INTERNATIONAL INSTITUTE OF SEISMOLOGY AND EARTHQUAKE ENGINEERING (IISEE)

REPORT OF STUDY TRIP (TOHOKU)

14 – 18 November 2011

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T course
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DAY 1: NOVEMBER 14, 2011

On March 11, 2011, a giant earthquake struck in Japan followed by tsunami. The earthquake and tsunami caused many casualties in Japan, approximately 20,000 people died or missing. The purpose of the study trip in Tohoku-Sanriku is to know the current conditions of Miyagi Prefecture and Iwate Prefecture after hit by the tsunami, to learn real condition when tsunami struck in Japan, and to learn how tsunami warning system worked when tsunami came to Miyagi Prefecture and Iwate Prefecture. First, we visited Tohuku University where we saw the Faculty of Civil Engginering building damaged at the second floor.

Figure 1. Damage in Faculty of Civil Engginering.

Next, we visited Arahama beach which is located in Miyagi Prefecture, Tohuku, with coordinate: 38.042 N, 140.905 E. Dr. Daisuke Sugawara(Disaster Control Research Center (DCRC)), specialist in geology and paleotsunami, guided us to explain tsunami hit on Arahama beach.

In Arahama we found deposit tsunami from the Jogan Earthquake in 869, the sediment can be traced up 4 km from the coastline.

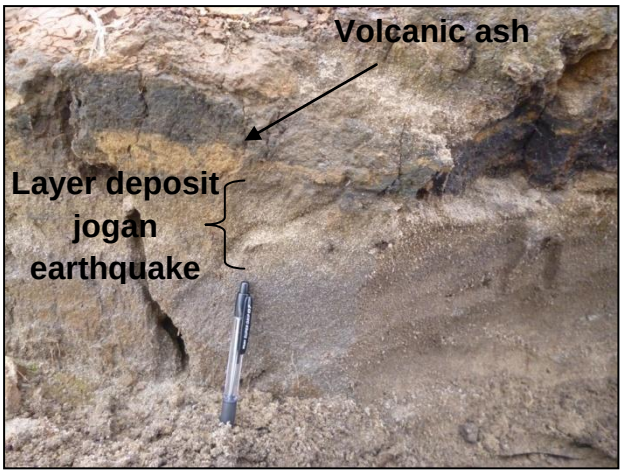

Figure 2. Layer deposit from Jogan Earthquake with thickness 3 cm.

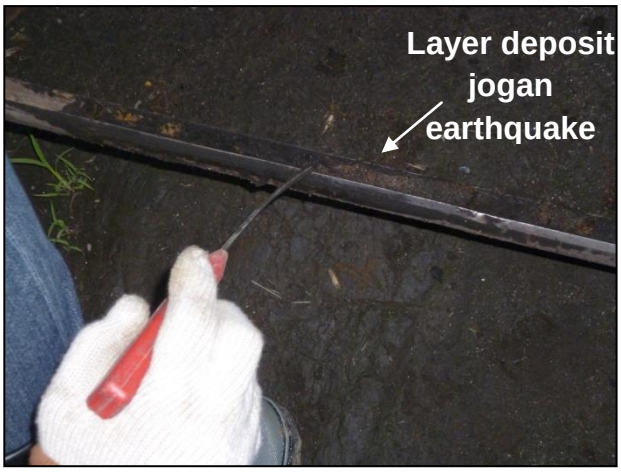

Figure 3. Layer deposit from Jogan Earthquake using drill hand method (auger).

The sediment deposit from Jogan tsunami with thicknesses approximately 3 cm, upper the layer it's volcanic ash (915), below the layer we found another deposit from the previous tsunami. In figure 3 we find the similar deposit from the jogan tsunami.The sample data were taken at 2.7 km from the coastline by using a drill hand (auger). I asked Dr.Sugawara how to estimate the time the Jogan earthquake occured. He said, distribution of sample data and dating molusca or any sediment on Jogan sediment layer we can estimate time of occurence the tsunami, of course the result maybe any residual error, to minimilize the error we can compare from the historical records.

In Arahama approximately 200 – 300 people died due to the tsunami on march 2011, we found an elementary school building still standing. Only 1 student died in the elementary school. The sirens we found were broken near the coastline.

Figure 4. Elementary school building still standing in Arahama beach.

Figure 5. Siren has broken, near coastline.

Subsidence in Arahama was 30 cm. After the tsunami on March 11, 2011, local governments now prohibit to construct a building or a house near the beach in Arahama.

DAY 2: NOVEMBER 15, 2011

The first place we visited was Matsushima in Miyagi prefecture which is one of the 3 most beautiful places in Japan. The other two places are Amanohashidate in Kyoto prefecture and Itsukushima in Hiroshima prefecture. Matsushima consists of many tiny islands *(shima)* of some 260 and it is covered with pines (*matsu*). The size of the tsunami hit the coastline in Matsushima was not too big, because Matsushima was sorrounded by many islands. Tsunami hight in Matsushima was about 2-3 m with inudation around 250 m from the coastline or near the Zuiganji Temple (38.372178 N, 141.059597 E). The victims of the tsunami evacuated to the Zuiganji temple.

Figure 1. Matsushima sorrounded by many islands.

Figure 2. Some little damaged but still visible on the beach of Matsushima.

The second place we visited was Ishinomaki (38.42 N, 141.3 E) known as the large fish market. We found a manga museum and a replica of the statue of liberty there (Figure 3). Tsunami hight in Ishinomaki was about 10 m, and the total number of confirmed dead were 3000 in Ishinomaki. Subsidence in Ishinomaki was about 0.78 m. Okawa Elementary school in Ishinomaki was completely destroyed and 75 of 108 students and 10 of 13 teachers and staff were killed. The teachers and students evacuating from the school were killed when tsunami crossing a nearby river bridge. One teacher and 3 students were saved since they went up to the hill. According to the story of a teacher in the classroom, they did not immediately evacuate. Since a tsunami warning said that tsunami hight would be only 3 m, the teacher still stayed in the school. After she knew that the tsunami was more than 3 m, they evacuated by going up the hill. From here we learn the lesson that when there is a tsunami warning, we should evaquate quickly and we must know whether the area around us is safe and evacuation is needed or not.

Figure 3. Replica of the statue of liberty still standing after hit by tsunami.

The last place we visited was Onagawa (38.44 N, 141.45 E). Tsunami hight in Onagawa was approximately 20 m with inudation about 1 km. Over 1,000 people died or missing in Onagawa. Most people evacuated to Onagawa Hospital (Figure 5).

Figure 4. Situation at Onagawa Town November 15, 2011.

Figure 5. Onagawa hospital is used for evacuation building.

Near Onagawa, we found a region far from the coast line at which the tsunami reached. Tsunami reached this place due to the overflow of the river (Figure 6). Inudation of tsunami was affected by topography of the region. In this region we saw a municipal house which will be used as the Onagawa Tsunami Memorial Museum (Figure 7).

Figure 6. Tsunami follows the flow of the river.

Figure 7. Municipal house.

DAY 3: NOVEMBER 16, 2011

Minami Sanriku (38.68 N, 141.45 E) is a town with large fish market with population about 18.000. Mr. Kazuma Goto, one of the survivors of the tsunami, gave us an explaination about the time the tsunami hit the Minami Sanriku. After the Chili tsunami hit Japan, Minami Sanriku built the break water (sea wall) with hight around 5 m. Now the break water was broken after the tsunami on March 11, 2011. The shake of Earthquake on March 11, 2011 was about 6 minute with intensity 6 (jma intensity). I asked Mr. Kazuma Goto how the tsunami hit Minami Sanriku 9 times in March 11, 2011. He said, like a stone dropped into water, the first wave was large, followed by other waves. He gave us advice that "we should make friends with nature and neighbors around us. Now the town of Minami Sanriku almost dissapear with 2,188 people missing or died".

Figure 1. Crisis Management Department.

Figure 2. Elemantary school in Minami Sanriku stiil standing, all students were safe.

One of the officials in Crisis Management department died as a hero. According to the explanation, she stayed in the building (Figure 1.) to give warning to people, and when tsunami came, she did not have enough time to evacuate. One example to show how important it is for us to make friends with nature is the case of an elementary school in Minami Sanriku. All students in the elementary school were safe, the teacher quickly evacuated them to the safe place. Before the earthquake of March 11, 2011, they had experince of the earthquake on March 9, 2011 (38.440°N, 142.840°E, 168 km E of Sendai, Honshu, Japan. Mag 7.3 (USGS)) after the earthquake they discussed how they evacuated if a big earthquake occur in the future.

In Kesen'numa (38.88 N, 141.58 E) the break water (sea wall) was broken, the subsidence in Kesen'numa was about 0.74 m, we found the big ship stranded about 100 m from the coastline.

Rikuzen-Takata (39.02 N, 141.38 E) is a city in Iwate prefecture. One famous place in Rikuzen-Takata is Takata-Matsubara with a green pine forest of about 70,000 trees which are over 300 years old. Now after the earthquake on March 11, 2011 only one pine tree is still standing. The pine tree is a symbol of hope for people who lost everything after the earthquake. Subsidence in Rikuzen-Takata was about 0.84 m, a list of all subsidences in Japan is shown in Table 1 (original source: http://www.gsi.go.jp/sokuchikijun/sokuchikijun40003.html).

Figure 3. Break water in Kesen'numa was broken.

Figure 4. Pine tree symbol of hope.

Table 1. Subsidence around Japan.

No	City	Subsidence (meter)
1	Miyako, Iwate	0.5 m
2	Yamada, Iwate	0.53 m
3	Otsuchi, Iwate	0.35 m
4	Kamaishi, Iwate	0.66 m
5	Ofunato, Iwate	0.73 m
6	Rikuzentakata, Iwate	0.84 m
7	Kesennuma, Miyagi	0.74 m
8	Minamisanriku, Miyagi	0.69 m
9	Oshika Peninsula, Miyagi	1.2 m
10	Ishinomaki, Miyagi	0.78 m
11	Higashimatsushima, Miyagi	0.43 m
12	Iwanuma, Miyagi	0.47 m
13	Soma, Fukushima	0.29 m

The last place we visited was Ofunato (39.07 N, 141.72 E). Ofunato is a coastal city in Iwate Prefecture with population approximately 42,000. Tsunami on March 11, 2011 caused heavy damage in Ofunato, tsunami hight was around 23.5 m with inudation about 3 km. Subsidence in Ofunato was about 0.73 m. In Ofunato, we found old monument for Showa sanriku tsunami hit and disappeared by tsunami on March 11, 2011, but another old monument for Meiji sanriku tsunami still standing.

Figure 5. Old monument of Showa tsunami disappear.

Figure 6. Old Monument of Meiji tsunami still standing.

DAY 4: NOVEMBER 17, 2011

On the Day 4, the first place we visited was Kamaishi (39.27 N, 141.88 E). The break water in Kamaishi was the deepest in the world with 1,950 m long and 63 m in depth. After the earthquake on March 11, 2011 the break water was broken, but the break water succeeded in reducing the power of the tsunami. Mr Kawai from MLIT (Ministry of land, Infrastructure, Transport, and Tourism) explained the break water can reduce the run up until 50% and make additional time for evacuation about 6 minutes. I asked Mr Kawai if the break water will be rebuilt in the future. He said, yes, and the target to rebuild the break water is 5 year. The target is very short, bacause the community need mental readiness to prepare tsunami in the future.

Figure 1. Break water on Kamaishi port was broken after the earthquake on March 11, 2011.

Figure 2. Kamaishi East Junior High School after the earthquake March 11, 2011.

Approximately 2,000 people died or missing in Kamaishi port. Subsidence in Kamaishi was about 0.66 m. In Kamaishi about 2,900 students as well as Kamaishi East Junior High School survived. The teachers and students very quickly responded and evacuated to the higher place. The students had a learning and participated in tsunami drills guided by the disaster prevention education program to learn how to escape from an earthquake and tsunami.

The next place we visited was Aneyoshi, Miyako. In Aneyoshi we visited a memorial statue of the great tsunami. The statue told us “Remember the calamity of the great tsunamis. Do not build any houses below this point”. Tsunami on March 11, 2011 did not reach at this point (the memorial statue) but run up in this place was highest about 40 m.

Figure 3. Memorial statue of great tsunami.

Figure 4. Run up at Aneyoshi about 40 m.

Then, we visited Miyako (39.64 N, 141.96 E). Tsunami hight on Miyako city was about 2–3 m, the sea wall reduced the power of tsunami. Figure 5 shows the situation of Miyako city right now which was cleaned very quickly.

Figure 5. Situation at Miyako City November 17, 2011.

The final destination we visited was Jodogahama (beach of heaven), a beautiful beach in Japan. We saw the monuments of Showa tsunami and Chili tsunami. The damage by the Tsunami on March 11, 2011 was not so much in Jodogohama.

DAY 5: NOVEMBER 18, 2011

Taro (39.734 N, 141.968 E) is a town in Miyako city in Iwate prefecture. Taro had break water and 4 seawalls with hight of 10 m from sealevel, but after the earthquake and tsunami on March 11, 2011, break water was broken and the east part of the seawall was broken as well

We can compare the situation of Taro town before March 2011 (Figure 1) and after March 2011 (Figure 2).

Figure 1. Taro before March 2011 (picture from Dr. Yushiro Fujii).

Figure 2. Situation of Taro on November 18, 2011 .

The east part of taro town was totaly broken, of course because the seawall in east part broken, compare than the west part. West part of Taro town we found tsunami high about 4.5 m, and in east part we found tsunami high about 12 m. Actually in Taro town the highest tsunami is around 20 m. Subsidence in Taro (Miyako area) is about 0.5 m.

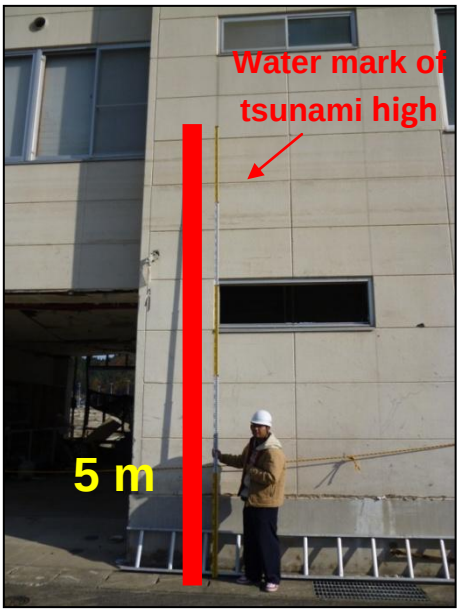

Figure 3. Tsunami hight in west part of Taro town, 4.5 m.

Figure 4. Tsunami hight in east part of Taro town (Taro Hotel), 12 m.

In Taro town we visited the sign of Meiji Sanriku Tsunami (1896) about 15 m, and Showa Sanriku Tsunami (1933) about 10 m. The tsunami on March 11, 2011 was bigger than Meiji and Showa by about 20 m. The final place of Tohuku-Sanriku trip we visited was Koborinai Fishing Port (Miyako), in this place tsunami hight was about 37.9 m (Tsuji et al., 2011).

From this trip, we concluded that condition of the cities in Miyagi Prefecture and Iwate Prefecture now are better than March 11, 2011. The streets, electricity and water networks were repaired. In real condition if tsunami will hit around us we must know the safe area for evacuation and we must quickly evacuate if we see or hear tsunami warning. Tsunami early warning system has been running well, warning message, sirens, evacuation routes, break water, sea wall etc. have worked well to reduce casualties. In the future we should be able to improve the quality of tsunami early warning system.

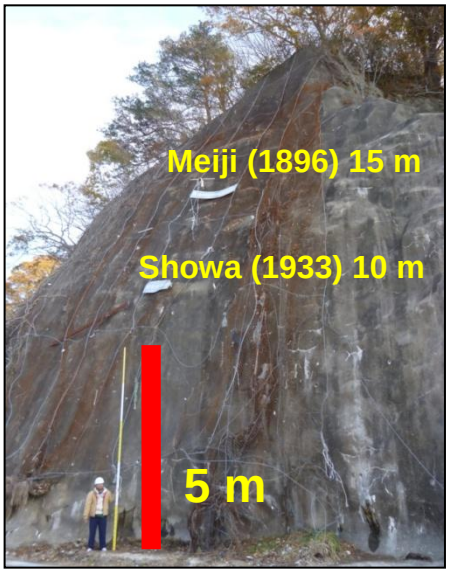

Figure 5. Tsunami sign on the stone.

Figure 6. Koborinai Fishing Port, tsunami run up in this place about 37.9 m.