Part I: Report on the GEJET 10:00 - 12:00

"Summary on the great East Japan earthquake and tsunami"

Prof Shoichi Yoshioka, Research Center for Urban Safety and Security, Kobe University

"The Behavior of 3.11 Tsunamis in the Sendai Plain and the Damage to the Disaster Prevention System"

Prof Akira Mano, Disaster Control Research Center, Tohoku University

"Present Status of Japanese Nuclear Power Plants and Radiation Disaster"

Prof Keiji Oda, Graduate School of Maritime Sciences, Kobe University

"Damage situations of ground, infrastructures and others"

Prof Yasuo Tanaka, Research Center for Urban Safety and Security, Kobe University

"Summary on the great East Japan earthquake and tsunami"

Prof Shoichi Yoshioka, Research Center for Urban Safety and Security, Kobe University

On March 11th 2011, the large earthquake and tsunami hit Tohoku region, northeast Japan. The Magnitude of the earthquake was 9.0, which is the fourth largest trench-type earthquake ever recorded in the world. The hypocentre was just off the coast of the Tohoku region and the depth was about 24 km. The earthquake fractured the plate boundary there, approximately 450 km in the north-south direction and 200 km in the east-west direction on the inclined plate boundary.

In Japan, large trench-type earthquakes tend to occur, for the Japanese islands are located where four different plates meet together. The oceanic Pacific plate is gradually subducting beneath the continental North American platewith a velocity of several centimeter per year. Last March, the continental plate released accumulated strain abruptly, causing the earthquake and tsunami in northeast Japan. The magnitude 7.3 Sanriku-oki earthquake, which occurred just two days before the Great East Japan earthquake, is considered to be its foreshock. Numerous aftershocks were also observed, including three major earthquakes with magnitude greater than 7.0 occurred in this region within one hour after the main shock.

The earthquake caused the crustal deformation in the Tohoku region. According to the data obtained at GPS stations, Tohoku region moved eastward about 5.3 m and subsided about 1.2 m. The crustal deformation can still be continued.

One of the characteristics of the Great East Japan earthquake is the damage caused by tsunami. A wave of more than 15 m high was recorded in various places along the east coast of Tohoku region.

Last April I visited some areas in the Tohoku region to survey

the tsunami height and to investigate its behaviour in the V-shaped bays. One area in Miyako City, where a large tsunami levee had been constructed, was entirely damaged and other area in Rikuzen-takata City, one of the most seriously damaged cities, everything was washed away. At Ryori Bay, which is a bay with small aspect ratio, the height of tsunami wave was amplified 1.3 to 1.9 times the size at the bottom of the bays. On the other hand at Hirota Bay, which is a bay with large aspect ratio, the amplification of tsunami was not found between the mouse and bottom of the bay. As a result of the survey, the damage caused by tsunami last March is considered to be depending on the shape of the bay.

"The Behavior of 3.11 Tsunamis in the Sendai Plain and the Damage to the Disaster Prevention System"

Prof Akira Mano, Disaster Control Research Center, Tohoku University

The coast affected by the tsunami is categorized into three parts, Sanriku Coast, Sendai Bay Coast, and Joban Coast. Sanriku Coast, a cliff coast in the north, is uplifting so tsunamis are amplified by collision. In the submerging south part of the coast, tsunamis are amplified by energy concentration and bay water resonance. In this area people had frequently tsunami attacks, especially in 1896 there were around ten to 25 metres high tsunamis.

In the Sendai Bay Coast, where a long, sandy beach and shallow water in the sea, tsunami propagation was very slow, resulting in some energy dissipation crossing the bay. Very low frequency in large tsunami is the greatest characteristic of this area. Joban Coast has similar characteristic. In a recent research a geologist found very old tsunami traces in 1869, Joban Tsunami, whose magnitude was about the same as that of 2011.

The Tsunami last march destroyed over 100,000 houses and killed around 20,000 people, although tsunami reached these areas about one hour after the main shock. Why couldn't people escape from tsunami before it reached them? One reason for the delay of evacuation is explained by the tsunami warning underestimate. The Japan Meteorological Agency (JMA) issued its first large tsunami warning just three minutes after the main shock, the estimated wave height is however, three metres in Iwate Prefecture, six metres in Miyagi Prefecture, and three metres in Fukushima Prefecture. They are too low compared with the actual tsunami height, and even lower than the levee height, so that the first warning gave some kind of relief to people. After 30 minutes, the JMA revised the warning that tsunami is much higher than estimated.

People however couldn't get the revised information, because of the blackout. So many aftershocks caused serious damages to the electricity facilities, for example televisions, and hazard information transfer systems, so that people were shut down from the information. In addition, traffic signals were widely stopped, it caused traffic jam and many cars on the road were washed away by the tsunami. And the blackout also caused the meltdown in the nuclear power plant in Fukushima.

There was historically a very good mitigation system along the Sendai Bay Coast composed of sandy beach, and coastal channels, forests, and levees, even though urban growth may have added vulnerability by clearing away some of the coastal forests. Reconstruction of robust levees requires restoration of broad beaches, and control of the return flow concentration through the development of coastal channels and forests.

“Present Status of Japanese Nuclear Power Plants and Radiation Disaster”

Prof Keiji Oda, Graduate School of Maritime Sciences, Kobe University

There are 17 nuclear power stations and 54 plants in Japan. Five stations are facing the Pacific Ocean and there are six units in Fukushima. In a steady operation, efficient products of radioactive materials are normally contained by pellet in the rod, which is the fundamental unit of nuclear fuel, and the pressure vessel of about 16 centimetres thick steel, and the containment vessel of about one metre concrete in the reactor building. In addition, all the plant stations facing the Pacific Ocean were constructed on the higher ground than the expected height of tsunami. Actually, the three units were operating at the moment of the huge earthquake, and all of them were successfully stopped. No additional fission energy was produced after scram. About 40 minutes later, however, the 15 metre high tsunami, much higher than expected, destroyed everything needed for cooling system, leading to the heartbreaking accident of meltdown.

In the reactors number 1, 2, 3, the temperature of the fuel rose and increased up to 1,000 degrees as a result of loss of cooling system. At such a high temperature, the metal reacts chemically with the pressurized water, producing hydrogen gas. This very light gas permeated through the small gap of metal and accumulated in the upper area of the reactor building. It was a matter of time before the hydrogen explosion releasing some of the light radioactive materials, such as iodine and cesium into the air. As a radiation protective action, the Japanese government decided to take action according to the guideline of IAEA, and restricted people from entering the area within 20 kilometres from the nuclear power station. The evacuation area was also established after referring to the estimated radiation map. Decontamination work will continue in this area for several years or tens of years. By this nuclear accident, Japan received much radioactive exposure. However, to avoid meaningless panic and rumor, I want the people of Japan and the world to understand several scientific facts. The first is the existing of natural radiation as essential element in all living bodies, with an activity of 7,000 becquerel. The second is that living cells have the inherent ability of repairing DNA damages. Every day almost all damages to the cell are repaired. And third, the most reliable data, delivered from long-term investigation against atomic bomb survivors, more than 100,000 people in Hiroshima and Nagasaki, shows that there is no effect on embryo and fetus under 100 millisievert. Over 300 millisievert, cancer risk increases significantly, but about 30 percents of cancer death are caused naturally by other reasons. So, we don’t need to be anxious, even for children.

“Damage situations of ground, infrastructures and others”

Prof Yasuo Tanaka, Research Center for Urban Safety and Security, Kobe University

Last March the earthquake and tsunami hit super widespread areas in East Japan. The Great East Japan Earthquake and Tsunami (GEJET) caused large human casualties as well as wide physical damages to houses, public buildings, and infrastructure such as roads, railways, water, electricity and gases, compared with even the Kobe Earthquake in 1995, which is the largest one until 2011. The amount of the economic loss in Kobe is 10 trillion yen, two percent of GDP at that time, but this time it is estimated around 17 trillion yen, 3.5 percent of GDP. The number of collapsed houses is similar, 104,906 against 112,528, but the victims are quite different. The Kobe Earthquake killed 6,434 people and 83.3 percent of them died due to collapsed houses. This time, as of September 6th, on the other hand, 15,769 people are killed and 4,227 are missing and 92.4 percent of them are drowned because of tsunami. Infrastructural damages are also more serious, for instance, electricity, gas and water are not provided to the 2-3 times more houses than in case of Kobe. The highest intensity 7 of ground motion is observed in the both disasters, but the predominant frequency of shaking is very different. In Iwate Prefecture, the northern part of Tohoku region, the first phase of shaking is really strong, in Miyagi Prefecture, south to the Iwate, there are two strong phases, and in Fukushima, where nuclear plants are, the second phase is larger. And further south, there is only one phase of shaking. These different patterns of strong motion combined with ground condition of each area caused various types of ground failure, for instance, extensive liquefactions and subsequent differential settlements in Urayasu, road embankment failure in Hitachi-Naka Port, natural slope in Shirakawa, earth fill dam in Fujiwara and so on.

The GEJET is a super wide area disaster and its effect is compound or cascading. As a result, the recovery is much complicated and takes longer. However, we are now going into the reconstruction stage. Our task is to how to derive a solution and implement DRR for such compound disaster. A recommendation report “Towards Reconstruction - Hope beyond the Disaster” presented by the Reconstruction Design Council on June 25th, says that towards reconstruction, key solution is how to bridge and link the people, communities, regions, and countries.