Study Trip Report on
THE SENDAI GOVERNMENT OFFICE BUILDING #3
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The visit to the Sendai Government Office Building #3 was conducted on Tuesday, September 6, 2011. The Building is addressed at 1-3-15 Gorin, Miyagino-ku, Sendai-shi, located about 470m northeast from Tsutsujigaoka Station. This building was constructed in 1991 and used as a joint office building by the governmental institutions in Sendai City, and the structure consisted of 9 floors which were made from reinforced concrete. In 2008, the building was retrofitted and the base isolator system was installed to enhance its seismic resistant. The 850 base isolators were constructed from the 80% Lead Rubber Bearing (LRB) which was to cover the horizontal building displacement up to 50 cm. The location and the view of the building are represented in Figure 1.

(a) (b)

Figure 1. The Sendai Government Office Building #3, location (a) and the front view (b)

In this building, we had a chance to observe some rooms in accordance with earthquake monitoring system, those are: the basement that had a displacement monitoring plate, the top floor, the JMA office room, and JMA strong motion instrument.

1. Visit to the basement and the top floor

In the basement floor, the visitors were introduced to the displacement monitoring plate that was installed to record the trace of building movement anytime when an earthquake struck. The instrument consists of the needle and the plate. The steel needle with vertical spring is anchored to the main building structure above the base isolator and could move as well as the movement of the building, and the plastic plate with circle scale is anchored to the basement floor below the base isolator to measure the maximum trace directly. The displacement monitoring instruments can be seen in Photo 1.

Mr. Kagaya from the Ministry of Land Infrastructure, Transport and Tourism (MLIT) explained that on March 11, 2011 the plate recorded the building movement due to the mainshock of the off Pacific coast of Tohoku Earthquake 2011 with maximum displacement 18 cm from the center point, some needle on the other places were broken during the shaking caused by the power of the shock or the high acceleration of the vertical motion. After recording the mainshock, the plastic plate was replaced by the new one and then recorded the biggest aftershock on April 7, 2011 with the maximum displacement 11 cm. All of the needles were turn back into the original position after experiencing strong motions, it means that the structure did not suffer any residual displacement, the base isolation system were working properly and still in a good condition.

(a) (b) (c)

Photo 1. The plastic plate (a), Needle (b), and the trace records of the mainshock of Tohoku earthquake March 11, 2011

According to the strong motion data that were recorded on the basement, the second, the forth and the ninth floor, the maximum acceleration of the building was reduced by 50% comparing to that of the ground (on the basement). Although the structural members were safe, some damages were observed on the non-structural elements when the building moved with the maximum velocity up to 40 cm/sec under the mainshock of the Tohoku Earthquake March 11, 2011. Some of the non-structural elements were broken such as the fire resistant material that filled the gap between the top of the basement wall and the bottom of the building, and some parts of the ceiling were also broken caused by collision with the lid of the utility holes which was placed right below the ceiling. The photo of some damages can be seen in Photo 2.

(a) (b)

Photo 2. Damage on the non-structural elements such as gap filler and ceiling

After visiting the basement floors, Mr. Kagaya showed us the top floor which was in a good condition and no damage was observed. There were some instruments placed and belonged to the Japan Meteorological Agency (JMA) and other institution which were used for acquiring data, sending or receiving data, or other purpose like power sources. Some of the instruments such as strong motion sensors, sunlight and weather sensors, GPS, and communication antenna were placed. There were also the solar cells installed to generate electric power for daily use.

2. Visit to the JMA office and strong motion instrument

The JMA Office was located on the second floor which had the phenomena observation systems corresponding with earthquakes and volcanoes matters. Mister Funakoshi kindly explained the daily activity of the JMA that had planted about 4,000 seismographs throughout Japan. This office also included the volcanoes monitoring system for the Tohoku area that has 18 active volcanoes.

The earthquakes data which has been collected in this regional office is then sent to the JMA Office centre in Tokyo to be processed and resulted earthquake parameters as very useful information. The earthquake parameters such as location, magnitude and intensity which are analyzed by the JMA are then disseminated to the public within 3 minutes after an earthquake is detected by seismographs. The information of earthquake is released to the public through mass communication

systems such as television, radio, website and cell phone. The JMA regional office analyzes more precise earthquakes everyday and always checks all of the data including the very minor earthquakes.

During the mainshock of the Tohoku Earthquake on March 11, 2011 that generated the high tsunami, the JMA recorded the sea levels through the 25 observation points on the Pacific Coast of Tohoku. In the last 3 months, some big earthquakes were recorded in this JMA office, but no damage occurred on the building because most of the earthquakes were the short period vibration whereas the building itself had a long natural period, about 1 second under the small earthquake up to 4 seconds under the big earthquake due to the base isolation system.

According to the public survey by the JMA, the aftershock on April 7, 2011 was more fearful than the mainshock on March 11, it could be explained by the graph of response spectrum that had a long range of period from 0.2 to 1.2 second. Besides that, the event occurred at night while people at that time were sleeping and big vertical motion was felt larger because people were lying down. A graph of the aftershock which occurred on the April 9, 2011 was showed by Mr. Funakoshi. He explained that the aftershock had maximum intensity "6 upper" in Sendai City, while the intensity scale of the JMA are 0 to 7 with the scale 4, 5, and 6 are divided into the "lower" and the "upper".

After showing the activity of the JMA office, Mr. Funakoshi led the visitors to the strong motion installation building on the western side of the Sendai Governmental Office Building #3. It was a square reinforced concrete building with the seismograph installed on the base floor about 3 meters below the ground surface. The office room and the strong motion installation are shown in Photo 3.

(a) (b) (c)

Photo 3. JMA Sendai Regional Office (a), Strong motion installation building (b), and Strong motion instruments (c)

There were many types of the seismograph which were placed on the massive concrete block with the rectangular shape about 150x350x80 cm3, from the old types to the new one. The old seismographs were operated from 1960 to 1990 and manually recorded the strong motion to the sheets of paper and archived on the shelves placed in the same room with those seismographs. All of the data on papers had been copied in the microfilm files to save the contents of the data records and to be quickly accessed. Now, the newest seismographs record the data to the computer server, and there are two sensors: one is the main strong motion sensors and the other is used to monitor the noise for correcting the data records.

3. Conclusions

By visiting the Sendai Government Office Building #3, we witnessed the effect of retrofitting and seismic base isolation system on the building that evidently enhanced the building safety under a big earthquake such as the mainshock of the Tohoku earthquake that occurred on March 11, 2011.

Monitoring on seismic activity as well as volcanoes are very important to carry out, in order to increase awareness and to provide early warning for society, hence reducing a risk of the disasters. Data records of seismic and volcanic activities can be used to study its phenomena for more understanding of natural disaster characteristics to support the effort in reducing the disaster risk.