

INTERNATIONAL INSTITUTE OF SEISMOLOGY AND
EARTHQUAKE ENGINEERING (IISEE)

REPORT OF STUDY TRIP (Niigata & Miyagi Prefectures)

14 – 17 November 2011

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INTRODUCTION

Under the guide of our instructor Dr. Yokoi and coordinator Mr. Ajima, all participants of earthquake engineering and seismology course had a study trip to Niigata and Miyagi Prefectures in Tohoku Area of Japan from Monday, 14th November to Thursday, 17th November, 2011. Our itinerary includes three cities or towns: Nagaoka City, Ojiya City, Sendai City and Onagawa Town. In Niigata Prefecture which suffered the 2004 Chuetsu earthquake, we were given a lecture on the disaster and recovery of the earthquake, and had a field trip to the disaster area. In Miyagi Prefecture, the focus of our study trip was the 2011 Tohoku earthquake and tsunami. The remains in hit area showed us the horrors of the disaster. The lecture in Tohoku University helped us understand the causes and process of the 2011 Tohoku earthquake, the main methods of crust deformation observation and difficulties of earthquake prediction. Through this study trip I got deep impressions about earthquake disaster emergency and recovery in Japan. All of the knowledge is very useful and instructive for my country and my city.

NIIGATA PREFECTURE

Our travel began at the morning of Monday, 14th November. We went to Ueno station by Joban Line and transferred to Joetsu Shinkansen. By the superexpress train, we got Nagaoka City in Niigata within two hours. Niigata is the most famous rice producing area in Japan, the agriculture is well developed. Along the way, the scenery of farmlands and mountains were very beautiful. The 2004 Niigata Prefecture Chuetsu Earthquake occurred here and caused great damages. After storing our luggage at hotel, we first visited the Nagaoka Earthquake Disaster Archive Center.

Nagaoka Earthquake Disaster Archive Center

After the earthquake, the local government of Nagaoka City built lots of memorial halls and earthquake ruins parks, collectively referred to as the Chuetsu Earthquake Memorial Corridor. Nagaoka Earthquake Disaster Archive Center is one important part of the “corridor”.

At first, Mr. Higuchi from the Regional Development Strategy Department of Nagaoka City government gave us a lecture on the 2004 Chuetsu Earthquake, Disaster and Recovery: The earthquake occurred on October 23rd, 2004. Although the magnitude was 6.8, not particularly large, the intensity got upper 6 even 7 in some districts of Nagaoka. Nagaoka City was also the worst-hit area, accounted for majority of the casualties and housing damage in Niigata Prefecture. Mr. Higuchi showed us the newspapers at that time in his commentary (Fig 1.). I had an intuitive understanding of the severity of the Chuetsu earthquake.

The recovery, reconstruction and development after disaster were the focus of the lecture. Mr. Higuchi introduced us the Nagaoka City recovery plan and implementation programs at great length. The post-disaster revival was not only simple reconstruction and instauration, but also comprehensive development. To formulate recovery plans, Nagaoka local government extensively solicited and collected the views of the community: In addition to the Municipal Executive Council,

the mayor organized the Recovery Committee composed of Scholars and professionals, and carried out the forums with people in disaster areas. Government staff had repeatedly field survey and visit, etc. Finally, the recovery plan was carefully worked out, and constantly revised in the implementation.



Figure 1. Collections of the newspapers reported the earthquake disaster in Nagaoka Earthquake Disaster Archive Center

According to the plan, the recovery of Nagaoka City was divided into three main parts: boosting the public confidence in safety and security, revitalization and promotion of the economic and social vitality of the affected areas, and sustainable development of mountain areas. As of 2010, the restoration phase and resuscitation phase of the plan had already been completed. The most important and basic parts of recovery plan, e.g. the anti-disaster reinforcement of traffic network, the ensurement of the safety of mountains, rivers and residential houses, the repair and update of public facilities had implemented.



Figure 2. Getting the information of the Chuetsu Earthquake disaster area on the detailed satellite map by ipad

After the lecture, we observed the video and image data of the Chuetsu Earthquake disaster in Nagaoka Earthquake Disaster Archive Center. In the hall of the center, a Chuetsu Region satellite map which almost covered the entire floor attracted our attention. At that time, the staff of the center distributed the ipad Tablet PC to each of us. Under their guidance, we found that we could identify the affected areas are specifically identified on the satellite map through the ipad camera (Fig. 2).

When we touched a selected area on the ipad screen, the local disaster information would be retrieved and displayed: seismic intensity, casualties, building damage, and the comparison photos before and after earthquake, etc.

This earthquake disaster information display by using advanced IT technology is very innovative and vivid. I have never experienced before. I think that all the participants must be impressed with the disaster. In my country, the propaganda of earthquake knowledge for public, just through simple pictures and video, is relatively backward. This new approach is very worthy for reference.

Ojiya General Hospital, Base Isolated Building

After leaving the Nagaoka Earthquake Disaster Archive Center, we came to the Ojiya General Hospital to learn some knowledge about the base isolation and vibration control structure of building. Ojiya is a small city on the south of Nagaoka, where the Chuetsu Earthquake intensity level reached upper 6. The Ojiya General Hospital is located in the downtown of Ojiya city. In the earthquake, the main building of the hospital located at the edge of a hilltop was severely damaged. But the nearby building Suisen-no-ie (Welfare Nursing Care Center, Fig.3), which just located at the foot of the hill, was almost not affected.

In the basement of Suisen-no-ie, structural engineer Mr. Shinozaki introduced the base isolation system of the building (Fig.4). Although I did not learn something about Earthquake Engineering, I and other participants of seismology course were interested in the lecture. Through Mr. Shinozaki's explanation, I basically understood the concept and principle of base isolation structure. Relative to the cost of buildings, this system was not too expensive. But it can be very effective to resist strong motion, and protect buildings.



Figure 3. Welfare Nursing Care Center (Suisen-no-ie) of the Ojiya General Hospital



Figure 4. Base isolation system of Suisen-no-ie

Yamakoshi District

November 15th was the second day of our study trip. In the morning, we visited the Yamakoshi District of Nagaoka City. The name Yamakoshi had been heard and seen many times in the Nagaoka Earthquake Disaster Archive Center. It is a small mountain village near the epicenter, whose intensity reached upper 6 in the 2004 Chuetsu earthquake. In order to learn details of the earthquake damage in this village, we first visited the Yamakoshi Branch Office.

Staffs of the office were very hospitable to us. In the conference room, they introduced the situation of the disaster and recovery work of Yamakoshi village: There were five people died in the earthquake, 25 people were injured, and about 1,500 dwelling houses were damaged. The slope failures and landslides blocked roads and rivers, all communications were interrupted. All of the more than 2000 residents of Yamakoshi village were transferred by the helicopters of the Japanese Self-Defense Force.



Figure 5. Snow disaster after the 2004 Chuetsu earthquake in Yamakoshi (taken in the Nagaoka Earthquake Disaster Archive Center)

It was about to be winter at that time. According to introduction, the snowfall could reach 3 to 4 meters every year in this place (Fig.5). Therefore, the victims' lives were very difficult. Some people had to eat their expensive Nishikigoi Carps to stave off hunger. Fortunately, the disaster-hit area got help from many parts of Japan in a timely manner. Professional emergency rescue teams, volunteers and relief supplies arrived soon. 1,755 evacuees from Yamakoshi moved into the 631 temporary houses in Nagaoka City. They got meals prepared by volunteers.

Now, with the implementation of the Nagaoka City recovery plan, the resuscitation of Yamakoshi has been basically completed. Over 70% of the residents have moved back to the village and start their new lives.

After the presentation, time was approaching noon. Accompanied by a staff of the Yamakoshi Branch Office, we visited the remains of the earthquake, the residential houses built by government and the aquaculture industry in Yamakoshi.



Figure 6. The landslide and barrier lake caused by the Chuetsu earthquake in Yamakoshi Village

Collapse of the housing had been cleared long ago. The roads and tunnels had also been repaired. Even most of the failed slope of the mountain had been reinforced and re-planted vegetation. Wounds caused by the earthquake here were difficult to see now. But we still saw the remains of barrier lakes and landslides (Fig.6). The houses soaked in water in those days had been abandoned for a long time; almost buried to the roof by the soil taken by flood and surrounded by overgrown weeds.



Figure 7. Model units built by government in Yamakoshi

We then visited the model residential houses for the victims (Fig.7). These houses were built by government with excellent quality. Both exterior and interior are very beautiful. And the construction costs are cheap. The residents who cannot afford the construction costs will also be provided financial assistance.

Yamakoshi village is famous for its bullfighting and Nishikigoi carps. Unfortunately, the time we visited here was not in the bullfighting season, so we missed to enjoy the very unique culture. In carp farms, we saw the very beautiful Nishikigoi which is one of the Japanese national treasures. Yamakoshi people's optimism of life and love of the traditional culture deeply impressed us.

MIYAGI PREFECTURE

In the afternoon, we left Yamahoshi District. So far, half of our trip had passed. We changed Joetsu Shinkansen to Tohoku Shinkansen at Omiya station, and then went to Sendai City in Miyagi. Dr. Hara joined us here. When we arrived at Sendai, it was already evening. Sendai is the capital of Miyagi Prefecture, and is the political and economic center of Tohoku Region. Sendai City and the coast of Miyagi are the hardest hit areas of the 2011 off the Pacific coast of Tohoku Earthquake and tsunami. The serious damage in this disaster is the theme of our study trip here.

Sendai 3rd Joint Governmental Building

In the morning of Wednesday, 16th November, we first visited Sendai 3rd joint governmental building. This building was constructed in 1978. In 2007 to 2009, it was retrofitted to install the base isolator system. In the basement floor, we saw a seismoscope that uses a needle to record the trace of building vibration on a plastic plate. In the Tohoku Earthquake, It recorded the maximum displacement 18 cm (Fig.8). According to the staff, some seismoscopes at other places were broken during the shaking caused by the power of the shock. The needles couldn't turn back into the original position.

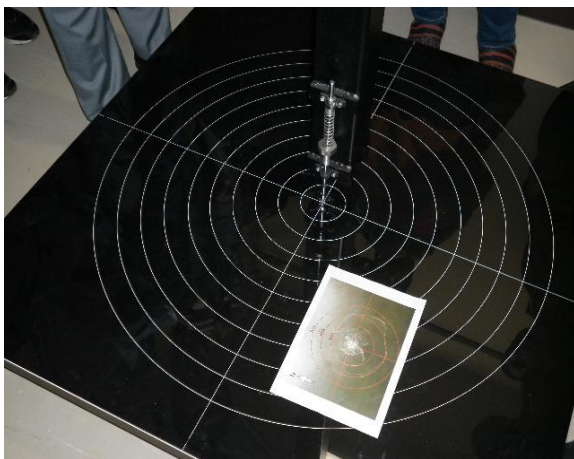


Figure 8. Displacement monitoring plate seismoscope



Figure 9. Minor damage of Sendai 3rd joint governmental building

Because of the the base isolator system, the main structural part of this building was almost not affected in the earthquake. Only some of the non-structural elements were damaged such as the fire resistant material (Fig.9).

Tohoku University, Research Center for Prediction of Earthquake and Volcanic Eruption

The Research Center for Prediction of Earthquake and Volcanic Eruption in Tohoku University was our next destination. Professor Norihito Umino received us. Before his lecture, Professor Umino led us to visit this research center. The center has a long history, can be traced back to 1912, when it was established for monitoring earthquake. There are many old types of instrument for earthquake monitoring and precursor observation (Fig.10). Some of them are no longer used, just kept as historical data, such as the Wiechert Seismometer. Some of them still work now.

In the tunnel under the research center at depth of 45m, we saw some crust deformation observations, such as water tube tiltmeter, quartz tube strainmeter, quartz pendulum tiltmeter and so on. Professor Umino explained the principles of these observations to us. My personal focus of work exactly is the crust deformation. The same or similar observation instruments are also used in my city.



Figure 10. Instruments for earthquake monitoring and crust deformation observation in the Research Center for Prediction of Earthquake and Volcanic Eruption

(Left: The Wiechert; Middle: Water tube tiltmeter; Right: Quartz tube strainmeter)

Professor Umino gave us a lecture in a small meeting room: At first He began with a brief history of the Research Center for Prediction of Earthquake and Volcanic Eruption. Then combined with the great Tohoku Earthquake he talked about the difficulties of earthquake prediction. In his view, various theoretical models of generation Mechanism of Earthquakes are too simple at present. In current theory, it is said that giant earthquake generally occurs in young oceanic plate subduction boundary. But the fact of great Tohoku Earthquake is contradicted: The age of the Pacific plate at northeast of Japan is old. The reason of Tohoku Earthquake cannot be explained well. Professor Umino encouraged us to study hard, and explore further in the future.

Onagawa Town

Onagawa town is located in Oshika District, at the northeast corner of Miyagi Prefecture. In the Tohoku earthquake and tsunami, it was heavily damaged. Under the effect of the superposition, the height of the tsunami in the shallow Onagawa bay got as high as 15 meters. The terrain of the town is flat without sufficient embankments or seawalls. All area within 3 kilometers inland was inundated. And most of the houses were swept away or overturned by the tremendous tsunami.

As shown in left of Figure 11, a hospital on the hill was located approximately 14 meters high from the below ground. Its first floor was all immersed in the tsunami. Most of the buildings near the seashore were completely destroyed by the strong waves, only left their foundations or ruins (Fig.11). Some of the places in Onagawa town were still covered by sea water. Dr. Yokoi told us there were over 1000 people missing, more than 700 confirmed dead in the disaster. Before coming to Japan, I had read a touching story happened here in Chinese newspapers: A director of a fish processing company named Sato saved his workers and 20 female Chinese resident trainees. He evacuated them to higher ground, but he was swept away.



Figure 11. Ruins in the Onagawa town after the tsunami swept through

(Left: Residual bases and the hospital on the hill; Middle upper and lower: Completely uprooted and destroyed buildings; Right: A three floors hotel facing the sea was totally inundated)

Sendai City: Tohoku Regional Development Bureau, Aoba Ward and Wakabayashi Ward

November 17th was the last day of our trip. The itinerary began at Tohoku Regional Development Bureau in Sendai City. We were given a lecture of emergency and recovery of “Eastern Japan Great Earthquake Disaster”. A lot of tragic scenes from closed-circuit televisions and helicopter aerial photography at Sendai were showed to us. Facing of helpless people in the video, I almost could not bear to look. The efficiency of the disaster response was amazing. According to report, just within one week, 97% of the national high ways in Tohoku were cleared up to ensure the rescue teams and relief supplies accessing the disaster area timely. When the quake happened, the Sendai airport had immediate subsidence and then was badly flooded by the subsequent tsunami. Besides submerging the

tarmac and runway, the water reached up to the 2nd floor of the passenger terminal. But on 13 April 2011, only one month later, the airport had reopened.

In the Aoba Ward of Sendai, we observed the ground failure caused by the quake. The residential area we visited was on a hill. Yokoi Sensei told us the ground of this area was made by earth-fill. The building bases here were not strong enough to resist the severe shake in the Tohoku Earthquake. As shown in Figure 12, the road had split and deformed. The walls along the ramp had tilted or collapsed. Because of the landslide, some houses on the hillside sank and almost tumbled down.



Figure 12. A residential area in Aoba Ward destroyed by the earthquake

Wakabayashi Ward was the last destination of our trip. This ward is located in the southeast coast of Sendai City. It was also severely damaged. As the same as Onagawa Town, a broad and barren ground came into view. There were only ruins of houses and some boulders washed ashore by the tsunami. Such a huge destructive power was beyond my imagination.

COMMENTS and CONCLUSIONS

The first visual impression I got in this study trip was that facing the overwhelming power of nature, human beings were so weak and helpless. Although scientists have made a lot of explore on earthquake prediction, we have to admit up to now the accurate forecasting of earthquake is impossible. However, these facts do not mean we have nothing to do but only wait for disaster. During this trip, I found that all the preparation of pre-disaster and the disaster emergency and recovery are well taken into account and meticulously implemented. Without these measures, I can image that the disaster losses will grow exponentially. In my opinion, all these practices are worthy of learning for the disaster mitigation. The innovative and vivid disaster education on earthquake and tsunami for the public is vital; the advanced base isolation and vibration control structure should be promoted in China. The government-led reconstruction and recovery should be more humanized and systematic.

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