GROUND MOTION MEASUREMENT AT J-PARC

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Abstract

In the next generation accelerator, construction of the machine on the stable ground is preferable for accelerator beam operation. We have measured ground motion at the J-PARC site under construction, where the ground is very close to the Pacific Ocean.

In this paper, some of observed results are shown, comparing with the results of the previous observation at some accelerator facilities and hard rock areas in Japan.

INTRODUCTION

Stable ground is preferable for accelerator beam operation. In general, the hard rock bed is stable and has less seismic noise [1,2]. It is very important to know the characteristics of the ground motion to select the site for an accelerator facility such as large intensity or high luminocity machines.

Although J-PARC site is located on complicated grounds and is very close to the Pacific Ocean, they have started construction without detailed ground motion study. It is important for us to know the magnitudes by the ocean swells and other ground motions.

In this paper, we report the results of the ground motion measurement at the J-PARC site, comparing with the results at the other sites, and including some existing accelerator facilities and hard rock areas in Japan.

GROUND MOTION AT THE J-PARC

Measuring Points

J-PARC is located in the north of Ibaraki Prefecture in Japan, and it was continuing the construction during our ground motion measurement. We selected six measuring points in the straight section of the MR tunnel of J-PARC paralleling to the coastline, which were set at intervals of 20 meters. Those points were selected to understand the influence by the ocean swells, the differences of ground conditions and the complicated surface of the soft mudstone bed. Schematic drawing of the measuring points are shown in Figure 1. P1J and P3K were the both ends of six measurement points, which were about 500 meters away from the coastline.

The MR tunnel of J-PARC is made of reinforced concrete, and which is supported by a lot of piles. Grounds under the tunnel are almost composed of sands and gravels. Thickness of sands and gravels are different according to the measurement points, so the depth of rockbed is complicated. As the river runs near the south of the ring of J-PARC, the depth of rockbed at P3K is deeper than that at P1J.

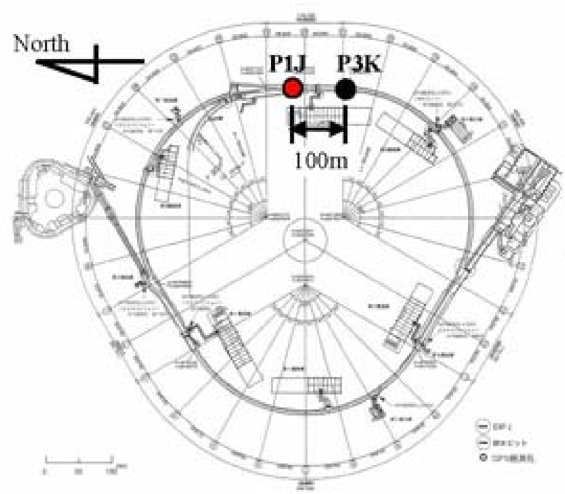

Figure 1: Measuring points in the MR tunnel of J-PARC.

Condition of Measurement

The condition of measurement is listed in Table 1. The sampling frequency was set to be 100Hz.

Table 1: Condition of measurement

Name	Number	Measuring period
J-PARC	6	From: 21:00 Oct. 28 (Fri.), 2005
		To : 09:00 Oct. 31 (Mon.), 2005

- 30 min. consecutive duration for 60 hours at J-PARC
- No construction activities at night and Oct.30 (Sun.)

Measurement Instruments

In the present measurements, we used the servo type velocity meter STS-2 of Streckeisen (Response: 0.00833-50Hz, Clip level: 1.3(cm/sec)) and the data logger LS-7000XT of the Hakusan Corporation. Before regular accumulation of the data, calibrations for all instruments were done.

Power Spectrum Density

The observed Power Spectrum Density (PSD) was classified into two groups, daytime (9am-5pm) and night-time (9pm-5am). The PSDs in each group were averaged. The FFT analyses were made dividing the measured data into 30minutes intervals. The PSDs for daytime and night-time on Oct. 30 (Sun.) are shown in Figure 2. These figures are concerning for vertical ground motion. The spectra are valid in the frequency region less than 50 Hz which is the Nyquist frequency corresponding to the sampling rate 100Hz.

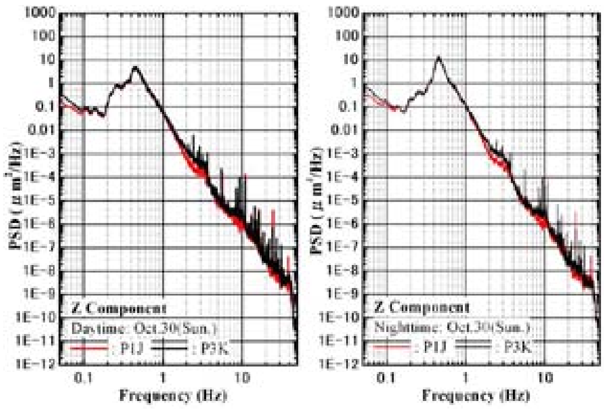

Figure 2: PSDs of vertical ground motion in the daytime and night-time for J-PARC.

From these results, the level of the ground motion at P1J is found to be lower than that at P3K. In these spectra, there is obvious one peak around 0.4 Hz. It is said to be caused by some natural phenomena such as ocean swells. In the frequency region higher than 2 Hz, we can see some sharp peaks which are said to be caused by some artificial noises such as traffic noise and machine noise. As the J-PARC site is surrounded by the various facilities for nuclear experiment, it is considered to be influenced by noises from them.

Integrated Spectrum

We calculated the integrated spectra by using observed PSDs. The integrated spectra were also classified into daytime and night-time and are shown in Figure 3. These figures are also concerning for vertical ground motion.

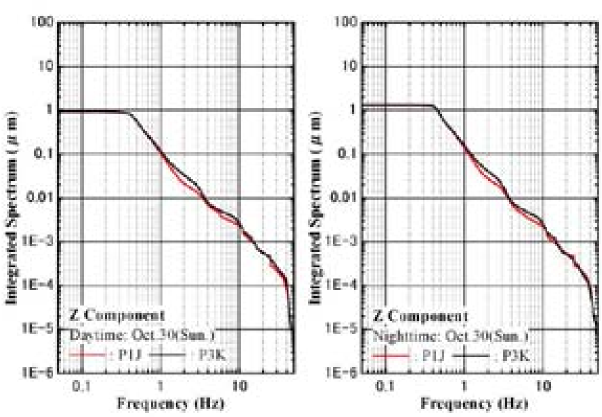

Figure 3: Integrated spectra for vertical GM in the daytime and night-time for J-PARC.

We cannot find out the differences between day and night. However, in the frequency region lower than 1Hz, the amplitudes at nighttime are higher than those at daytime. Further more, the amplitudes at P3K are a little bit higher than those at P1J. It is considered to be affected by the difference due to the ocean swells and ground conditions.

In order to clear the time serial spectrum densities, we classify the integrated spectra into three groups according as the frequency bands, those are larger than 0.1Hz, larger than 1Hz and larger than 10Hz. The results are shown in Fig. 4.

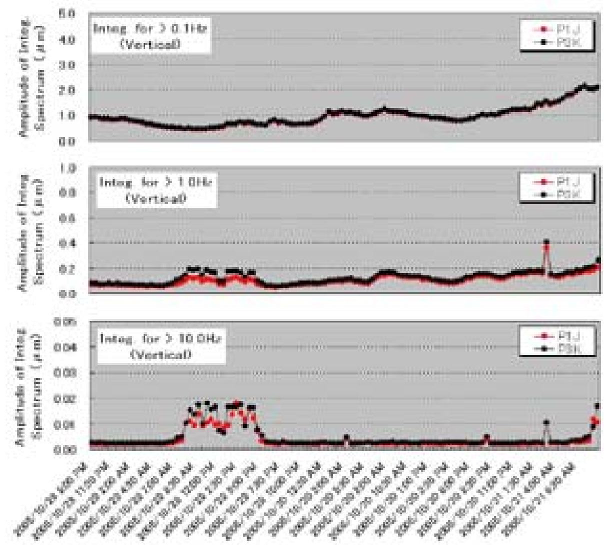

Figure 4: The time serial spectrum densities of J-PARC.

The difference in the amplitude between weekdays and holiday can be seen in the frequency region more than 1Hz. It is specified by influences of construction activities. However, the difference in the amplitude between day and night cannot be recognized in the frequency region lower than 1Hz. It is considered that the amplitudes in these frequency regions are only dominated by the ocean swells and site dependent incoherent noises.

COMPARISON WITH OTHER AREAS

We have measured ground motion at some existing accelerator facilities and some quiet sites for large future accelerators in Japan. The areas we have observed ground motion are listed in Table 2 and shown in Figure 5. The PSDs and integrated spectra for vertical ground motion are shown in Figure 6 and Figure 7.

Table 2: Observation areas or facilities

Area or Facility	Geological Property
KEKB*	Diluvium ground in Kanto plain
Spring-8*	Kamigori meta-gabbro rock area
Sefuri	Granite rock area
Kitakami	Granite rock area
J-PARC#	Sands and Gravels

*Existing accelerator facitlity.
#Under construction.

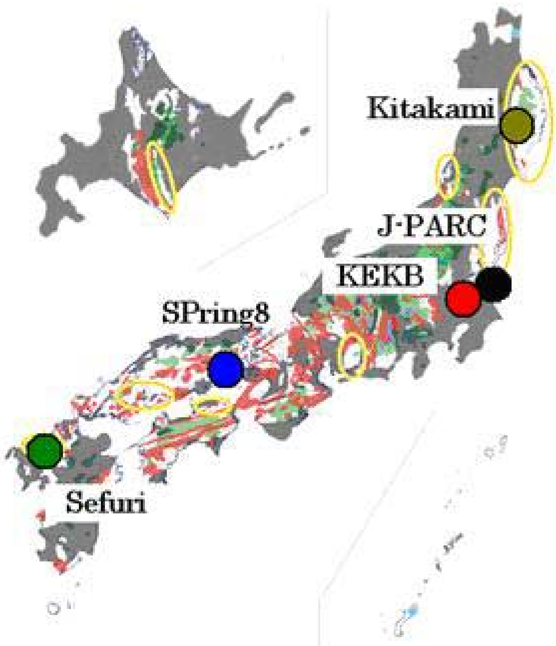

Figure 5: Map for Table 2

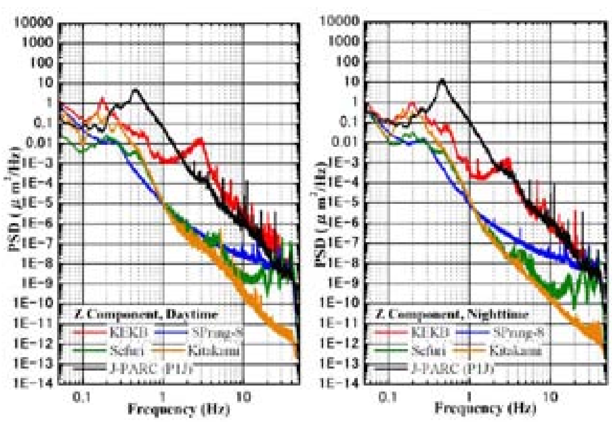

Figure 6: Comparison of PSDs (vertical).

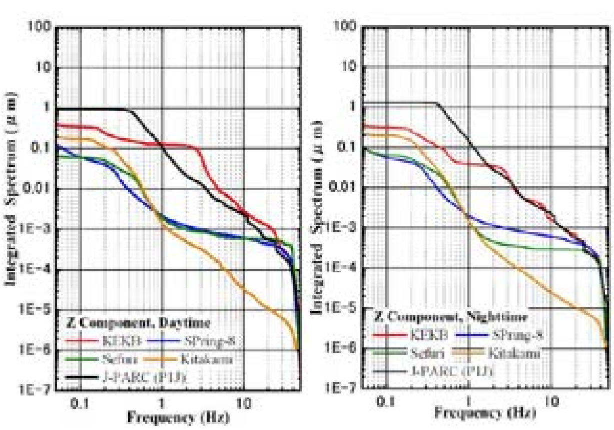

Figure 7: Comparison of integrated spectra (vertical).

We can clearly find out that the amplitudes of KEKB and J-PARC is larger by two orders in PSDs and by one order in integrated spectra than those of SPring-8, Sefuri and Kitakami around 1-3 Hz. The influences by ocean swells are the strongest at the J-PARC, and those by artificial noises are the strongest at the KEKB tunnel.

KEKB is located on the diluvium ground in Kanto plain, and J-PARC is on the sands and gravels. However, SPring-8, Sefuri area and Kitakami area are located on some rock areas. These areas are considered to be stable and suitable for accelerator facilities.

SUMMARY

The ground motion has been observed in the MR tunnel of J-PARC. The followings are clearly shown by the observed and analyzed data.

- The amplitudes of the spectra around 0.2-0.5Hz of J-PARC are higher than those of other areas. This factor is thought to be caused by the ocean swells, as J-PARC site is very close to the Pacific Ocean.
- One of the differences between J-PARC and KEKB is a broad bump around 2-3Hz of their spectra. However, the amplitudes of the spectra around 2-3Hz of J-PARC are only a little lower than those of KEKB.
- It is shown that rock area is suitable for accelerator facilities. And it is better for them to be constructed in site far from the sea.

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