

CHARACTERISTICS OF MICRO TREMOR IN KEKB (TSUKUBA)

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Abstract

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

In this paper, some of analysis results are shown, and the characteristics of the ground motion at the KEKB site 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 part and underground part at the KEKB site. The KEKB is located on the diluvium ground in Kanto plain, and the KEKB tunnel is buried 10m deep in the ground.

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

OUTLINE OF MEASUREMENT

Measurement points

The measurement was individually executed in three facilities of KEKB. The facilities where the measurement was executed are shown in Figure 1. The measurement facilities were selected to understand the influence from utilities and traffic. Three facilities were selected along the KEKB ring, one of which is close to the main street, Higashi-odori, and the others are far from it.

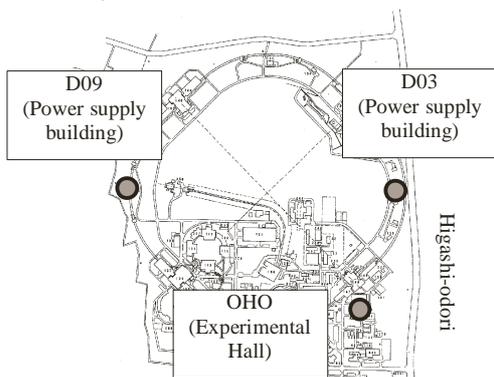


Figure 1: Measurement facilities in KEKB

The measurement points in each facility are listed in Table 1. Some examples of the measurement points are shown in Figure 2 and Figure 3.

Table 1: List of measurement points

Measurement Points	Base Condition	Facility		
		D09	D03	Oho
Underground	On concrete	Set up	Set up	Set up
Ground (1)	On concrete	Set up	Set up	Set up
Ground (2)	On soil	Set up	Set up	-
Ground (3)	On soil	Set up	Set up	-

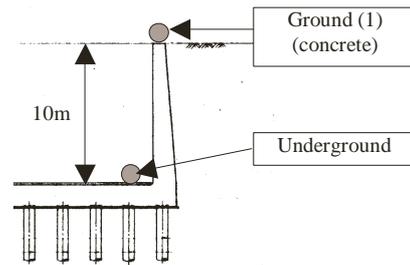


Figure 2: Measurement points in the Oho exp. hall

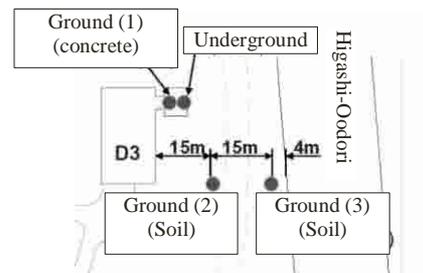


Figure 3: Measurement points in the D03 building

Condition of Measurement

The measurement was executed during the machine shutdown period. The sampling frequency was set to be 100Hz in all measurements. The condition of measurement is listed in Table 2.

Table 2: Condition of measurement

Facility	Points	Measuring period
D09	4	13:00 Jan 5, 2003~12:10 Jan 6, 2003
D03	4	13:00 Jan 8, 2003~12:10 Jan 9, 2003
OHO	2	13:00 Jan 15, 2003~12:10 Jan 16, 2003

*10 minutes duration in every hour 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 MEASUREMENT

Comparison by RMS value in time history

The obtained data is time history in velocity. We calculated the RMS of them, and observed the variation according to time of the day. We pay attention to the vertical component. Results for the D09 building are shown in Figure 4, and those for the D03 building in Figure 5, and those for the Oho hall in Figure 6.

From these results, the RMS in the underground is generally lower than that on the ground. The RMS in the underground of the D03 building is about two times larger than that of the D09 building at daytime. By the way, it can be seen that there is the correlation between the RMS and the wind at the D09 building. It is thought that this correlation is due to some towers for power line near the D09 building. But we have to pay attention to that the traffic and the data of wind have the same variation according to time of the day.

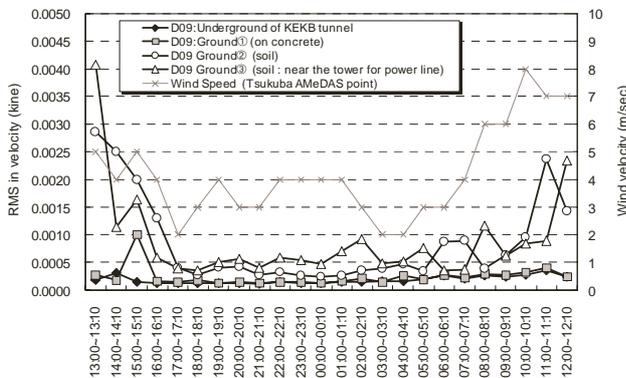


Figure 4: RMS of vertical velocity of ground motion at the D09 power supply building

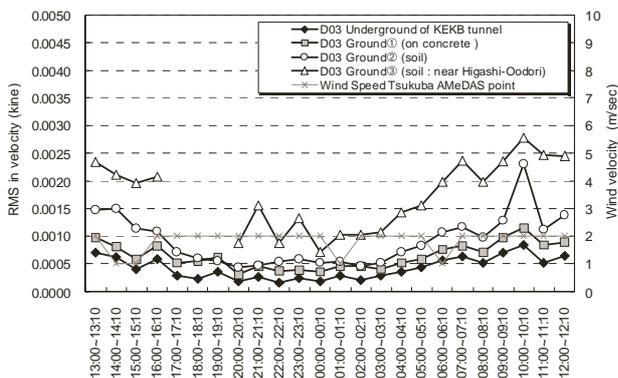


Figure 5: RMS of vertical velocity of ground motion at the D03 power supply building

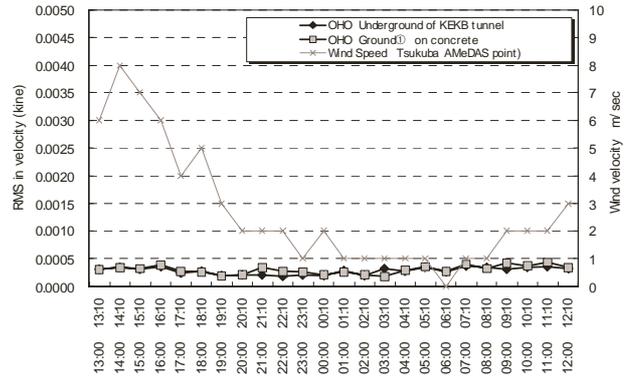


Figure 6: RMS of vertical velocity of ground motion at the Oho experimental hall

Comparison with the results of traffic census

In the measurement at the D03 building, the traffic census was executed in Higashi-odori. The results of the traffic census are shown in Figure 7, and the comparison between the RMS and traffic is shown in Figure 8.

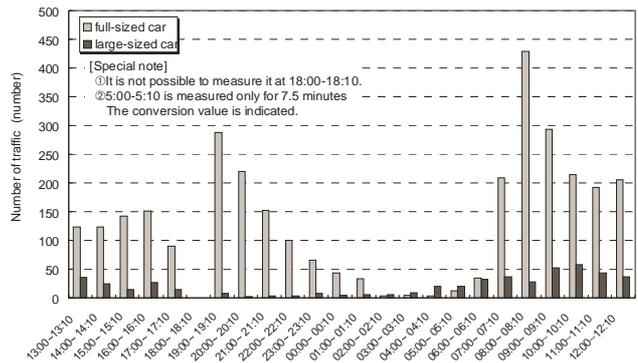


Figure 7: Results of traffic census in Higashi-Oodori

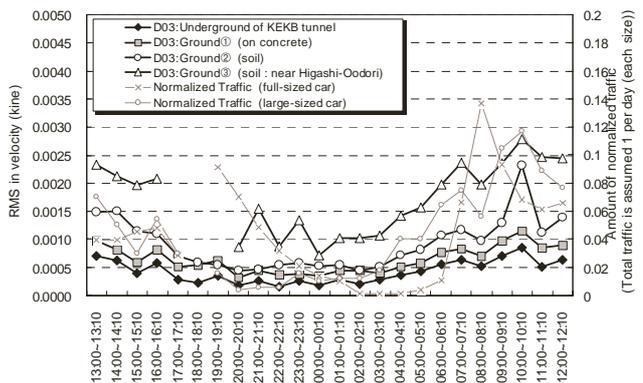


Figure 8: Comparison between the RMS and traffic at the D03 power supply building

According to these results, it is clear that the variation for traffic according to time of the day has the correlation with the RMS in velocity. Even if the KEKB tunnel is buried 10m deep in the ground, the energy of traffic vibration is transmitted into the direction of the underground.

Spectral analysis

The spectra for 24 measurements were analysed. The duration of measurement is 10 minutes. Those spectra were averaged. The averaged spectra of vertical ground motion over 24 hours are shown. The spectra at the D09 are shown in Figure 9, and those at the D03 in Figure 10, and those at the Oho experimental hall in Figure 11.

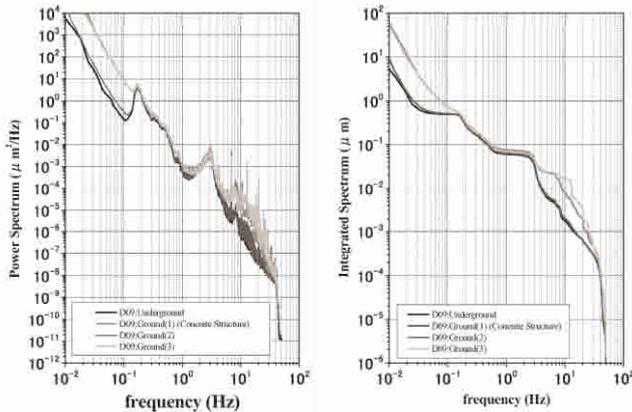


Figure 9: Spectra of vertical ground motion at the D09

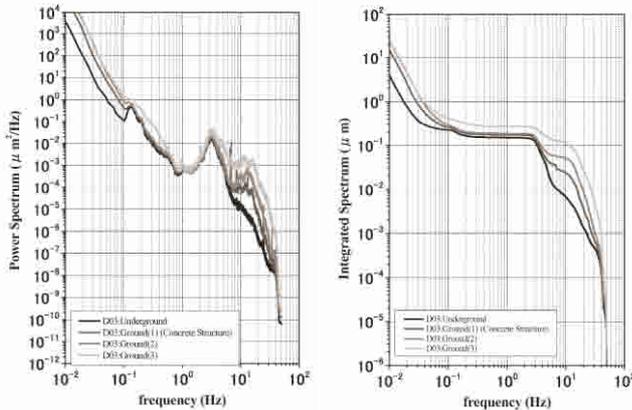


Figure 10: Spectra of vertical ground motion at the D03

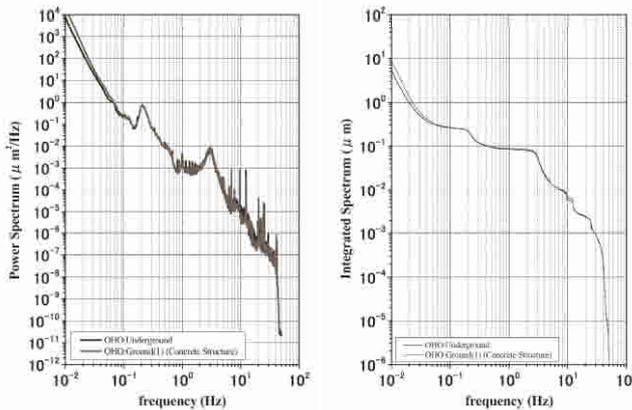


Figure 11: Spectra of vertical ground motion at the Oho

In all spectra, two peaks are observed clearly. One is around 0.1-0.2Hz, which is said to be caused by some natural phenomena such as ocean swells and the wind. The other is around 3Hz, which is said to be caused by some artificial noise such as traffic noise and utility noise in factories. At the each measurement point, the spectra

on the ground part and the underground part look almost the same on the low frequency side from about 3Hz. It is considered that the ground motion around this frequency band is a vibration based on the position that is deeper than the KEKB tunnel. But the difference in the amplitude between the ground part and the underground part is remarkable on the high frequency side from about 3Hz.

Comparing the spectra at the D09 building, those at the D03 building and those at the Oho experimental hall, the spectra at the D03 building are most remarkable. When we pay attention to the gentle peaks around 10-20Hz, we can find two characteristics. One is that the gentle peaks around 10-20Hz can be seen at the D03 building. The other is that the difference between the underground part and the concrete part is seen at the D03 building, but that is not seen at the others. It is indicated that there were some influences from the traffic near the D03 building. It is considered that the vibration due to heavy traffic is transmitted from the ground toward the direction of the underground through the concrete structure.

SUMMARY

The micro tremor measurement was executed in the D09 building, the D03 building, and the Oho experimental hall in KEKB. The followings are observed in the analysis of the data.

- The peak around 0.2Hz and 2Hz-3Hz can be seen in all measurement points.
- The amplitude of the vertical ground motion around 10-20Hz is remarkable at the D03 building. It is thought that there are some influences from the heavy traffic.
- If there are some vibration sources in surroundings, the vibration is transmitted from the ground toward the direction of the underground.
- There is a possibility that the level of the ground motion grows up due to some high structures in surroundings when the wind is strong.

ADDRESS OF THANKS

We 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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