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Research Article

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Geophysical Studies in Soil Investigations

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Abstract The contributions of geophysical engineering in soil studies are very important. Geophysical studies are extremely important, especially in areas with earthquake risk, both in construction and in settlements. This study was carried out in order to find out the ground parameters in Istanbul-Esenyurt province and to determine the inequality. The methods used in the study are the MASW, micro tremor and laboratory experiments. The MASW technique is an improved method for obtaining the shear wave velocity of shallow layers. It is also the name of all kinds of vibrations that exist in the ground, except for short-term earthquakes or explosions. As in earthquake seismology, the spectrum of a noise measured in the field consists of the characteristics of the source causing the noise and the ground structure characteristics of the land from which the measurement is taken. The site effect is important in engineering seismology because it can cause amplitudes of seismic waves to increase during an earthquake. Later on, drillings were made where necessary to obtain information about the soil parameters.

Keywords MAW, micro tremor, laboratory experiments, Esenyurt-Turkey

1. Introduction

In the case of earthquakes, residential areas may exhibit different behaviors in spite of the same ground, the same building materials, even the same people. In these settlements, the buildings are heavily damaged or moderately damaged, and there is no damage to the buildings next to or around the buildings. Geologic, geological and geophysical investigations have been carried out by many researchers in order to reduce the damage of structures in earthquakes due to the random distribution of earthquake heavy damages. In the 1985 earthquake in Mexico City, the earthquake struck the very center of the city, 350 km from the center. The great damage in the area can be explained by geophysical methods including deep investigations that it is a deep canyon below the city center [1]. have used geophysical methods to investigate geological structures and to calculate the physical parameters of rocks [2]. In addition to geophysical methods, engineering parameters are taken into account in studying the soil structure in geotechnical studies. Severe damage zones in the Kobe earthquake of 1995 were explained by the fact that the folds of the seabed which can be detected by seismic measurements are caused by earthquake focusses on the propagation path of earthquake waves [3]. It has been found that the mechanical properties of the rocks are closely related to the ultrasonic velocity and rock properties [4, 5, 6, 7, 8]. Earthquakes in recent years have shown that significant damages and loss of life are directly related to the impact of local ground conditions (for example, Michoacan Mexico 1985, Northridge 1994, Kobe 1995, Chi-Chi Taiwan 1999, Kocaeli and Düzce 1999, Sichuan China 2008, Christchurch). -New Zealand 2010, Van 2011, Elazığ 2020, İzmir 2020, Elbistan 2023, Pazarcık 2023). Although there are other factors affecting the damage and loss of life caused by earthquakes (ground motion characteristics, liquefaction and structural deficiencies, etc.), ground motion amplifications due to local ground conditions play an important role in increasing seismic damage. Although Ankara is relatively far from major fault systems (approximately

75 - 100 km), it is considered that it should not be considered safe in terms of earthquake hazard. For this reason, experimental or theoretical conformity is used between various physical and mechanical properties of rocks to obtain special design parameters of rock mass.

2. Method

The MASW method developed by [9] is used to obtain the one-dimensional S wave velocity from the inverse of the transformed phase velocity of the S wave, which has a dominant effect on the generation of Rayleigh waves in a layered soil model [10]. MASW, which is carried out using an active seismic energy source, basically consists of three stages. These are data acquisition, dispersion curve generation and inversion operations. The equipment used in data acquisition is essentially similar to seismic refraction equipment. However, low-frequency geophones (4.5 Hz) should be preferred in order to record surface waves well [9, 11, 12, 13]. Another issue to be considered in data acquisition is the receiver range and offset selection. In this choice of wavelength, the profile length determines the depth of search associated with the largest wavelength that can be recorded, and the geophone spacing determines the resolution associated with the smallest wavelength [13, 14]. If the geophone spacing is dx, the greatest exploration depth is Zmax and the distance between the first geophone and the last geophone is X; It is recommended that the geophone range be less than one-tenth of the greatest exploration depth ($dx \leq 0.1*Zmax$). Near offset should be half of the greatest search depth to avoid effects from near field [13, 15]. The total paving length should be calculated as greater than or equal to the greatest exploration depth ($X \geq Zmax$) [13, 16]. The other process to be applied to the data recorded in the time-distance (x-t) environment with linear expansion is to transfer the data to the frequency-phase velocity (f-Cf) environment with frequency wavenumber conversion (f-k) as defined in [11]. This transformation makes it possible to observe the frequency-phase velocity relationship in the recorded surface waves. The aim here is to obtain the Rayleigh wave dispersion curve in which the phase velocity changes with frequency. The selection of the dispersion curve is one of the most important steps in obtaining the shear wave velocity. In this step, the phase velocities of the ground roll wave are calculated from the slopes of the records at each data acquisition point in the frequency domain. The last step of the method is the inversion of the dispersion curve consisting of Rayleigh wave phase velocity-frequency pairs. The dominant effect of the S wave velocity on the Rayleigh wave phase velocity will result in the S wave velocity versus the depth profile as a result of the inversion process [9, 10, 13].

Sources of microtremor; rotation of the earth in a certain axis, tidal effect, geothermal activities, underground seismic activities, atmospheric effects, wind and cultural noises. (traffic, industrial activities and some other anthropogenic effects). All these factors can be perceived as vibrations on earth. The amplitudes of these vibrations vary between 0.1 micron and 1 micron, and their periods vary between 0.05 seconds and 2 seconds. These are mostly industrial machinery, traffic, earthquakes in the distance, etc. due to factors such as Due to the source types, the daytime is more active than the night, and the waveforms are irregular. Depending on the geological structure, vibrations in some periods are dominantly observed. The first of the parameters aimed to be found in these methods is to find the ground dominant vibration period. Some periods of earthquake waves reaching the environment during an earthquake are more dominant. These seismic waves in the dominant period are the waves that most affect and damage the structures on earth. By examining the very small amplitude natural emissions of the place, the effective oscillation periods of the place can be determined and in this way the behavioral characteristics of the place can be determined. In this case, regional location classifications can be made according to the parameters to be obtained by utilizing these natural vibrations of the ground. Very small horizontal or vertical vibrations (microtremor) on the ground, which can be caused by various reasons, can be recorded in the form of acceleration, velocity or displacement with the help of special vibration meters (seismometer) [17].

In order to determine the seismic velocities (P and S), thickness and dynamic engineering parameters of the basement rocks in the study area, a seismic fracture study was carried out along 1 profile. P wave - active source surface wave is made from seismic refraction method. In the studies, 8 kg 4.5 hertz vertical geophone and PASI brand 16SG-24N (24 channels combined instrument and electrical imaging) model recorder with spreading cable were used as seismic source. Sledgehammers were used to send signals. 3.00-2.00 m in seismic studies.

By choosing the geophone range, two shots were made, the first and the last of the season, and 12-24 channel recordings were taken. The offset distance in head and tail shots is 6-4 m. the total length of one profile (including offset) is 39-50 meters. The number of sampling records is 256 milliseconds, and the record length is 1024 ms.

3. Real Data Application

The study area is located in Istanbul-Esenyurt region (Figure 1). The regional base rock forms the Paleozoic (Carboniferous) Thrace Formation, which does not outcrop in the study area. The greywacke and clayey schists, which are the main lithological units of this formation, were formed from rough breaks with a slurry of turbidite sediments in deep marine environments (Figure 2). The general structure of the massif determines the normal fault systems. The most effective and the most effective of these fault systems extending perpendicular to each other are the NW-SE-oriented normal faults starting from the Bulgarian border and reaching the Sea of Marmara from the Çatalca coast. The second system is the NE-SW directional faults cutting and shifting them perpendicular to these faults.

Figure 1: Working area.

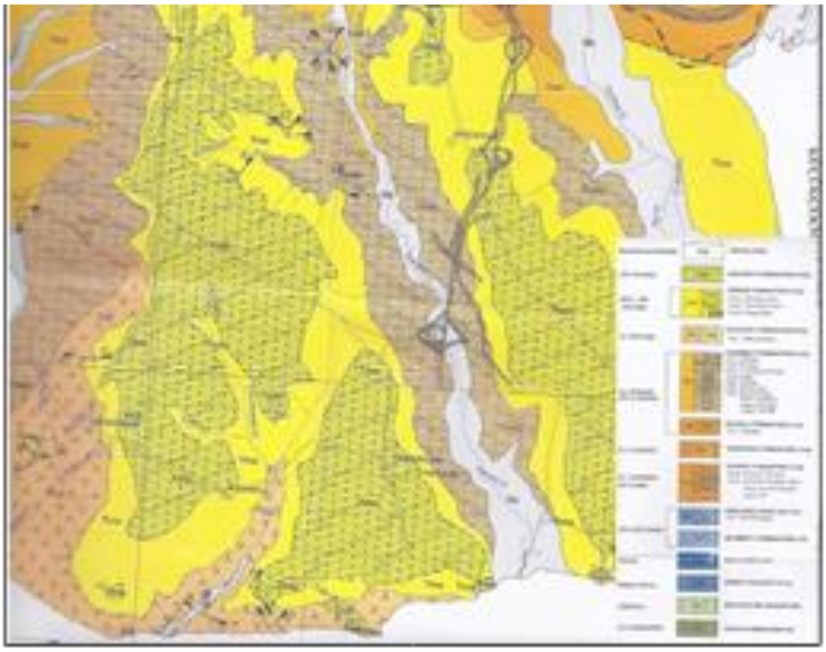

Figure 2: Geology of the study area (MTA)

4. Seismicity of the region

Istanbul and its surroundings have an extremely important potential for our country in terms of social and economic aspects, but is one of the regions with the highest risk in terms of earthquakes. This risk becomes clearer when the earthquakes that have occurred in the past are examined. The main reason why the Marmara Region has been a region where damaging and destructive earthquakes have been encountered throughout the ages is that a significant part of the North Anatolian Fault Zone (NAF) is located in the Marmara Region.

It is located in the sea. The formation order and westward migration of important earthquakes on the NAF were observed semi-systematically after the 1939 Erzincan Earthquake, and its westward rupture continued with the 1967 Adapazarı-Mudurnu Suyu Valley Earthquake, and finally the 1999 Gölcük-East Marmara and Düzce Earthquakes (Figure 3).

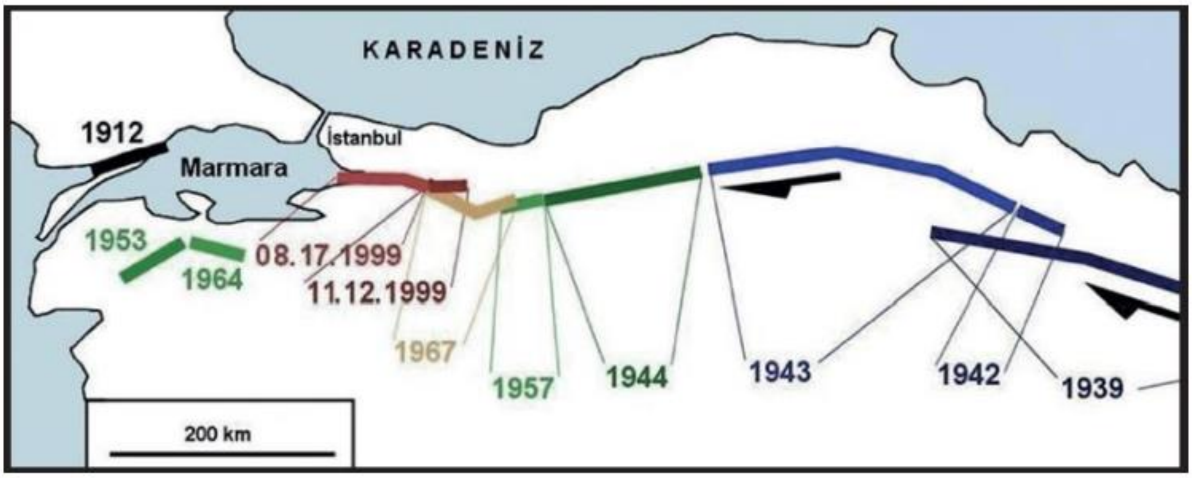

Figure 3: Westward Migration of Great Earthquakes After the 1939 Earthquake [18]

5. Result

Period consists of natural or artificial factors, earthquakes with a period of 0,05-2 s (Ercan, 2001). The number of repetitions of a certain period in a given position is the maximum. The period with maximum repetition is defined as the dominant period (Kanai, 1984). The dominant vibration period of the survey area is given in Table I. Depending on the period of the ground vibration prevailing; the lower vibration period Ta = To / 1.5 and the upper vibration period Tb = To * 1.5 are calculated (Table II).

Table I: Layer Thickness of Units in the Examination Area [19]

	1. Profile	2. Profile	3. Profile	4. Profile	5. Profile	6. Profile
1. Layer	3,14	4,03	3,89	2,88	5,21	4,78
2. Layer	14,15	27,28	19,48	19,48	16,37	15,02
3. Layer	--	--	--	--	--	--

Table II: Dominant Vibration Periods of Units in the Examination area [19].

	1.Profile	2.Profile	3.Profile	4.Profile	5.Profile	6.Profile
To(sn)	0,45	0,53	0,36	0,3	0,29	0,52
Ta(sn)	0,3	0,35	0,24	0,2	0,19	0,35
Th(sn)	0,68	0,8	0,54	0,45	0,44	0,78

The bearing coefficient is resistance to unit displacement of the unit area of the floor under load. The bearing coefficient (kV) is calculated from the nearest approximation of the pressure-settlement curve using the largest possible plate diameters from the near-elastic properties of the floor. The calculation of the vertical bearing coefficient according to Bowless, 1988 in the study area is as follows. 15.0 m Vertical bed coefficient Ks = Qa x 40 x Gs 2,655 kg / cm2 = 26,55 tons / m3 ks = 40 * 3 * 26,55 = 3186 tons / m3 = 31860 kN / m3). For the clay unit at depth of 15.00 m in the study area, vertical bearing coefficient is recommended as 3100 ton / m3 when it is correlated with seismic records [19].

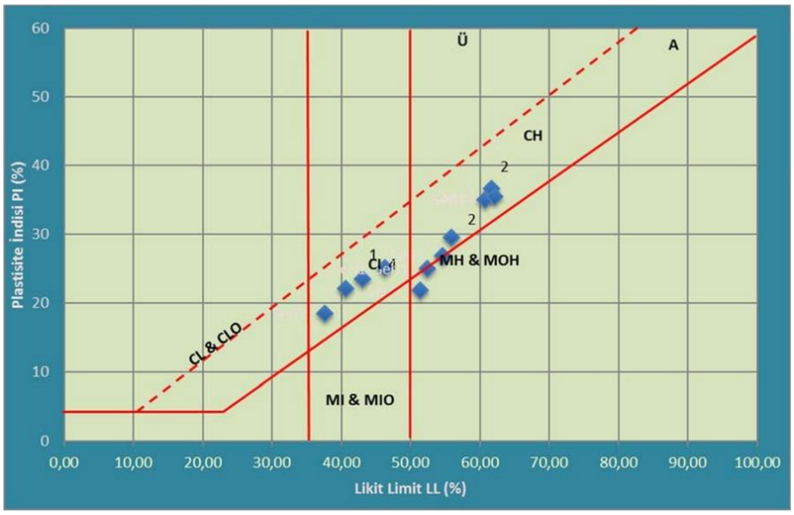

Figure 4: Ground Classification Table According to Consistency Index [19]

According to Atterberg Limits; Evaluating the silty clay taken as representative of the region according to the Combined Soil Classification; it was determined that the silty clay under the vegetable soil is predominantly in the group "CI-CH". CI-CH group floors Plasticity is defined as high inorganic clay, gravel clay, sandy clay, silt clay, weak clay. Environment and basic drainage should be done in order to prevent damages to the building bases of the leaking waters due to seasonal rainfall, and grobeton should be laid under the foundation [19].

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