;
3. Devices of protection and existing help either planned.

As in the measure where effects of site will really be taken in amount at the time of the calculus of works, the "H/V

background noise method" will be able to find numerous utilisations in the future. Measures of the noise being relatively little expensive, they can be as much denser. The method can be applied therefore for the establishment of Plans of Risk Prevention to specify frequencies of sedimentary site resonance, as well as to define the spatial extension of phenomena of site effects. The proposed spatial interpolations, as well as the integration of results in the geographical information systems will permit a better utilisation of studies.

REFERENCE

Bouden-Romdhane, N, Mechler, P. (1998). Etude du bruit de fond sismique en vue d'un microzonage sismique de la ville Tunis , Bulletin des Laboratoires des Ponts et Chaussées, N°213.

Duval, A-M, Meneroud, J-P, Vidal, S, Bard, P-Y. (1996). Une nouvelle méthode d'évaluation de la réponse des sols aux séismes par enregistrement du Bruit de Fond . Bulletin des LPC, N°203.

Pomerol, C., Renard, M. (1997).Eléments de Géologie, Ed Masson.

Ministry of the habitat, C.G.S, « Rapport final sur le Séisme du Chenoua du 29/10/1989 », December 1995.

Ministry of the habitat, C.G.S, [1998] Le Risque sismique.