Microtremor Observation for Local Site Conditions

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ABSTRACT

In this investigation microtremor recordings were conducted in three individual sites at Baghdad city. Three components of digital seismic recording system was used. The measurements were carried out in the frequency range of (1-10) Hz. Recording data were exposed to two types of analytical techniques. The first to their predominant frequencies, the second uses amplitude ratio of spectra obtained by point measurements. The results of analysis revealed that, the predominant peak frequencies in the spectral analysis are in the range of (3 - 5) Hz. This fluctuation may be due to local soil condition. The amplification characteristics in the form of spectral ratio for the three sites were also computed.

الاهتزازات الأرضية الدقيقة لظروف الموقع المحلية

الملخص

تم في هذا البحث قياس الاهتزازات الأرضية الدقيقة لثلاث مواقع منفصلة في بغداد . واستخدمت منظومة التسجيل الرقمي للزلازل وبثلاث مركبات . أنجزت القياسات بمدى ترددي (1- 10) هرتز. أخضعت التسجيلات إلى أسلوبين من التحاليل ، الأول باستخدام التردد السائد والثاني بالاعتماد على النسبة الطيفية للسعة . أظهرت نتائج التحليل الطيفي ، إن التردد الغالب كان ضمن المدى (3-5) هرتز ويعود هذا التذبذب إلى ظروف الموقع المحلية كما تم حساب الصفات التكبيرية للمواقع الثلاثة على شكل نسبة سعة طيفية .

INTRODUCTION

Microtremor is defined as the continuous low amplitude vibrations of the ground, which can only be detected by highly sensitive seismographs (Kishinouye,1960). They originate from the artificial vibrations such as traffic, operation and heavy machines as well as sources such as wind, rain flow, sea waves. The nature and characteristics of microtremors are very complex, since they represent a group of seismic waves originating from different sources surrounding the site of observation, (Allam, 1970).

Microtremor observation has been utilized in seismic and non-seismic areas as an effective tool to estimate local geological and soil conditions. A limited studies have been carried out and published in Iraq. According to Mahmood et al, (1988,) , microzoning of Baghdad Metropolitan area was studied. Alridha, (1996) was performed microtremor measurement at Adhaim dam site.

The purpose of this study is to show the effect of local soil condition in terms of microtremor observations and their predominant frequencies.

GEOLOGICAL CONSIDERATION OF BAGHDAD SUBSOIL

The subsoil in Baghdad area have been derived from three districts, namely, lower Mesopotamian plains, the desert area, and upland deposited by Tigris and Euphrates rivers which are extremely Calcareous (20-30)% lime and saline, (Buringh, 1960). The desert soil consists of limestone and gypsum rich soils. Most soils in Baghdad area are therefore secondary soils derived from the above regions, transported from place of weathering and accumulated as a result of sedimentation.

Three stratums have distinguished in Baghdad, Recent, Cohesive, and granular strata. The recent stratum comprise soft or firm but occasionally stiff clays with variable proportions of brick, pottery and bone fragments. The cohesive strartum generally comprises stiff to very stiff clays with presence of sandy clays and silty clays.The granular generally comprises a medium dense to dense silty fine and medium sand which is sometimes silty to gravelly, generally fine and occasionally medium sub-rounded gravel being present. Zones of more gravelly material vary in thickness up to 8m but generally occur at depth greater than 30m, in same cases the gravel comprises pellets of hard clay, (NCCL, 1986).

MICROTREMORS MEASUREMENTS

Measurements of microtremors were conducted at three locations in Baghdad, these are: Jadria, Dora, and BabAl-Muadham. Three components digital recording system was used with (10-15) minutes recording time was chosen for each location. Because of microtremors are highly affected by direct disturbances such as heavy traffic, wind etc, it is necessary to carry out their recording during quiet and windless time in order to minimize noise sources bearing in mind that recording should be made as far away as possible from artificial noise effects, (Kobayashi et al, 1986 a & b, Seo, 1986).

The locations and date of recording are given in the following Table

Locations	Date	Time
Jadria	14 April 1997	11:00:00
Dora	7 May 1997	10:50:00
Bab Al-Muadham	7 May 1997	12:00:00

DATA ANALYSIS

Fourier velocity spectra with Parzens lay window were computed by FFT for set of measured records. The duration of each set is taken as 16 seconds and the sampling interval is 0.02 seconds. Fourier spectra as a result will be evaluated with two horizontal components and with geometrical average to avoid impulsive noise. Some results are shown in Figures 1, 2 and 3. From these Figures, the predominant frequency is deduced

as (3-4)Hz for Dora and Jadria while a broad spectrum (3-5) Hz reflecting the third location, (Bab Al –Muadham).

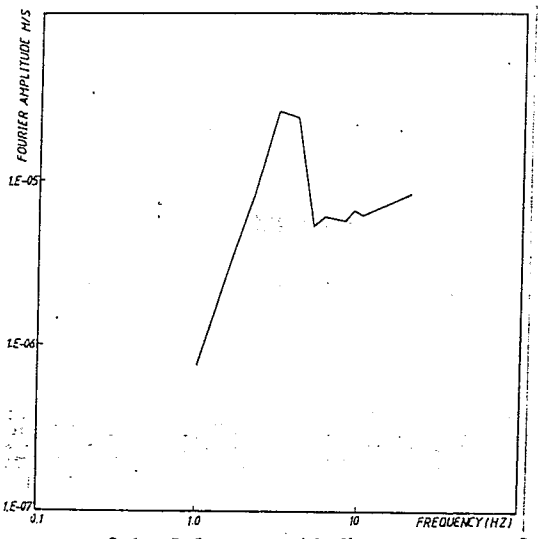

Fig.1: Fourier Spectra of the Measured Microtremors for Dora

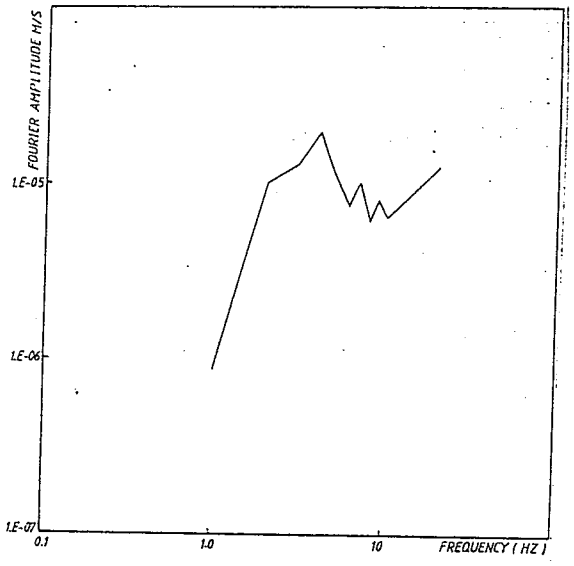

Fig.2: Fourier Spectra of the Measured Microtremors for Jadria

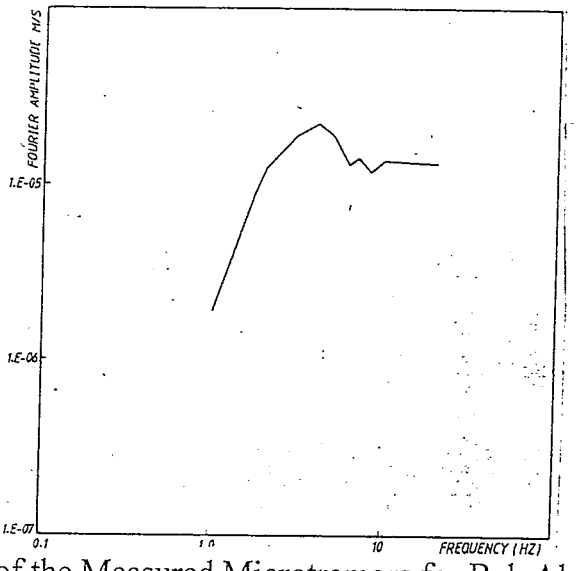

Fig.3: Fourier Spectra of the Measured Microtremors for Bab Al -Muadham

DYNAMIC PROPERTIES OF SOIL

The dynamic characteristics of surface layers deduced from the microtremors are used for the determination of the coefficient of ground relating to earthquake proof consructions, (Tanaka, 1982, Seo, 1991, 1994).

In order to find the amplification functions of the stratified layers for each location, spectral ratio method was applied for this purpose. The method uses vertical and horizontal components. As a result of this, the spectrum ratio of the horizontal and vertical components of microtremors resembles that of transfer function for horizontal motion of surface layers. It means that the transfer function of surface layers may be estimated from the tremor on the surface only, (Nakamura, 1989).

Figure 4 shows spectral amplitude ratio of microtremors for three locations in Baghdad, the amplification characteristics during earthquake may be evaluated from this figure. The amplitude ratio seems relatively high at the predominant frequency of 4 Hz for Dora and Jadria locations, at the third location(Bab Al-Muadham), the spectra are scattered with frequencies ranging from (3-6) Hz.

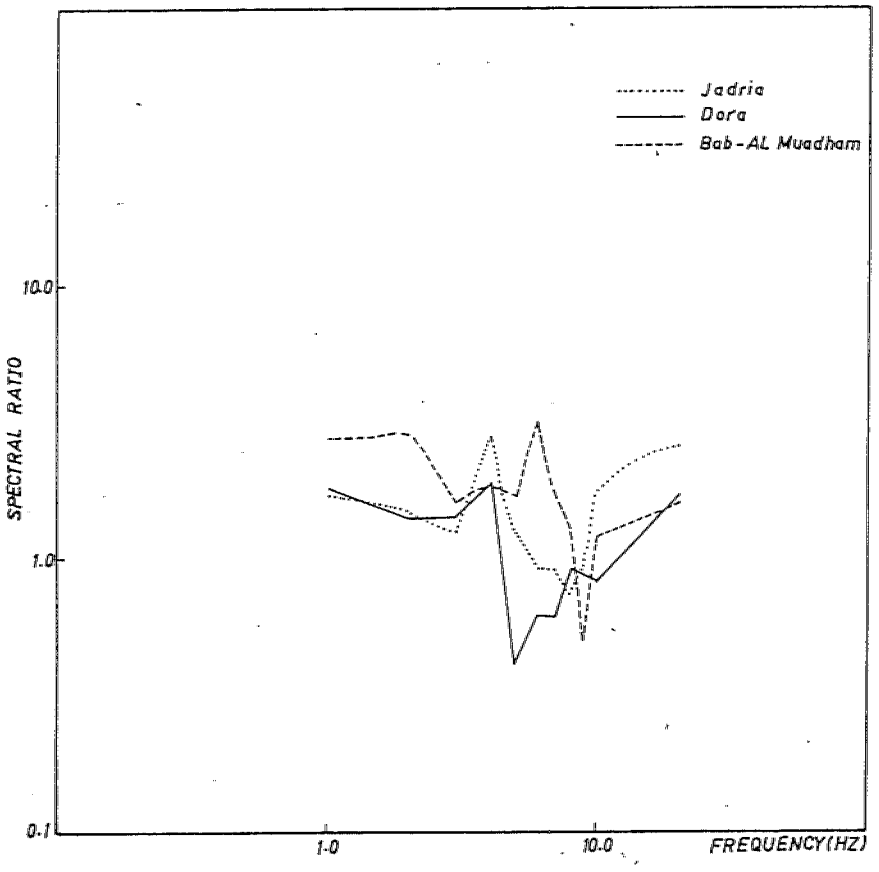

Fig.4: Spectral Amplitude Ratio of Microtremors

DISCUSSION AND CONCLUSIONS

It was found that every site has its own frequency characteristics, which is strongly related to local soil conditions. The uniformity or irregularity of curve greatly depends on complexity of soil structure. When the lithology of a soil section is simple, the resulting vibration characteristics are simple. On the other hand, the existence of complex layering of sub-soil gives rise to irregular curve, (Yazia, 1982).

Local site conditions at Baghdad were carried out by means of microtremor measurements, Dora and Jadria locations show clear peaks around (3-4) Hz which reflect the soil condition of these two locations composed mainly of very stiff to hard silty clay and very dense grey silty sand.

The third location (Bab Al-Muadham) has abroad spectrum scattered around 3, 4, and 5) Hz which reflects soil characterized by soft to stiff clayey silt with little sand, and loose to medium silty sand. Regarding the spectral amplitude ratio of microtremors, amplification factors during earthquake can be estimated as several times at the predominant frequency of 4 Hz for Dora and Jadria locations and (3-6) Hz for Bab Al-Muadham.

RECOMMENDATION

More investigations are still required in the field of mathematical modeling of the subsoil layers in order to give a clear picture to the response of subsoil during earthquakes.

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