I-494 SEISMIC WAVE PROPAGATION DURING THE CHIBAKEN-TOHO-OKI EARTHQUAKE

Univ. of Tokyo, S.M. Turgay TURKER
Univ. of Tokyo, M. Fumio YAMAZAKI
Univ. of Tokyo, M. Tsuneo KATAYAMA

INTRODUCTION: In the wave propagation phenomenon, one of the most difficult parameter to access is the apparent velocity. Since multiple random reflections and refractions induce different apparent velocities during wave propagation. This phenomenon is also due to the presence of waves approaching from the other directions with diverse apparent velocities. Array networks provide extensive study in the determination of the basic parameters for nonstationary characteristics of earthquakes such as the apparent velocity and azimuthal angles, etc. The three-dimensional Chiba Array (Ref. 1), shown in Fig.1, has been used in this study in order to examine the wave propagation characteristics.

NONSTATIONARY CHARACTERISTICS OF THE EARTHQUAKE: The Chibaken-Toho-Oki earthquake on December 17, 1987 has been selected to demonstrate the seismic wave propagation due to body waves. The epicentral distance was 45km and the epicentral direction S51.9°E from the array. The magnitude of the event was 6.7 (JMA) and the focal depth was 58km.

The time history and nonstationary spectrum (Ref. 2) for radial component recorded at C001 (GL-1m in C0 borehole) is shown in Fig. 2. The arrival of the S-wave can be seen about 8s in time. The time history consists entirely of the body waves and the power of the spectrum is concentrated in between 0.10-0.40s.

The orbit spectrum analysis has been carried out for the time segment t=0-24s. From Fig. 3, it seems that it is very difficult to separate the SH and SV components. It is apparent that the released energy is almost equal in the radial- and transverse-directions for each frequency content.

VARIATION OF THE AZIMUTHAL ANGLE AND APPARENT WAVE VELOCITY: The FK spectrum analysis (Ref. 3) is conducted using the records from eleven points at GL-1m and seven points at GL-20m in order to obtain the variation of the apparent velocity and the azimuthal angle of the traveling wave in a frequency domain. Also the tripartite analysis is performed in order to compare with the FK spectrum results. In the analysis, the time segment t=0-8s was selected from the UD-component for P-wave propagation and the time segment t=8-16s was selected for both transverse- and radial-components corresponding to the SH and SV waves, respectively. Figure 4 shows that azimuthal angles obtained by the FK spectrum match the epicentral direction. The variation of the apparent velocities is shown in Fig. 5. The incident angles were found almost zero degree by these two methods, not shown here. On the other word, the direction of the wave arrivals was vertical to the ground surface.

It is seen that the apparent wave velocities are almost constant in these frequency bandwidths. In the lower frequencies of P-wave propagation, some trends were observed due to the insufficient energy of the time history in these frequencies. For the higher frequencies, the random reflections, refractions in nonhomogeneous media and involving other waves from the reverse direction may prevent the constant variation in the apparent velocity.

The tripartite method gives slightly different values compared with the FK results. Since three points used in the tripartite analysis are only in the distance of 100-140m, the time lags between each record were very small. Thus it may be difficult for this method to identify the accurate azimuthal angle and apparent velocity in the present case.

CONCLUSIONS: Seismic wave propagation during the 1987 Chibaken-Toho-Oki earthquake were investigated using the record from the Chiba Array. It was found that this event mainly consists of the body waves. The FK spectrum analysis and the tripartite analysis showed that the variation of the azimuthal angles matches the epicentral directions and it was shown that the variation of the apparent wave velocities are obtained at an almost constant value in certain frequency ranges.

REFERENCES: 1) F. Yamazaki et al. "An Array Database of Earthquake Ground Motions Recorded at Chiba Experimental Station", Bulletin of ERS, Institute of Industrial Science, University of Tokyo, No. 23, 1990. 2) M. Kamiyama, "Nonstationary Characteristics and Wave Interpretation of strong Ground Motions", Proc. of JSCE, No. 284, pp. 35-48,1979(in Japanese). 3) N. A. Abrahamson, "Estimation of Seismic Wave Coherency and Rupture Velocity using the SMART-1 Strong Ground Motion Array Recordings", EERC Report 85/02, 1985.

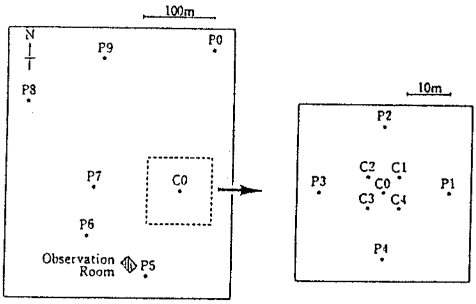


Fig. 1 Layout of the Chiba Array

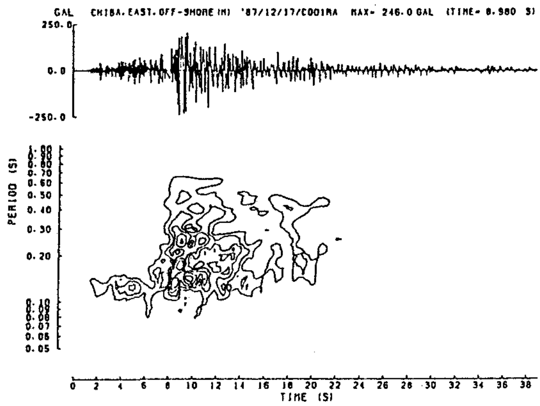
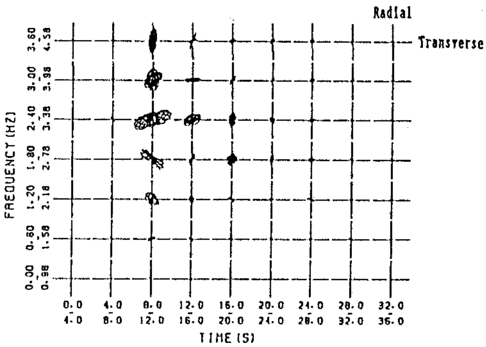
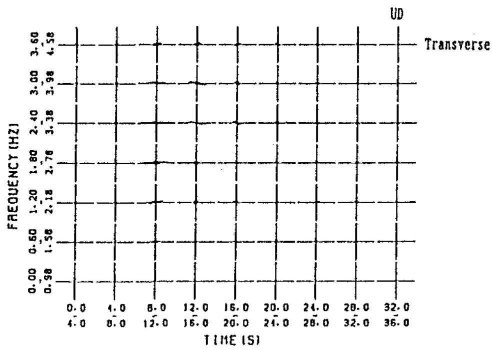


Fig. 2 Nonstationary Spectrum at C001



a) Radial-Transverse Components



b) Transverse-UD Components

Fig. 3 Particle Orbit Spectra at C001

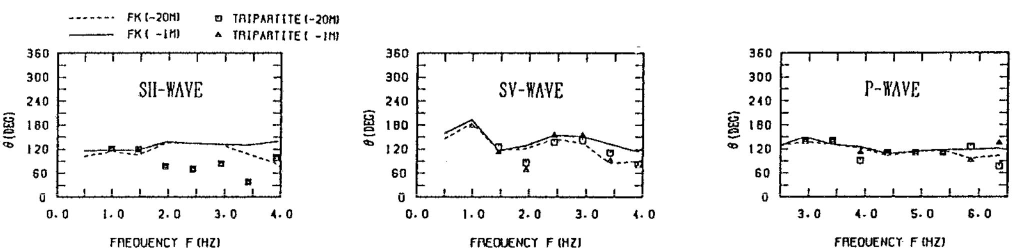


Fig. 4 Variation of the Azimuthal Angles with frequency

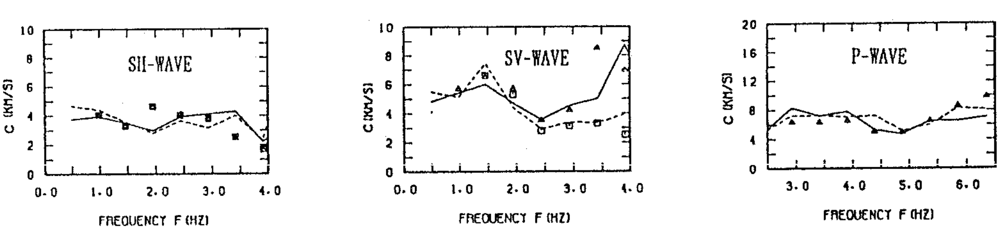


Fig. 5 Variation of the Apparent Velocities with frequency