East Japan Disaster- Preliminary Report

Association of Japanese Consulting Engineers (AJCE)

1. Introduction

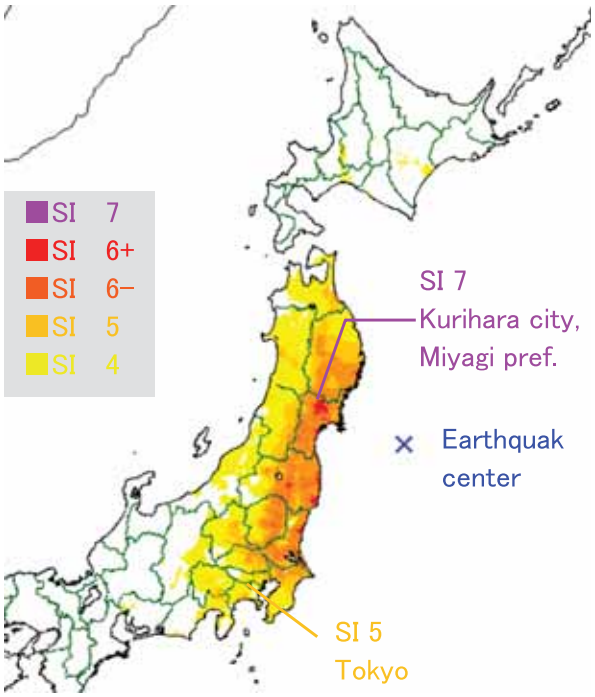
At 14:46 March 11, 2011,
It started with slight shakes. Japan has a lot of earthquakes. There are about 10 earthquakes that we physically feel significant shakes. Therefore, at the outset, we felt it was one of these earthquakes. However, the shakes did not cease but grew larger. It turned into the large magnitude that we couldn't stand up. Creaking sound surrounded over the office.
Fortunately, there were no damages in the AJCE secretariat. We swiftly accessed internet to check real-time earthquake information. Sole information was "strong earthquakes hit north-east of Japan". At this point, people in Tokyo did not know the scale of disasters. People tried to contact with family members by cell-phones to check safety, however, it was not functioning. Cell-phone providers controlled the system against massive calls that may breakdown the entire system. While holding a cell-phone, we kept on watching internet about the progress of information on the scale and magnitude of the earthquake. It started reporting casualties that several hundreds of people were taken away by Tsunami. Growing severity of disasters was reported time to time.
And in the next morning, people in Japan were shocked by watching pictures broadcasted by TV news. "Is this real ?"

【Magnitude】

1960	Chile Earthquake	9.5
2004	Sumatra Is Earthquake	9.2
1964	Alaska Earthquake	9.2
2011	East Japan Earthquake	9.0
～		
1995	Hanshin-Awaji Earthquake	7.5

【Seismic Intensity, SI】
Amplitude of earthquake shake defined by the Japan Meteorological Agency (JMA). SI tends to be larger near earthquake center or near-surface earthquake even at small magnitude. SI is classified in 10 scales (0～7):
SI 0～2 : Do not feel shake
SI 3 : Feel shake
SI 4 : Hanging objects move significantly
SI 5 : Unfixed furniture fell down [Tokyo]
SI 6 : Difficult to stand, buildings may tilt
SI 7 : Wooden house collapsed [Miyagi]

【Distribution of Seismic Intensity in East Japan Earthquake】



[Japan Meteorology Agency]

2. Earthquake

2.1 Scale of Earthquake

Magnitude, scale of earthquake energy, was 9.0. It was the 4th worst in the history of observation. "Seismic Intensity (SI)", unique indicator of earthquake in Japan recorded SI 5 in Tokyo out of maximum SI 7. Areas exceeding SI 4 that people feel strong shakes extended from the Hokkaido (northernmost-island of Japan) to Aichi prefecture (southwest of Japan) affecting a half of Japan.

2.2 Damages by Earthquake

Despite of severe disasters caused by Tsunami as mentioned in the subsequent section, most of roads, railways and buildings could withstand the earthquake of magnitude 9 in the areas that were not afflicted by Tsunami. It is attributable to the newly revised standard of earthquake after Hanshin-Awaji earthquake. Following this revision, anti-seismic reinforcement has implemented

since then.
Tokyo recorded Seismic Intensity of 5. Though there were damages such as fell-down of furniture and cracks in some parts of buildings, major damages to railways, elevated highways, etc did not occur. Railways stopped for a while to secure safety and prevent damages from aftershocks. Some of railways started in operation at 9PM, 6 hours after the earthquake. By midnight, most of railways in Tokyo metropolis areas went into operation except for East Japan Railways.
Though there were cracks and damages within allowable design standards in highways and harbor facilities in the areas where larger earthquake than Tokyo were observed, collapse did not occur. This allowed passage of fire engine, self-defense force, police and vehicles carrying supporting goods to devastated areas. In addition, buildings such as municipal offices, schools used for disaster countermeasures could withstand the earthquake of magnitude 9. These buildings have been serving their role since the earthquake attack.

【Anti-earthquake design Road bridge】
Two design levels
Level 1 : No recovery is necessary to keep function of structures against several earthquakes that may occur in service life time
Level 2 : Structure do not collapse (some damages allowed) against significantly large earthquakes whose occurrence rates is small. Major important structures such as trunk roads can be repaired in short time

2.3 Liquefaction

Liquefaction occurred in the bed-town areas of Tokyo and caused stoppage of sewage system. This area was developed by landfill and locates in the coastal area of Tokyo bay. Liquefaction was observed not only in the coastal areas but also inland housing areas that were developed by landfill over the past riverbed.

3. Tsunami

The largest disaster ever occurred in the history of Japan is largely attributable to
Tsunami attacks after the earthquake. The Tsunami exceeded the wave height of 8m and maximum run-up of 37.9m in elevation in Iwate prefecture. The maximum wave height of Tsunami were not measured due to destruction

【Liquefaction Damage】

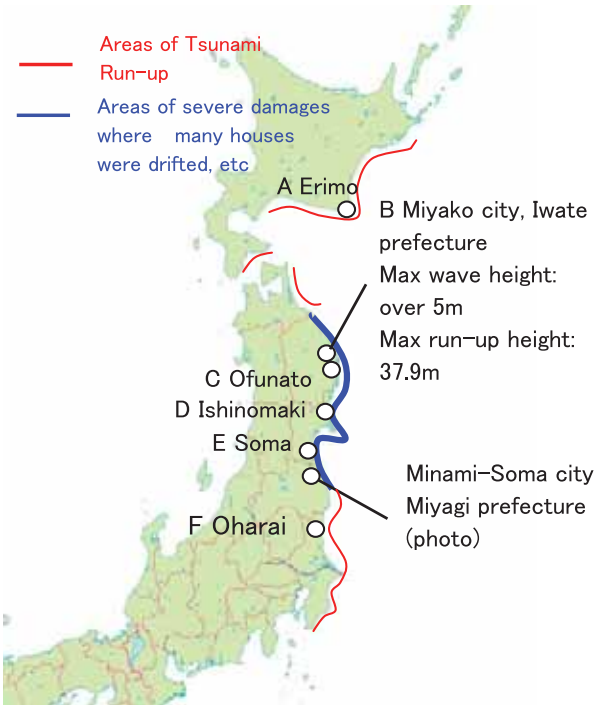
Uplifted manhole by liquefaction
Photo: Nihon Suido Cosultants

Bumped seawall caused by liquefaction
Photo: Chuo Kaihatsu

【Max amplitude of Tsunami】【Max. run-up height】

A Erimo	: 3.5m	B Miyako : 37.9m
B Miyako	: over 5m*	
C Ofunato	: over 8m*	
D Ishinomaki	: over 7.6m*	
E Soma	: over 7.3m*	
F Oharai	: 4.2m	

* Max wave height was not measures as tsunami destroyed titdal gauges.
[Japan Meteorology Agency]



[Quick Estimation by the Association of Japanese Geographers]

of tidal station. Tsunami easily overtopped breakwaters of 8m in height and flew into residential areas. As consequences, it tore down and washed out everything.

【Tsunami Disaster】

Minami-Soma City, 2006

Minami-Soma City, Tsunami induced water reached Inland ©2011 Google, GeoEye

【Tsunami Disaster】

Ship drifted by Tsunami was trapped by bridge pier

Center bridge girder was taken away by Tsunami
Photo: Oriental Consultants

Sewage treatment facility blocked by a heap of rubble

Sewage treatment facility tangled by fish nets
Photo: Nihon Suido Consultants

【Tsunami Disaster】

Site of flooded sewage treatment Facility

Flooded sewage treatment facility
Photo: Tokyo Engineering Consultants

4. Degree of Disasters

Number of death and missing persons is more than 27,000 leading to the most disastrous record. This number far exceeds Hanshin-Awaji earthquake disasters occurred in 1995 in which number of casualties were 6,437. Majority of casualties was caused by Tsunami. Afflicted areas spread over 12 metropolitan, prefectural and municipal governments.

【Damage Overview】

Death	14,013
Missing persons	13,804
Total	27,817

Total collapse/ burnout/ flush out	62,607
Half collapse/ half burnout	25,193

Number of evacuees: predicted over 450,000
[As of 20 April, Police Agency]

Total damage of infrastructure and buildings 16 to 25 trillion Japanese yen
[As of 23 March, Cabinet Office]

5. Power Shortage

In the subject disasters, Fukushima-1 nuclear power stations, large scale thermal power stations in Fukushima and Ibaragi prefectures were affected by Tsunami attacks and electricity generation was stopped. As the result of electricity failure, shortage of electricity supply occurred in Tokyo metropolis. Rotating blackout for about 3 hours was conducted at local municipalities. In April, blackout was ceased due to recovery of some power stations and rise in air temperature leading to less electricity consumption by heating. However, electricity shortage continue to exists and power saving measures has been in operation.

6. Efforts by AJCE Members

Nippon Koei established disaster countermeasure headquarters right after the earthquake lead by president Mr. Hirose. They started confirming safety of staffs and family members by utilizing internal safety check system and emergency communication network. On Monday 14th March, he sent messages to all the firm members. At the same time, other members of AJCE, Oriental Consultants, Pacific Consultants, NJS Consultants, etc have established disaster countermeasure headquarters in the vicinity of afflicted areas to check safety of firm staffs and their family members as well as to investigate damages.

Escalator was stopped for electricity saving.

In subways, some fluorescent bulbs for electricity saving.

【Portable Water Heater】
Jointly developed by Chodai and Pal corporation.

It contains aluminum bag, heat-inducing agent and water. After mixing water and heat-inducing agent in aluminum bag, it generates heat by chemical reactions. It can be used for heating baby bottle, pet bottle or canned drink. Temperature in the afflicted areas in March recorded below 3 degree C. Warm drink was appreciated at the devastated area where no gas and electricity were available.

Member firms distributed foods, water and necessary goods to their firm members and family right after the earthquake as well as to the disaster victims. NJS Consultants donated 120kg of rice, 350 sets of instant foods to the city of Sendai. Chodai offered the following goods to Tohoku University hospital: water, foods, cassette burners, compressed gas cylinders, and portable water heaters that were jointly developed by Chodai and Pal corporation.

And more, AJCE member firms have been contributing for various recovery and supporting activities.

Nihon Suido Consultants is engaging in damage investigation and drafting of recovery plan on entire sewage system such as pump stations, sewage lines, and sewage treatment facilities. They are further contributing to damage survey, geological investigation and designs necessary for recovery of river function.

Photo: Nihon Suido Cosultants

Pacific Consultants have been working for damage investigation of roads, bridges, tunnels, etc. They are further engaging in design and drafting of recovery countermeasures. Currently they are requested to participate in committees in charge of Disaster waste treatment, and Emergent energy measures

Tokyo Engineering Consultants (TEC) conducted flood prediction in Miyagi prefecture in the main sewage lines, incase of increasing sewage discharge in the course of sewage system recovery right after earthquakes. Utilizing the results of prediction, TEC examines vulnerable points that need reinforcement. TEC has further involved in recovery of sewage treatment facilities and sewage networks.

Oriental Consultants have engaged in disaster recovery measures such as damage investigation on national roads and major access roads as well as inspection of bridges, harbor facilities.

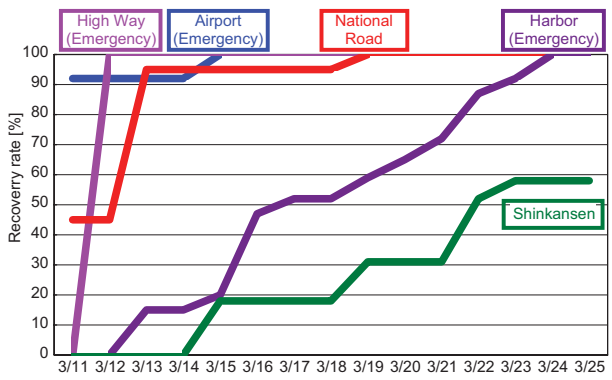
Photo :Oriental Consultants

Chodai is conducting bridges damage inspections. Chuo Kaihatsu Corporation is working on damage investigation.

7. Transportation Infrastructure Recovering with Greater Urgency

As mentioned in the preceding section, the subject earthquake of magnitude 9 was the forth

【Recovery History of Transportation Infrastructure】



[Ministry of Land, Infrastructure, Transport and Tourism]

worst in the history of observation. Despite of the strong magnitude, infrastructures such as roads, harbors, airports, etc withstood against the earthquake. Owing to exhausting efforts by concerned parties, emergency vehicles were able to pass on highways in the next day. After 2 weeks, on 24th March, regular vehicles were able to pass highways. Fifty percent of harbors resumed operation one week after the earthquake. All of them went in operation after 2 weeks while supporting to deliver goods and people in afflicted areas.

Fifty percent of the Tohoku Shinkansen (bullet train) has recovered its service after 2 weeks of the earthquake except for some areas severely damaged by Tsunami. Sendai Airport flooded by Tsunami resumed its normal operation on 13th April, one month after the Tsunami. Large-scale disasters like we experienced this time, transportation plays a vital lifeline role. Rapid recovery of transportation infrastructure has been contributing significantly in rescuing people and delivering goods to afflicted areas.

【Emergent Earthquake Advance Report】
Alarm warning system of informing prior arrival of earthquake via TV, radio and cell-phone that exceeds magnitude of 5 based on data taken by seismic instruments near the earthquake center. Average time elapsed from preliminary tremor of P wave to alarm warning is about 6.4 seconds. Though lead time before arrival of earthquake is short after the alarm warning, one can stay away from furniture or unstable objects. Railways are synchronized with alarm warning system in such a manner that trains will stop immediately at time of alarm warning to prevent from derailing and overturn. Elevator will stop automatically at the nearest floor to prevent from containment.

[Japan Meteorological Agency]

Emergent earthquake advance report on TV

8. "GANBAROU NIPPONN" (Hang on Japan)

We received heartfelt and encouraging messages from FIDIC president, Gregs Thomopulos and many FIDIC family members. All of these messages were conveyed to AJCE members through e-mails and home page. All of AJCE members are very much cheered up by friends of FIDIC families. We would like to express our sincere thanks to you all.

It is our deep sorrow to have many casualties and countless damages. We are acutely aware how helpless it is in such circumstances.

However, people in Japan never give up. "GANBAROU NIPPONN"(Hang on Japan) as common word, we will surely recover from the devastation. Members of AJCE as consulting engineers will be continuously endeavor to achieve swift recovery and realization of disaster-resistant city in harmony with nature.

Cherry blossom convey spring message
20 April Sendai City