MICROTREMOR STUDIES IN ADAPAZARI, TURKEY

by
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SYNOPSIS

For the purpose of studying the predominant periods of soft ground, microtremor records have been taken and analysed at seventeen stations mainly in the alluvial grounds of Adapazarı, Turkey. Predominant periods of the records are somewhat correlated with the subsoil conditions since, no general conclusions could be reached, further studies are recommended.

INTRODUCTION

It is clear from observational and theoretical studies that earthquake damage to a structure is increased considerably as the natural period of the structure comes closer to the predominant period of the underlying soil. Based on various acceleration records in Tokyo and Yokohama, Ishimoto found that each soil has a predominant period of earthquake motion peculiar to its own characteristics. Kanai demonstrated that at a number of sites the period distribution curves of microtremors and strong motion earthquakes coincided closely with each other.

The studies described in this paper are about the microtremor readings recorded at seventeen stations of different subsoil characteristics in the northwestern area of Turkey. Particularly, the stations were selected in the vicinity of buildings which suffered heavy structural damages during the July 22, 1967 Adapazarı and March 28, 1970 Gediz earthquakes. The lithology of subsoil at these stations were obtained through the bore hole tests and resistivity studies conducted by the Turkish State Water Works Department (DSI) in previous years.

INSTRUMENTATION AND SITE CONDITIONS

For measurement of microtremors, a three-component portable velocity seismometer and a Servogor model mechanical recorder were used under the guidance of a team supplied by the Kandilli Observatory of Istanbul. As seen in Fig.1, ten of the records are taken on the alluvial formations of the Sakarya river downstream basin. Additional records are taken at the ground and roof levels of several reinforced concrete buildings. The two horizontal components of measurements are selected to coincide with the lateral and longitudinal axes of the buildings, which had collapsed during the Adapazarı earthquake. Records No. 12 and 13 are along the İzmit-Bursa State highway, on an alluvial ground overlying deep layers of clay (Fig.2). One set of microtremor readings is also taken at the site of the Ortaköy anchorage of the Boğaziçi Suspension Bridge in Istanbul. The location, recording time, and calculated

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predominant periods of each site are summarized in Fig.3. A set of representative geological profiles are also given in Figs.4 and 5.

DATA PREPARATION AND SPECTRUM ANALYSES

The microtremor records traced by the Servogor recorder on milimetric paper with a speed of 1 cm per second are digitized under a magnifying glass at half milimeter points corresponding to a time interval of 0.05 seconds. A 60 cm length of record, representing one minute of recording time, is digitized visually at 1200 data points for each of the three components at each station. The spectrum curves, obtained from the Power Spectral Density and the Acceleration Response Spectrum analyses are plotted against the undamped natural periods within a range of 0.2 to 1,5 seconds. The frequency of period distribution curves are also plotted, using Kanai's method of zero crossings. The predominant periods determined by each of these three methods are generally in good agreement. Some sample spectral analyses results are given in Figs.6 to 10.

The microtremor records were also taken at different times with different sensitivities at respective locations to test whether the amplitude of vibrations has any influence on the predominant periods. The analyses of these different records at the same station produced almcst identical predominant periods.

SUMMARY AND CONCLUSIONS

Although the number of peak ordinates as well as the general appearance of the spectrum curves varied considerably from one station to another, the predominant periods of all the alluvial grounds are determined to be constantly in the range of 0.3 to 0.5 seconds for horizontal and 0.23 to 0.30 seconds for vertical vibrations. The thickness of alternating layers of clay and gravel varied considerably however, from one point to another.

It was surprising to note that the microtremor spectra displayed a distinct peak at 0.75 seconds at the site of the Boğaziçi Suspension Bridge anchorage where the ground was hard Paleozoic schists and graywack. No general conclusion could therefore be made with respect to correlating the subsoil conditions and the predominant periods. Each site however, appeared to have some distinct microtremor spectra and further research is desirable to include a variety of subsoil conditions.

ACKNOWLEDGEMENTS

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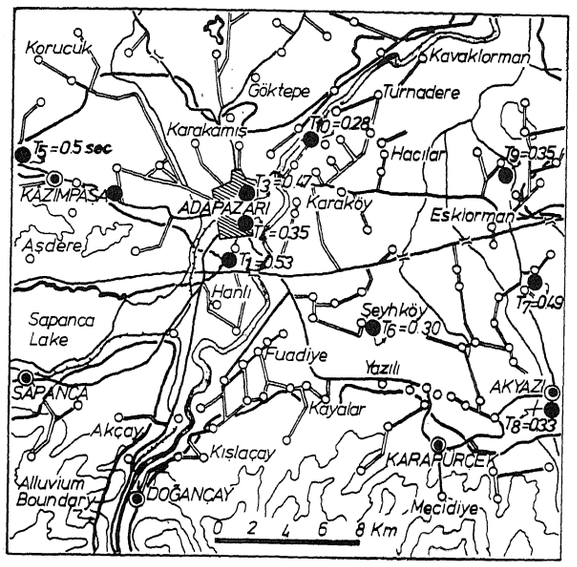

FIG. 1 MICROTREMOR STATIONS IN ADAPAZARI AREA

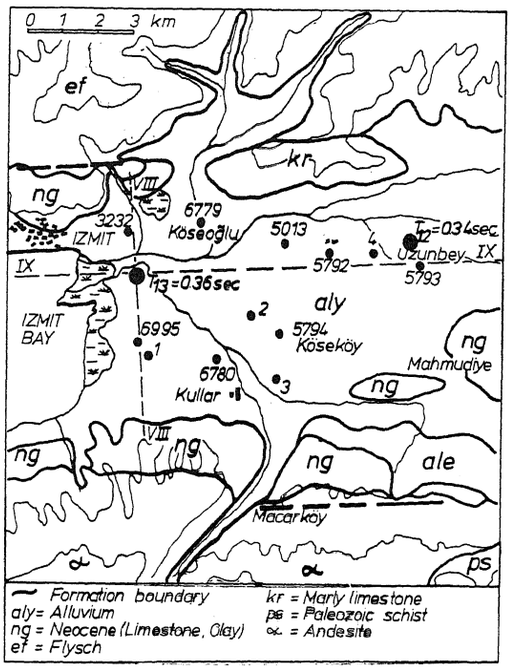

FIG. 2 MICROTREMOR STATIONS IN İZMİT AREA

No.	LOCATION	TIME	T(sec)		
			NS	EW	Z
1	Erenler Village	16:30	0.53	0.57	0.26
2	İ. Üner Apt. Roof	0:30	0.33	0.33	-
3	Bayraktar Apt. Ground	1:15	0.47	0.49	0.44
4	A. Akkoç Apt. Ground	2:10	0.35	0.55	0.48
5	Beeldere Village	12:00	0.50	0.60	0.43
6	Şeyhköy Village	13:30	0.30	0.28	0.23
7	Osmanbey Village	14:25	0.49	-	0.28
8	Akyazı Village	15:30	0.33	0.31	0.29
9	Sukenarı Village	16:30	0.35	0.35	0.23
10	Çelebiler Village	17:30	0.28	0.35	0.32
11	Sardoğan Square	18:45	-	-	-
12	Usunbey Farm, İzmit	10:55	0.34	0.34	0.34
13	Kullar Stream, İzmit	11:25	0.36	0.60	0.43
14	A. Aydın Apt. Roof	12:40	0.30	0.35	0.24
15	A. Aydın Apt. Ground	13:00	0.48	0.31	0.25
16	Tofaş Auto Factory	14:20	0.36	0.36	0.60
17	Tofaş Block D Roof	14:40	0.54	0.50	-
18	Ortaköy Anchorage, Boğaziçi Suspension Bridge	1:30	0.75	0.78	0.75

Notes:

1. All records were taken on January 28-31, 1971 with no wind conditions.
2. T = Predominant periods represent the results of Power Spectral Density Analysis.
3. Subsoil conditions are alluvial, except Paleozoic hard ground at station 18.

FIG. 3 SUMMARY OF PREDOMINANT PERIODS

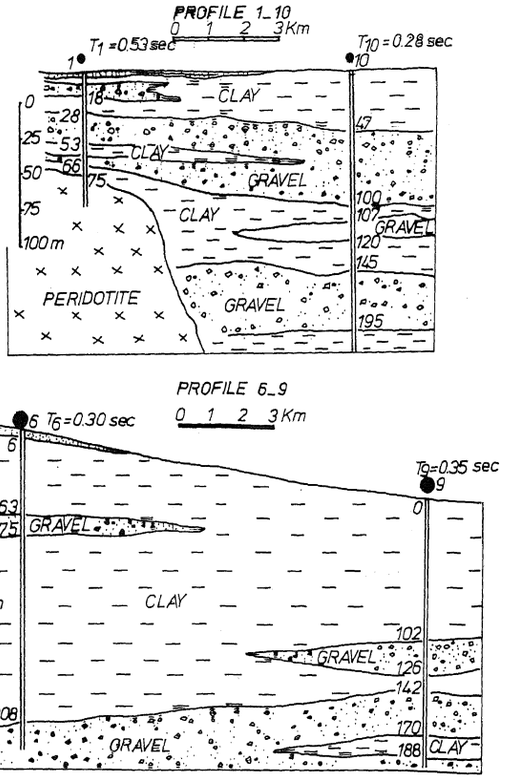

FIG. 4 GEOLOGICAL PROFILES 6-9 AND 1-10

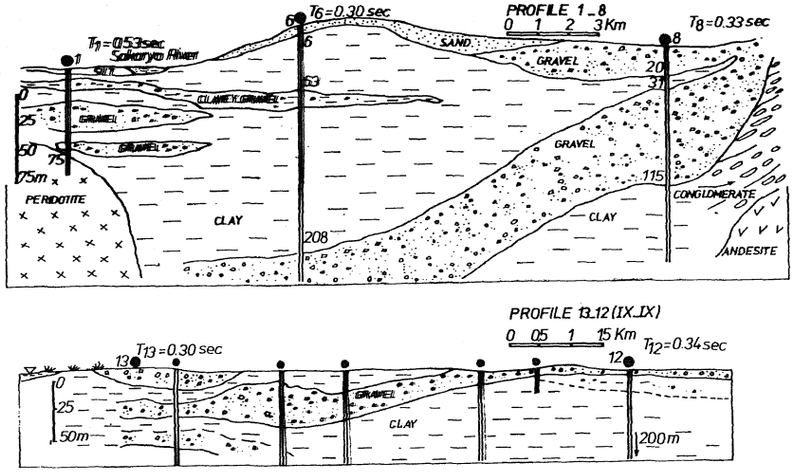

FIG. 5 GEOLOGICAL PROFILES 1-8 AND 13-12