CHARACTERISTICS OF MICRO TREMOR IN SPring-8 (HARIMA)

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Abstract

Stability of ground is preferable for accelerator beam operation. We have measured micro tremor of ground at the SPring-8 site.

In this paper, some of analysis results are shown, and the characteristics of the ground motion at the SPring-8 are discussed.

INTRODUCTION

Stability of ground is preferable for accelerator beam operation. For example, position errors of quadrupole magnets are required to be less than 5nm in the acceleration area and even 1nm at the collision point in GLC (Global Linear Collider)[1]. In general, the hard rock bed is stable and has less seismic noise. It is very important to know the characteristics of the ground motion to select the site for an accelerator facility such as GLC. We have measured micro tremor of ground at the SPring-8 site. Spring-8 is located on the Kamigori meta-gabbro rock area, and the SPring-8 ring is placed on the ground surface.

Measurement executed at the SPring-8 site and the SPring-8 ring is reported. Some analysis results on vertical ground motion are shown, and the characteristics of the ground motion at the SPring-8 are considered. Effect of traffic noise to the ground motion is also discussed.

OUTLINE OF MEASUREMENT

Measurement points

The SPring-8 site is located on the Kamigori meta-gabbro rock area. The SPring-8 site is located on the various foundations due to large-scale site preparation. We executed two kinds of micro tremor measurement. One was the "Site Measurement" which we have paid attention to geographical features at the SPring-8 site. Another was the "Ring Measurement" which we have paid attention to foundations and structural conditions under the SPring-8 accumulator ring.

Measurement points in the “Site Measurement” are shown in Figure 1, and those in the “Ring Measurement” are shown in Figure 2. The measurement points were selected to understand the influence from utilities and traffic, and to know the difference of foundations.

In the “Site Measurement”, four measurement points were selected at SPring-8, one of which is close to the street, the other one of which is on the high hill, and the others are far from them.

In the “Ring Measurement”, four measurement points were selected along the SPring-8 ring. The Spring-8 ring structure is placed on the firm rock bed at first point, and it is on the hardened ground by filling gravels at second point. At third point, there is a through path under the ring structure. The sensor was placed on a granite block in a building at fourth point.

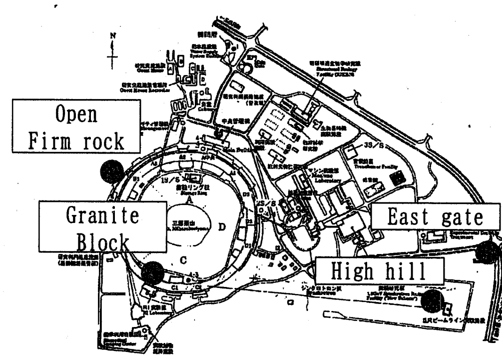

Figure 1: Measurement points in the ”Site Measurement”

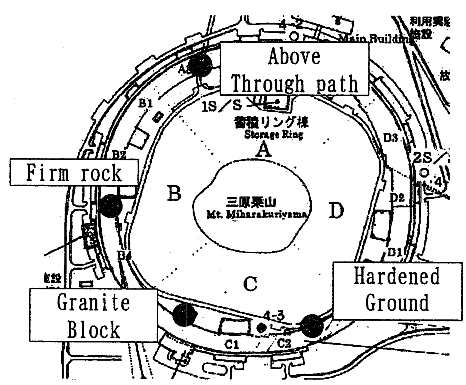

Figure 2: Measurement points in the “Ring Measurement”

Condition of the measurement

“Ring Measurement” was executed during the machine shutdown period. The sampling frequency was set to be 100Hz in all measurement. The condition of measurement is listed in Table 1.

Table 1: Condition of the measurement

Type	Points	Measuring period
Site M.	4	21:00 Jun 12,2003～21:00 Jun 13,2003
Ring M.	4	21:00 Jun 14,2003～21:00 Jun 15,2003

*30 min. consecutive duration for 24 hours

Measurement instruments

In this measurement, we used the servo type velocity meter VSE355G2 (Resolution: 10e-6 gal, Frequency band: 0.012-70Hz) and the data logger SAMTAC802H. These are manufactured by Tokyo Sokushin Co.,Ltd. Before accumulating data, VSE355G2 and STS-2 were compared on the same granite block, and the comparison authorization was executed.

RESULTS OF "SITE MEASUREMENT"

Comparison by RMS value in time history

The measured data is time history in velocity. We calculated the RMS of them, and observed the variation according to time of the day. The RMS is compared with the wind velocity and traffic. The traffic census was executed at the main road that is close to the east gate. We pay attention to the vertical component. Results for the correlation between the RMS and the wind velocity are shown in Figure 3, and those between the RMS and the traffic are shown in Figure 4.

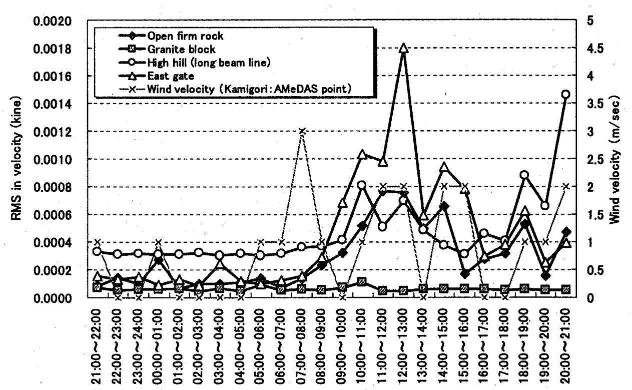

Figure 3: Correlation between the RMS of vertical ground motion and wind in the "Site Measurement"

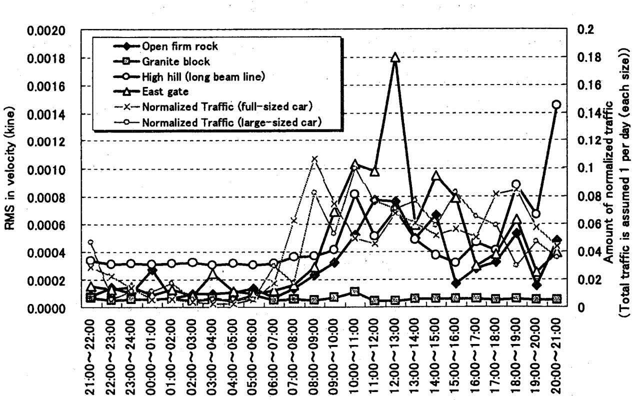

Figure 4: Correlation between the RMS of vertical ground motion and traffic in the "Site Measurement"

It can be seen in Figure 3 or 4 that the seismic noise is small at night and large in the daytime except for the granite block. Although the wind is said to be some source for seismic noise, it is not clear in Figure 3. It is thought that the ground motion was not excited because there was no tall structure and the wind was not so hard. But it can be seen in Figure 4 that some correlation between the RMS and traffic existed. It is considered that there were some influences caused by the traffic on the main street near the east gate and SPring-8 premise road. Especially we can see the high correlation for the large-sized car comparatively.

Spectral analysis

The spectra for 48 measurements at SPring-8 whole site for 24 hours were analysed. The duration is 30 minutes in the "Site Measurement". Those spectra were averaged. The averaged spectra of vertical ground motion over 24 hours are shown in Figure 5.

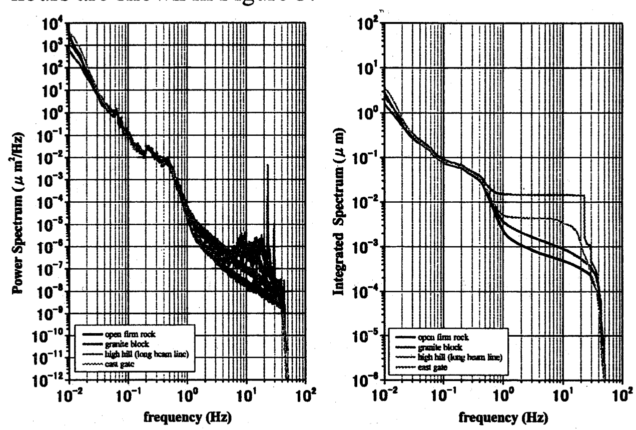

Figure 5: Spectra of vertical ground motion in the "Site Measurement"

From these results, the spectra for all measurement points look almost the same on the low frequency side from about 1Hz. However, we can see the difference on the high frequency side from 1Hz. In the spectra, some pulses around 20Hz are observed at the high hill, and the gentle peaks around 10-20Hz are observed at the east gate. The pulses are thought to be the influences from the utilities near the long-length beam line. The gentle peak is considered to be the influences from the traffic on the main street that is close to the east gate.

Comparison by minute earthquake record

During the "Site Measurement", the earthquake was occurred at about 23:03 June 12, 2003. The hypocenter of this earthquake was the Kagoshima Satsuma area (31° 59.2" north, 130° 15.9" east, and 155km in depth), and magnitude was M3.9. We could get the time history data in velocity as minute earthquake luckily. The examples of the time history in vertical velocity are shown in Figure 6, and maximum velocity at the all measurement points is listed in Table 2.

The observed amplitude in velocity at the open firm rock and the granite block was smaller than the others. Especially, if only this earthquake, it is considered that the horizontal component has been amplified more than the vertical component. This shows that the characteristic of amplification during the earthquake was obviously different according to the ground properties and the structure.

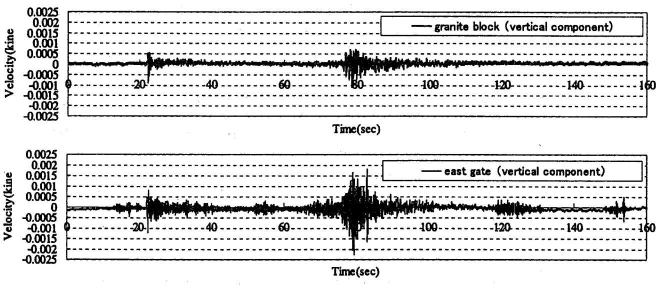

Figure 6: Examples of the time history in vertical velocity during the minute earthquake

Table 2: Maximum velocity during the minute earthquake

Measurement Points	Maximum velocity (kine)		
	NS	EW	UD
Open firmrock	1.84×10^{-3}	2.19×10^{-3}	1.24×10^{-3}
Granite Block	1.29×10^{-3}	1.35×10^{-3}	1.11×10^{-3}
High Hill	5.72×10^{-3}	5.74×10^{-3}	2.86×10^{-3}
East gate	4.36×10^{-3}	6.02×10^{-3}	2.23×10^{-3}

RESULTS OF "RING MEASUREMENT"

Comparison by RMS value in time history

We calculated the RMS of time history in velocity, as well as the "Site Measurement". The correlation between the RMS and the wind is shown in Figure 7. Although the wind is said to be some source for seismic noise, it is not clear. It can be seen in Figure 7 that the variation according to time of the day was very small. And it is clear that the RMS of the ground motion was lower than those obtained in the "Site measurement".

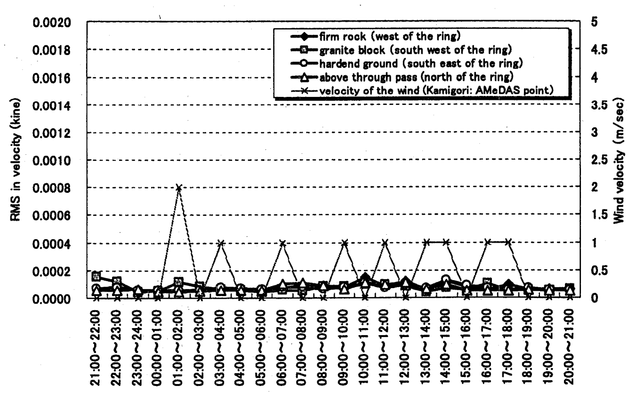

Figure 7: Correlation between the RMS of vertical ground motion and wind in the "Ring Measurement"

Spectral analysis

The averaged spectra of vertical ground motion over 24 hours are shown in Figure 8, as well as the "Site Measurement".

The most remarkable point is that only the point above the through pass has two or more peaks on the high frequency side around 10Hz. It is thought that these peaks were excited from some utilities and through pass itself. However, the peak around 0.2-0.3Hz is almost the same in every measurement points. It is understood that the degree of seismic noise in the Spring-8 ring is very low.

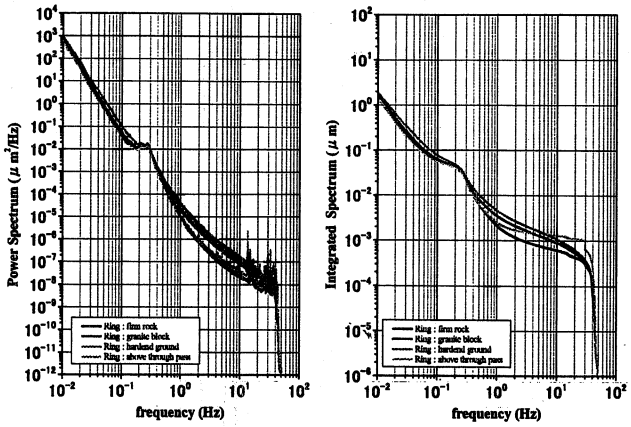

Figure 8: Spectra of vertical ground motion in the "Ring Measurement"

SUMMARY

The micro tremor measurement was executed in SPring-8 site and the SPring-8 ring. The followings are observed in the analysis of the data

- The level of the ground motion in the SPring-8 ring is lower than that on the ground such as the high fill and the east gate.
- From the record of the minute earthquake, it is clear that the amplification characteristic during the earthquake is different according to the kind of grounds.
- The difference is generally small around the low frequency side, and the variation according to time of the day of the ground motion is also small at the Spring-8 ring.

ADDRESS OF THANKS

We deeply thank to Professor Kumagai of SPring-8 because this measurement was achieved by his cooperation. We also thank to the staff of Electric Power Development Co., Ltd. who helped us in setting instruments and accumulating data during the measurement period.

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