

## FOREWORD

A gigantic earthquake with moment magnitude (Mw) 9.0- the largest event among ever recorded in Japan - occurred at 14:46:18 (local time) on Friday, March 11, 2011. The hypocenter (N 38.1°, E 142.9°, and 24km in depth) was located about 130 kilometers east offshore from Miyagi Prefecture. The Japan Meteorological Agency (JMA) named this earthquake "The 2011 off the Pacific coast of Tohoku Earthquake" on the date of the event. The Japanese government officially decided to call the total disaster caused by the earthquake the "East Japan Great Earthquake Disaster" on April 1, 2011.

The size of the seismic fault region was about 450 to 500 kilometers in the north to south direction and about 200 kilometers in the east to west direction, stretching from Iwate Prefecture to Ibaraki Prefecture. The impact of this earthquake has been enormous and is still being felt in various ways. Based on several site investigations carried out after the earthquake, I summarize the features of this disaster as follows.

- 1) Huge affected area (beyond the expectation of the Basic Act on Disaster Control Measures of Japan)
- 2) Damage due to ground motion
  - Relatively minor structural damage considering the large seismic intensity and maximum amplitude, and long duration of ground motion
  - Relatively large ground failures (man-made residential land, soil liquefaction)
  - Damage to non-structural members (fall of ceiling)
- 3) Huge and long-term direct and indirect effects of killer tsunami
  - Human casualties and structural damage, long-term and various effects
  - Structural and non-structural measures
- 4) Damage and various effects in the metropolitan area
- 5) Large and various impacts caused by the nuclear power plant accident
- 6) Historical turning points of politics, economy, energy policy, and the value of happiness

A maximum seismic intensity (JMA scale) of seven, the highest of ten levels on the JMA scale, and over 3g maximum ground acceleration were recorded at the northern part of Miyagi Prefecture. However, structural damage was relatively minor. The total number of dead and missing was approximately 20,000 people in 12 prefectures. Most of the dead and missing, however, were concentrated in just three prefectures - Miyagi, Iwate and Fukushima - which accounted for over 99% of the total number. About 5,900 people were injured in 19 prefectures; this number was relatively small compared with the number of fatalities.

The number of structures which were totally collapsed, burned, and/or washed away due to the tsunami, fires, and/or ground motion was 112,000; that of heavily damaged structures was over 140,000; and that of partially damaged structures was over 500,000. Regarding transportation facilities - 77 bridges were severely damaged and roads and railways were damaged at approximately 3,600 locations and 29 locations, respectively. River embankments were damaged at over 2,100 locations, and 190 kilometers out of a total of 300 kilometers of sea walls in the affected areas were also severely damaged. The total area inundated by the tsunami was 561 square kilometers. Regarding lifeline systems - over 8 million households lost power and over 1.8 million couldn't get water. At its peak, the number of people in refugee camps was over 400,000.

There were three nuclear power plants in the severely affected areas. Among them, the Fukushima I nuclear power plant lost all power, including emergency back-up power, subsequently losing the ability to keep the reactor cool and resulting in a critical accident which leaked large amounts of radiation. Due to this accident, people living around the power plant were forced to evacuate and live in refugee camps for a long time. In addition to the nuclear power plants, many thermal power plants located in the affected areas were also damaged, leading to a lack of power in the major parts of the nation. The total monetary loss due to the earthquake was officially estimated by the national government at 16.9 trillion yen; loss of buildings counted for 10.4 trillion yen, lifeline facilities for 1.3 trillion yen, infrastructure for 2.2 trillion yen, agriculture for 1.9 trillion yen, and others, such as public facilities, counted for 1.1 trillion yen. These losses are only the direct losses, and indirect losses and damage due to the nuclear power accident are not included.

Two days after the earthquake, I was called by the Office of National Strategy of Japanese government and asked for advice on disaster response. For quick and proper response, recovery and restoration of the huge area severely affected by the earthquake and killer tsunami, I introduced the following issues; 'restoration office and its activities' and Mr. Shinpei GOTO's 'Restoration Plan of Imperial City, Tokyo' and his four principles on the plan after the 1923 Great Kanto Earthquake Disaster, 'Pairing disaster support system' that the Chinese government adopted after the 2008 Sichuan Earthquake, limitations and issues of the current Basic Act on Disaster Control Measures in Japan and important issues that should be improved, and actions that the Japanese government need to tackle for reducing the damage due to future earthquakes such as the Tokyo inland earthquake and Tokai, To-nankai, and Nankai Earthquakes which may occur in the coming decades. In addition, I prepared my vision of restoration from the earthquake disaster as described below.

Goal of restoration: Creative restoration contributing to the future development and happiness of Japan

Four principles:


- 1) Restoration activities should solve the future problems of Japan as well as contribute to quick recovery for a safe built environment in the affected areas
- 2) Restoration should be implemented through good cooperation between all

stakeholders in Japan, such as national and local governments, private companies, NGOs/NPOs, and all Japanese people including citizens in the affected areas

- 3) Restoration should be done considering the environment, sustainability and recovery of local industries in the affected areas
- 4) Reconstruction should consider the potential for unexpected events

The meanings of the four principles can be explained as follows. 1) Of course, the first priority is the quick recovery of a safe built environment in the affected areas. However, the affected areas have many other problems, such as shrinking population, aging society, and weak local industry, and the severity of these problems is much higher than the average of other parts of Japan; therefore, reconstruction should provide solutions to these problems. 2) As the scale of the disaster was huge, restoration by the national and affected local governments and victims was not enough. For a speedy recovery and improvement of disaster management capacity of the whole country, restoration should be implemented through cooperation and giving money and ideas. 3) No need to explain. 4) After the earthquake, many people said ‘this was an unexpected event and beyond the expected conditions;’ however, we should consider unexpected situations when designing and building. Otherwise, we will face the same situation in the future.

Due to the huge magnitude of the earthquake and its induced tsunami, as well as the continuing effects of the nuclear power plant accident, recovery of the affected areas may take 10 or even 20 years. But I believe that the Japanese will work together and recover from the disaster, and that they will take advantage of this opportunity to create a safer and more comfortable built environment. Furthermore, I hope that they will give solutions to the problems which other parts of Japan may face in the future. We specialists in earthquake disaster mitigation should do our best to contribute to the activities mentioned above.



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