STUDY ON THE STABILITY OF H/V SPECTRAL RATIO OF MICROTREMOR IN SHORT PERIOD RANGE FOR THE ESTIMATION OF DYNAMIC CHARACTERISTICS OF SURFACE GEOLOGY

Yasumasa NAKAJIMA[1], Norio ABEKI[2] And Daisuke WATANABE[3]

SUMMARY

To find out the fundamental characteristics of microtremor in short period range, authors discussed on the stability of horizontal/vertical spectral ratios of microtremors used with observed data. As the results, though we found that the characteristics of microtremors are affected by traffic vibration, the predominant periods of horizontal/vertical spectral ratios are stable and good correspond to the natural periods of surface geology on the uniform ground structures. But on the irregular ground structure, it is not so much good correspond to amplification of SH wave.

INTRODUCTION

The spectral ratio of horizontal/vertical component of microtremor by Nakamura's Method[Nakamura et. al. ,1986] is correspond to the dynamic characteristics of surface geology, and it is effective to evaluate the dynamic characteristics of surface geology. Various discussions on the method are done to make clear on the theoretical background of the method recently by many researchers. But it is important to inspect that the method will be used in engineering under what kind of observation condition and under ground condition.

In this paper, we examined on the stability of horizontal/vertical spectral ratio of microtremor in the area where surface geology was clear in detail by the bore hole data. And at once we will discusse on the utility of the application of microtremor for the seismic microzoning.

OUTLINE OF MICROTREMOR OBSERVATION

The test field of microtremor observation is the campus of KANTO GAKUIN University in Japan, where is composed as a alluvial low land. This area is accumulated with thick silt and clay soils, and Miura Formation exists in the lower part as the bedrock. In the campus, we have many bore hole data. Figure-1 shows the campus map with observation points. Microtremor observations were carried out by the repeated observation at each hour continuously with set up timer in the point-A on 23-24 January, 1998, points-B and point-C on 23-24 June, 1999 of the campus. In the north part, an alluvial deposit is deep, and there are passing much traffics on the front road. It is expected that traffic vibrations are observed much. In the point-B and point-C, new building is under construction nearby. At point-A, natural period of seismometer is 1 second, natural period of seismometer is 5 second at point-B and –C. Mobile observation points are selected for east-west line where are bore hole loggings on the line. To analyse, we made 6 data sets of 20.48 second from recorded microtremor, and these data set were used to make a spectrum in geometric mean. Finally, the spectrum was applied Parzen's Window(band width is 0.5 Hz) once.

[1] *Technical Research Institute, TEKKEN Co. Inc., Japan, E-mail: yasumasa-nakajima@tekken.co.jp*
[2] *Department of Architecture, KANTO GAKUIN University, Japan, E-mail: abeki@kanto-gakuin.ac.jp*
[3] *ITSUKI Architectural Design Office, Japan*

CHARACTERISTICS OF MICROTREMOR DEPEND BY FIXED POINTS AND CONTINUOUS OBSERVATION

Continuous observation points are on the thick alluvial deposits, and surface geologies are cleared by the bore hole data at the points. Figure-2 shows bore hole logs of observation points.

Figure-3 shows fourier spectra of horizontal and vertical component every one hour. The predominant periods of records in the midnight are exist 0.8 second because in the few noise condition. But, they are 0.3 second in the daytime. And all records exists peak value of 0.8 second in the point-A and -B. In the point-C, predominant periods are 0.3 or 0.6 second. It shows that is effect of traffic vibration in the point-A, and construction work noise in the point-B, -C. For examination the difference of predominant periods, we discussed the spectrum of noisy part and quiet part. Figure-4 shows time history data, part(I) is quiet part and part(II) is noisy part. Figure-5 shows these fourier spectra. For the fourier spectrum of quiet part, predominant period is 0.8second. But predominant period of noisy part is 0.3 second. It is evident that peak value of 0.3 second is effect of traffic noise probably.

To examine the dynamic character of surface geology, we discussed the horizontal/vertical spectral ratio(H/V spectral ratio) of microtremor. Figure-6 shows H/V spectral ratio of quiet and noisy part, and shows the theoretical transfer function of SH wave. We found that all H/V spectral ratios mostly correspond to 1st predominant period of theoretical transfer functions. Moreover, Figure-7 shows H/V spectral ratios of all records. The predominant periods are obtained stable. That is, the fourier spectrum is effect of traffic noise or other noise, but the predominant period of H/V spectral ratio is shown the dynamic characteristics of surface geology.

CHARACTERISTICS OF MICROTREMOR DEPEND BY UNDERGROUND CONDITION

As the result of continuously observation on each hour, we found the predominant periods of each sites that are estimated by H/V spectral ratios are shown stably, and they show the dynamic characteristics of surface geology. In this chapter, we discussed on the dynamic characteristics depend with surface ground conditions by mobile microtremor observation.

As shown Figure-8 of section of observation line, it is uniform ground structure in the west side, and it is drowned valley in the east side. Figure-9 shows fourier spectra of horizontal and vertical components. In the points of thick alluvial deposit, the predominant periods exist 0.3 second. In the points of thin alluvial deposit, dynamic characteristics like flat. It shows that peak value of 0.3 second is generated with traffic noise. Figure-10 shows these H/V spectral ratios and theoretical transfer function of SH wave. In the west area, H/V spectral ratios are correspond to theoretical transfer functions. The east area is on the irregular under ground structures, the transfer functions estimated by multi-reflection method were not correspond the observed predominant period. It shows that the under ground structures are not horizontal structures, because the basement is inclined and valley. But, in the other flat layered area, the dynamic characteristics of surface geology are able to evaluate from microtremor observation.

UTILITY OF MICROTREMOR TO SEISMIC MICROZONING

The H/V spectral ratios show the dynamic characteristics of surface geology approximately by the observed data. That is, we can say that the microtremor is applied to seismic microzoning. As a sample, a distribution map of the predominant period will be shown by these parameter.

Figure-11 shows predominant periods map of H/V spectral ratios, and contour line of depth to bedrock. In the thick alluvial deposit area, the predominant periods are more than 0.8 second. In the thin alluvial deposit area, the predominant periods are short range. H/V spectral ratios are useful to estimate on the dynamic characteristics of surface geology, and it is applicable as one of the methods for seismic microzoning.

CONCLUSION

In this paper, authors discussed on the stability of microtremor and H/V spectral ratios depend with the time and the underground conditions. As the results, followings have been cleared.

1. The dynamic characteristics of microtremors are heavy affected by traffic noise or building construction noises and so on. But the predominant periods estimated by H/V spectral ratios are shown stability.

2. H/V spectral ratios correspond to 1st natural periods of surface ground on the uniform ground structure, but H/V spectral ratios are not similar to amplification of shear wave on the irregular ground structure

3. We can say that it is one of useful methods for seismic microzoning in the same like conditional areas of this test field. But we have to notice in the area of irregular under ground structure.

REFERENCES

Nakamura, Y. et al.(1986), "A Simple Estimation Method of Dynamic Characteristics of Subsoil", *Proceedings of the 7th Japan Earthquake Engineering Symposium*, pp265-270

Tokimatsu, K. et al.(1992), "Characteristics of Rayleigh Waves in Microtremors and Their Relation to Underground Structures", *Journal of Structural and Construction Engineering*, AIJ, No.439,pp81-87

Ohmachi, T. et al.(1994), "Refinement and Application of an Estimation Procedure for Site Natural Periods Using Microtremor", *Journal of Structure Mechanics and Earthquake Engineering*, JSCE, No.489/I-27,pp251-260

Wakamatsu, K. et al.(1994), "Application of Microtremors -Estimation on Application Characteristics of Soil Deposits Based on Spectral Ratio of horizontal to Vertical Spectra of Microtremors-", *The 22nd Symposium of Earthquake Ground Motion -New Phase of Development on Earthquake Ground Motion Research: spatial Evaluation and Real-Time Propagation for Effective and Rapid Countermeasure-*, AIJ, pp35-44

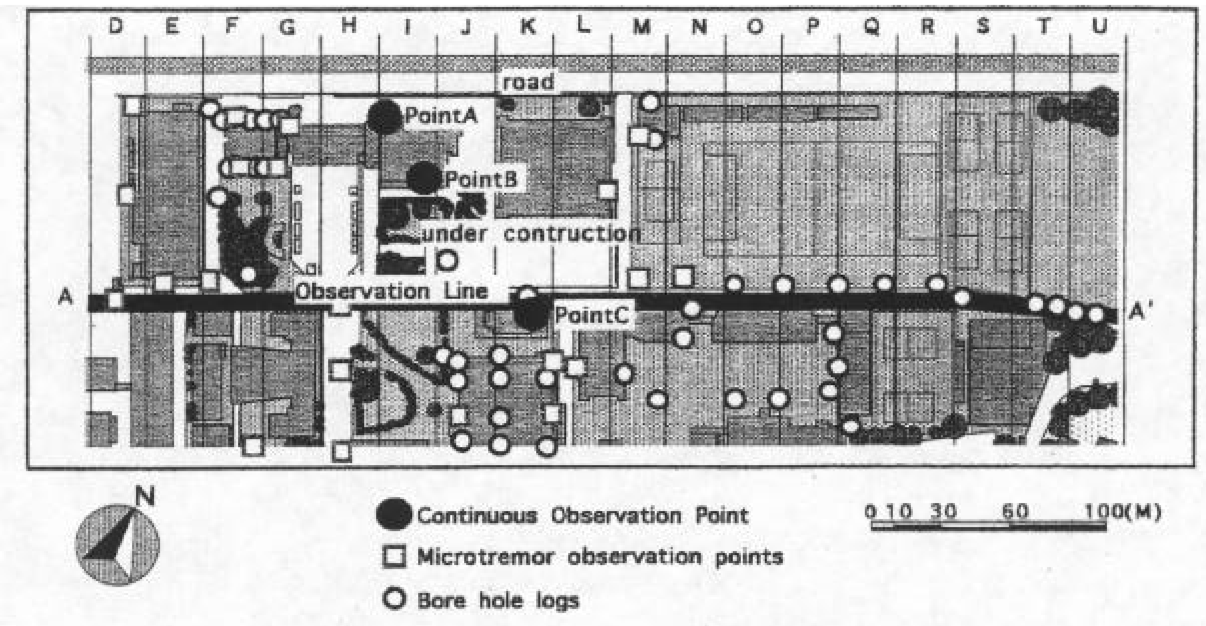

Figure-1 The object area and observation points

Table-1 Soil profiles of continuous observation points

Point: A			Point: B			Point: C		
Thickness (m)	Soil Character	Shear Velocity (m/s)	Thickness (m)	Soil Character	Shear Velocity (m/s)	Thickness (m)	Soil Character	Shear Velocity (m/s)
1.80	Fill	82.00	2.00	Fill	82.00	0.90	Fill	78.00
14.50	Silt	112.00	14.50	Silt	112.50	0.60	Silt	78.00
4.50	Silty Sand	159.00	4.50	Silty Sand	159.00	17.00	Silty Sand	114.00
3.95	Silt	129.00	3.95	Silt	129.00	5.50	Silt	127.00
	Tertiary	460.00		Tertiary	460.00		Tertiary	460.00

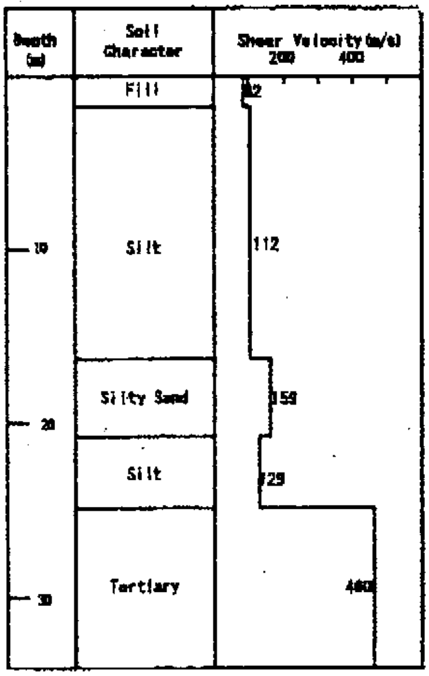

Figure-2 Bore hole logging at point-A

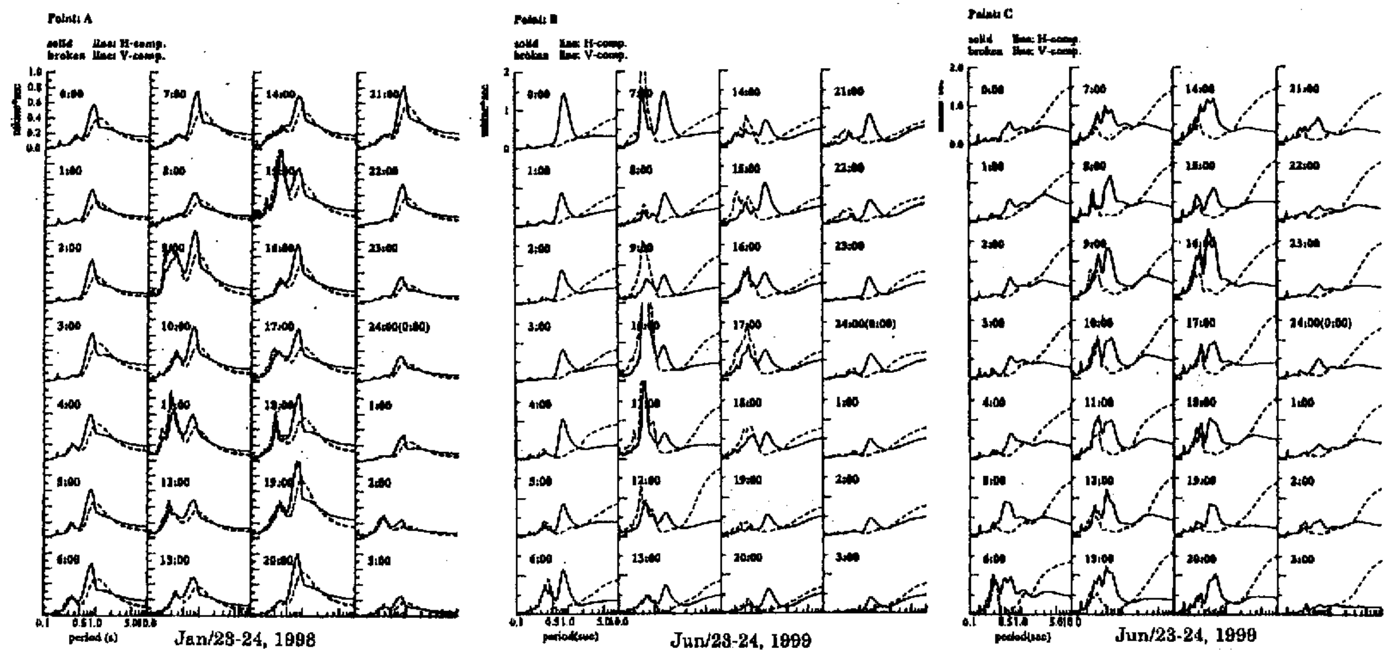

Figure-3 Fourier spectra of continuous observation every one hour

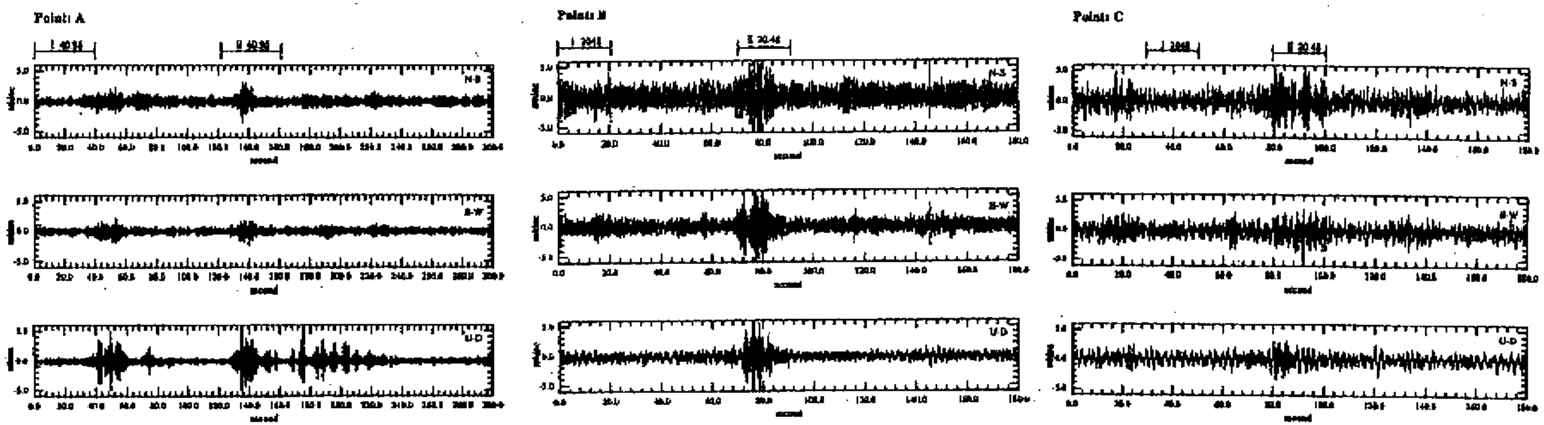

Figure-4 Time history data of daytime

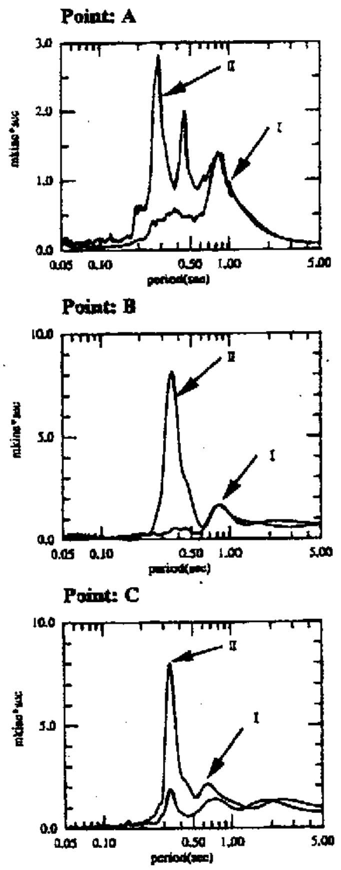

Figure-5 Fourier spectra of quiet and noisy parts

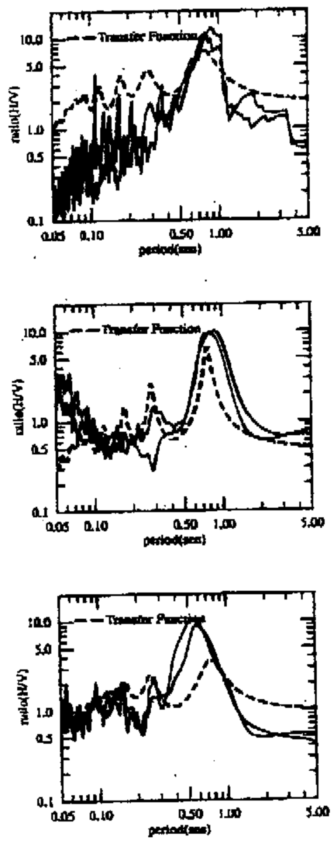

Figure-6 H/V spectral ratios of quiet and noisy parts

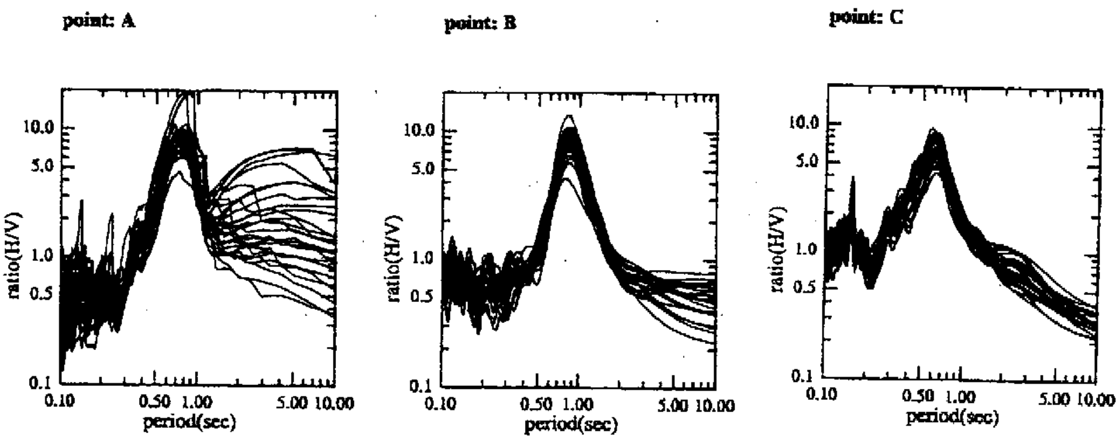

Figure-7 All H/V spectral ratios

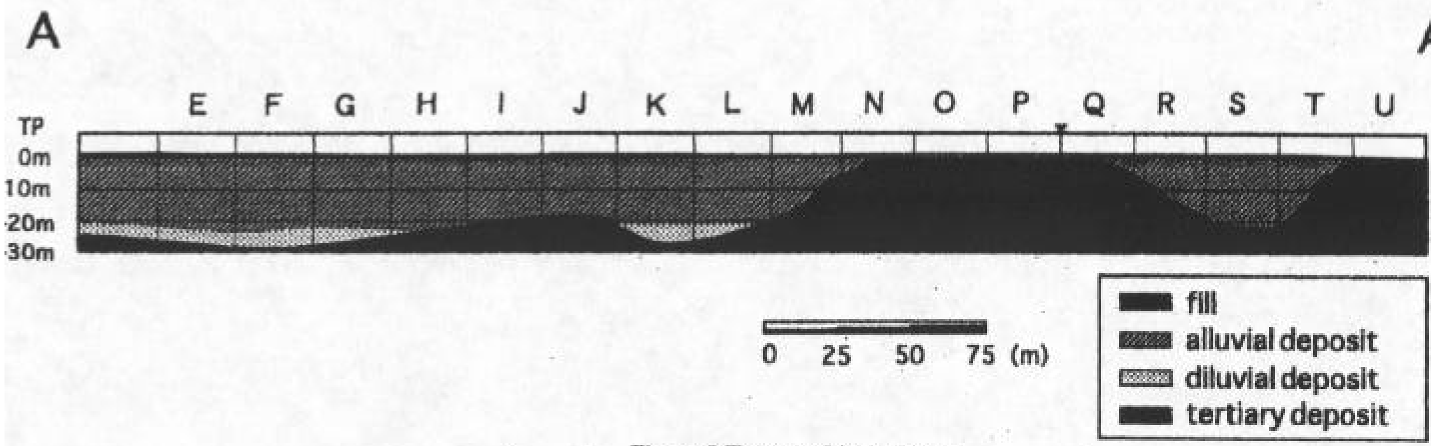

Figure-8 Topographical section

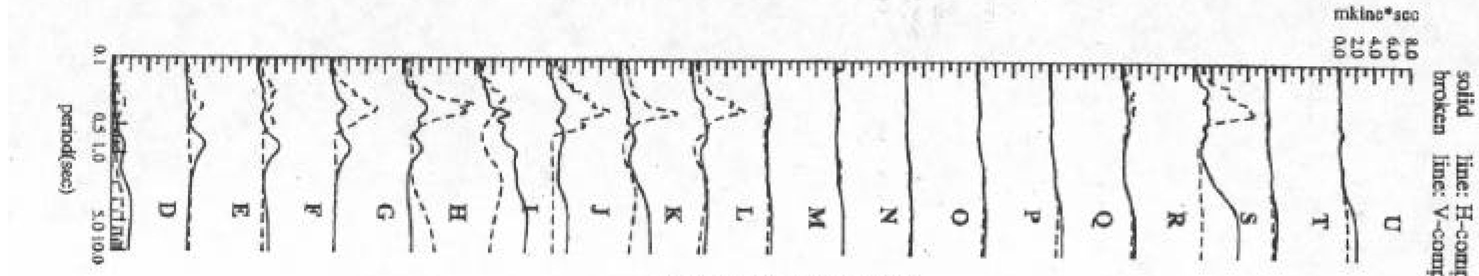

Figure-9 Fourier spectra

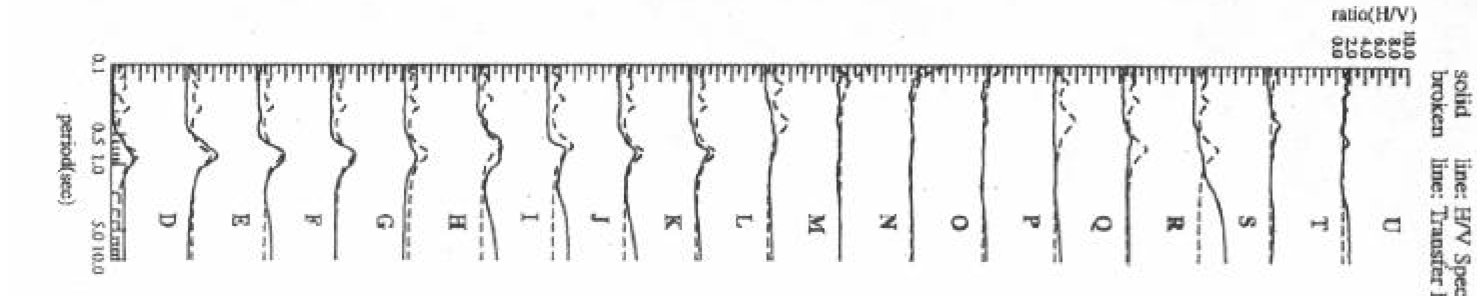

Figure-10 H/V spectral ratios

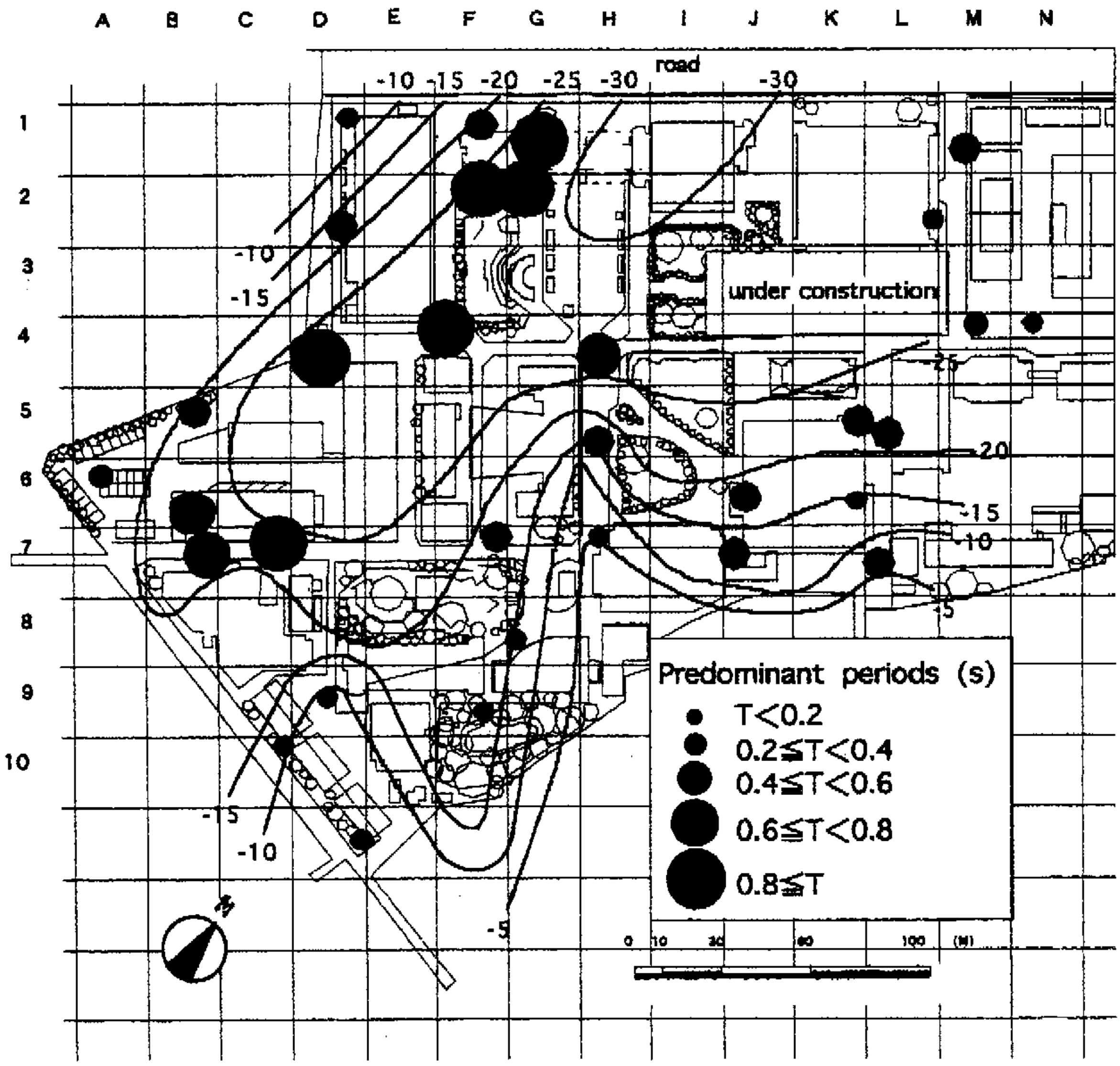

Figure-11 Distribution map of predominant periods