INTERNATIONAL INSTITUTE OF SEISMOLOGY AND
EARTHQUAKE ENGINEERING (IISEE)

# REPORT OF STUDY TRIP (TOHOKU)

14 – 18 November 2011

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**Day 1: 14th November 2011 (Monday)**

## Introduction

We went to the study trip in Tohoku District which was arranged by International Institute of Seismology and earthquake Engineering (IISEE). We left JICA Tsukuba by JICA bus at 7.40 am on Monday 14th November 2011 heading to Hitachino-Ushiku Station. From there we took a train to Sendai station transit at Ueno Station. It took about 2 hours and half to reach Sendai. Upon reaching Sendai City, we went to Tohoku University.

## Tohoku University

We went to Disaster Control Research (DCC) of Tohoku University to meet Dr. Suguwara. Before leaving, we had a chance to see a damage of a building caused by the Tohoku earthquake. There was a crack at the second floor of the Civil Engineering building with approximate height of 10 meters from the ground. From here, we visited the damaged places hit by tsunami of the Tohoku earthquake on March 11, 2011.

**Figure 1.1**. Traces of crack at Civil Engineering building in Tohoku University.

## Arahama Beach

After that we visited Arahama area, the most devastated area, accompanied by Dr. Suguwara. He guided us visiting around the inundation area. The first place we stopped by was a paddy field for sediment observation purposed. This point located within 4 km of the inundation area and totally destroyed by the tsunami in March 2011. After 8 months it was still undergoing reconstruction process. We found the deposit of the 869 Jogan tsunami below the volcanic ash from the 11,000 – 12,000 years ago which erupted 300 km away from this place.

Then, Dr. Suguwara guided us to a small shrine nearby. This shrine was located approximately 1 km from the coastline and the only place which was safe from the tsunami. The inundation height in this area was about 1.5 m.

We then visited Arahama village near Arahama Beach. The population here was approximately 20,000 – 30,000 and 200 casualties reported with 1 death. According to Dr. Suguwara, 30 cm land subsidence was observed during the earthquake and tsunami arrived 70 minutes after the

quake. A 12 meters run up and 10 meters inundation height were observed in this area. However the watermark cannot be traced anymore. This residential area has been prohibited to live in future.

**Figure 1.2.** The broken sea wall in Arahama Beach.

**Figure 1.3.** Tsunami Siren collapsed in Arahama Beach.

**Figure 1.4.** Hand Auger.

**Figure 1.5.** Deposit of the 869 Jogan tsunami.

The seawall of 5 meters height and the breakwater was broken. As this beach was a tourist attraction, a tsunami siren had been installed. However, it was collapsed and broken.

We moved forward to another paddy field located about 2.7 km from the coastline for another sediment observation. Hand auger was used to dig up some soil. We found the 869 Jogan deposit and a layer of older tsunami deposit beneath. It is believed to be a tsunami soil of the tsunami that occurred 2000 year before the Jogan tsunami. The layer below was unidentified except for the grey layer at the bottom part identified as paleo soil which contained rice paddy field.

**Day 2: 15th November 2011 (Tuesday)**

On the second day, we visited Matsushima. It is a group of islands in Miyagi prefecture. The area was protected by its natural geography and suffered less damaged from the tsunami of the Tohoku Earthquake. The observed tsunami height was from 1 – 2 m. The evacuation area was about 500 meters from the coastline and the signs were found on the sidewalk.


**Figure 2.1.** Small islands in Matsushima which reduced the tsunami impact.


**Figure 2.2.** Broken tide wall in Matsushima.

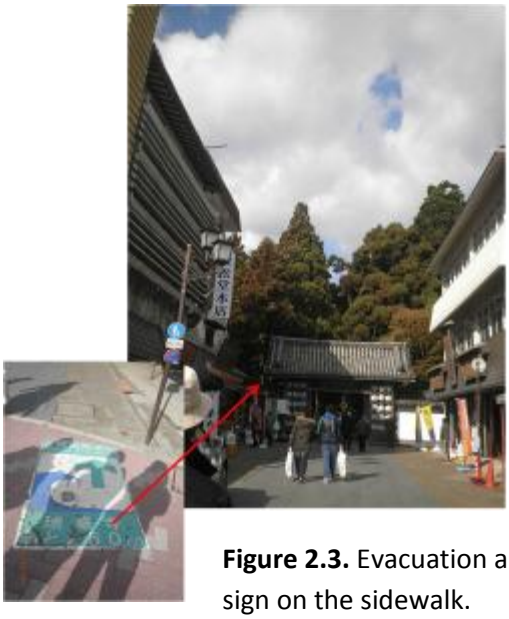

**Figure 2.3.** Evacuation area sign on the sidewalk.

**Figure 2.4.** View of Ishinomaki City from Hiyoriyama Park.

We then continued to Ishinomaki City. From the bus window, we could see the damages along the way. We could see an overall damaged view of Ishinomaki City from Hiyoriyama Park. The city was among the most seriously affected by the March 11, 2011 tsunami. The waves inundated 600 m inland, 60 minutes after the earthquake.

From Ishinomaki we went to Onagawa town. The 15 m height of evacuation area in the hospital area was flooded with tsunami up to the first floor of the hospital building. The inundation height was approximately 20 m and the land was subsided 1.2 m.

There were a few collapsed buildings in Onagawa town. Some buildings were shifted from its original location about 70 m away. However, they were removed when we visited there.

We observed a building which collapsed in the opposite way of the tsunami propagation direction. It is believed that the building was collapsed due to the receding tsunami wave current. Some other buildings were partially damaged.

**Figure 2.5.** The collapsed RC building in Onagawa town. View from the evacuation point (15 m from the ground level).

**Figure 2.6.** Sea water covering the road around the building describes the land subsidence.

Farther inland about 1-2 km from the coastline, we could still find tsunami damage. The water level reached the first floor of the three storey residential apartment.

On the way to Minami Sanriku, we stopped by the Okawa Elementary School which was the most effected school in Ishinomaki. We were explained by a coordinator Mr. Okada in the bus and we were not able to take any photos. The school was affected by the tsunami wave. From 108 pupils, about 20 – 30 pupils were taken home by their parents' minutes after the evacuation alert was issued. The remaining pupils and teachers were evacuating (more than half an hour after the tsunami alert) when the tsunami came. Only 1 teacher and 3 - 4 pupils survived since they went up to the higher ground behind the school.

**Day 3: 16th November 2011 (Wednesday)**

On the third day, we were at Minami-Sanriku visiting the Crisis Management Department at its tentative location. This place was athletics and culture centre, but became tentative city hall as the original city hall was severely damaged. 1,200 people came here after the earthquake for evacuations.

Here we met two of the survivors from the tsunami disaster, Mr. Kazuto Oikawa and Mr. Kazuma Goto. We were accompanied by both of them to see the pictures around the town. Both of them shared their experience with us and then after accompanied us visiting the damaged town of Minami-Sanriku. Minami-Sanriku was largely destroyed by the tsunami of the Tohoku earthquake with most buildings swept away by the 16 m waves and over half of the population went missing and almost certainly dead.

Among the totally destroyed buildings was the disaster mitigation centre of 12 m height. The building was totally damaged when a 16 m of tsunami height came. 2 people died in this building while giving evacuation instruction. A 6 m high breakwater was also broken. Land subsided about 1 m and wave inundated 3 km inland.


**Figure 3.1.** Disaster Mitigation Centre in Minami Sanriku.

Mr Goto was at Tokura Junior High School located at 20 m above sea level at the time of earthquake occurrence. Later he evacuated at the higher ground nearby his house together with his family. Tsunami came up until the top of the first floor of the school building. The school now is still close for renovation. It will resume its operation in April 2012.

We went to Kamaishi through Kesennuma, Rikuzen Takata and Ofunato. In Kesennuma, the fishing harbor and the break water as well were completely destroyed.

15 minutes drive from Kesennuma, we reached Rikuzen Takata. The town was completely destroyed. The 6.5 m high of seawall was broken and not enough to protect the city against the

tsunami wave in March 11, 2011. Most of the building has swept away. Of all the damages, only 1 pine tree survived from the tsunami. It is called “a pine of hope”.

In Ofunato Bay, we found a broken monument of 1933 Showa Sanriku tsunami. About 200 m away we found a monument of 1896 Meiji Sanriku tsunami still intact on the ground. The area was inundated during the tsunami in March 2011.


**Figure 3.2.** The broken monument of 1933 Showa Sanriku tsunami in Ofunato Bay.

**Figure 3.3.** The 1896 Meiji Sanriku tsunami monument in Ofunato Bay.

In Ryori area, there were a marker pole indicated that 1896 Meji Sanriku tsunami inundated in this area as high as 38.2 m.

Later we went to Shirahama beach. The tsunami height recorded in this area was about 10 m. The 7.6 m height of sea wall was totally damaged left only the broken tsunami gate. Temporary barrier were set up to prevent the overflow of seawater during high tide.

**Figure 3.4.** The broken sea wall at Shirahama Beach.

**Figure 3.5.** Temporary barrier to prevent overflow of sea water.

**Day 4: 17th November 2011 (Thursday)**

In Kamaishi, we visited Kamaishi Port Office. Mr. Kawai Masanobu of Ministry of Land, Infrastructure & Transport gave explanation about the condition after the tsunami disaster in March 2011. In the Kamaishi Port office itself tsunami height was up to approximately 1.5 m. the watermark was still observed inside the port office.

A GPS gauge was installed 20 km from the coast and it recorded 6.7 m height of wave height offshore. Upon reaching the coast, the wave became 2 – 3 times larger which caused the tsunami. Tsunami height inside the bay was between 8.1 – 11.7 m whereas tsunami height outside the bay was between 12.5 – 18.3 m. The breakwater which was completed in 2009 reduced the tsunami impact 40% and delayed it arrival time by 6 minutes. The breakwater then was severely damaged.

This breakwater was the deepest breakwater and one of the counter measures that have been established in Kamaishi because it was hit by many tsunamis in the past; 1896 Meiji Sanriku tsunami, the 1933 Showa Sanriku tsunami and the 1960 Great Chilean tsunami. The breakwater was located at the bay mouth. It consisted of north and south part with length of 990 m and 670 m respectively. The entire 990 m length of the northside of the breakwater was broken whereas 300 m from the entrance to the south side of the breakwater remained intact but the following 370 m had sunk.

We then visited the Kamaishi port to see the breakwater closely. The port area was subsiding 0.6 m and it caused the increasing of water level. Temporary barrier were set up to prevent the overflow of seawater during high tide.


We also visited Unosumai beach area to observe the tsunami damaged. The area was slightly higher and therefore high level of tsunami wave wasn't expected in this area. Tsunami came inland and the damaged nearly the first floor of the nearby hotel which had been designated to be the evacuation building then.

**Figure 4.1.** The collapsed sea wall in Kamaishi Bay.

There were Unosumai Elementary School and Kamaishi East Junior High School nearby, which located out of the inundation area in the tsunami hazard map. They made a wise decision to evacuate to a higher ground. No casualties reported from both schools. Students from both schools were well educated regarding such disaster.

In Aneyoshi District of Miyako City, there was a monument of the 1896 Meiji Sanriku tsunami. The monument marked the inundation limit of the Meiji Sanriku tsunami in 1896 with 30 – 40 m runup in this area. In March 2011, inundation height was between 19 – 23 m with 40 m runup with limited inundation area compared to the Meiji Sanriku inundation area.

Next we visited Miyako City. The building was located along the Heigawa River. On March 2011, the city was devastated by the tsunami of the Tohoku earthquake. The wave overflowed over the tide wall and damaged the first floor of the Miyako City Hall building. By now, watermarks have been cleaned up. The inundation depth was 4 – 5 m and runup 37.9 m almost equaling to the 38.2 m record of 1896 Meiji Sanriku tsunami.

**Figure 4.2.** 1933 Showa Sanriku tsunami in Jodogahama Beach.

**Figure 4.3.** 1960 Chillean tsunami in Jodogahama Beach.

In Jodogahama beach area, 2 monuments were here as the evidence this area was hit by Showa Sanriku and Chilean tsunami in 1933 and 1960 respectively. Jodogahama beach was also damaged by tsunami in March 11. 2011. The place now has been restored and no debris can be found here. However the trace of water level can be seen from the hills and trees nearby.

**Day 5: 18th November 2011 (Friday)**

On the final day, we visited Taro area in Iwate Prefecture. The town had two 10 meter tall seawalls to prevent flooding from tsunami. The seawalls were designed to divert tsunami water to the side of the town, so that the damage of the residential area was minimized from tsunami as high as 15 m. However, the seawall did not protect the town when an earthquake and tsunami struck Japan on 11 March 2011 with a height estimated from 12 m to 37.9 m. The residential area was totally destroyed and the areas now are in clearing process. There were a few buildings still standing only with its outer frame intact. One of them is Taro Kanko Hotel.

**Figure 5.1.** Embankment in Taro.

**Figure 5.2.** The road in Taro was designed for easier evacuation.

We went up to the higher ground which had been designed as the evacuation place in this area. According to the local resident that we met there, about 40 – 50 peoples came here for evacuation. The road in this town had been designed in such a way to make it easier for evacuation. It didn't have this normal 90 degrees corner instead it was built as in diamond shape to make the road bigger for easy evacuation escaped (Figure 5.2). We went to the Taro Kanko Hotel to have a better look of the damaged. Damaged can be observed up until level 3 of the building, which was about 12 m from ground level.

Both Meiji Sanriku and Showa Sanriku tsunami has inundated this area in 1896 and 1933 respectively and devastated the town. The water level from both events were marked on the rock as shown in Figure 5.4. Clearly, the tsunami from the Tohoku earthquake was larger than both Meiji and Showa Sanriku tsunami. The evidence can be observed from the debris found higher than the Meiji Sanriku water level mark.

Our final destination was Koborinai Port in Miyako City. The highest run up of March 11, 2011 tsunami was recorded in this small fishing port at 37.9 m. The tsunami went up the valley and it was explained be the debris we found up side the valley. The port was located in low land, sandwiched between two mountains which may have contributed to the big wave size.

There were voluntaries collecting and clearing the debris in the port area.


**Figure 5.3.** The damaged building in Taro.

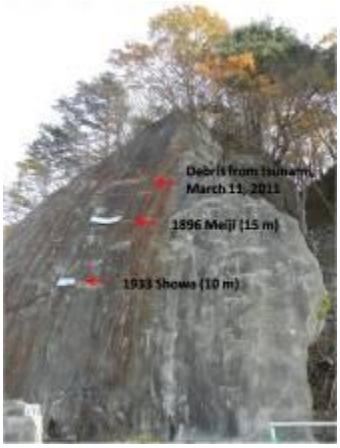


**Figure 5.4.** The previous tsunami water levels were mark on the rock.

**Figure 5.5.** Koborinai Port.

## Conclusion

Although Japan is well prepared for the tsunami disaster with its great sea wall, break water, dike as well as controlling forest also the awareness and education, this huge disaster cannot be prevented as in total. This strong tsunami wave cause massive damage few kilometers from the beach. Therefore, we cannot underestimate the power of tsunami,