Reconnaissance Report on the China Wenchuan Earthquake May 12, 2008

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On May 12, 2008 at 14:28 local time (6:28 UTC), an M_w8.0 earthquake struck the Sichuan Province, China. Millions of houses were destroyed and damaged, leaving approximately 4.5 million people homeless. At the time of this report, the government recorded that the earthquakes have caused human losses of about 69,100 (18,000 still missing) and 374,000 injured. Following the earthquake on May 27th, NCREE joined a Taiwanese reconnaissance team to the affected region to collect information. It includes structural and geotechnical damages, as well as social impacts. This reconnaissance team could be the first to reach the damaged area nearest to the epicenter to observe the detailed damages on the schools, hospitals, residential buildings, landslides and bridges. From 27th May to 2nd June, the team has visited the area of Chengdu, Dujiangyan, Pongzhou, Shiaoyudong, Mianzhu, Zhuendou, Zhiulong, Wudu, Hanwang, Hsuanko, Yingshow (epicenter) and Highway 213. More than 5000 photos had been taken to document the damages observed in this catastrophe. We would like to take this opportunity to express our condolence for those who suffered from this earthquake. It is hoped that the information shared herein could help the community in making a safer society in the future.

Observations of Structural Damages

The observations of structural damages in the affected region consist of buildings (schools, hospitals, commercial and residential buildings), towers, and bridges.

Buildings

There are three major types of buildings commonly used in the affected area such as reinforced concrete (RC), half-reinforced masonry (HRM) and brick (un-reinforced masonry, URM) buildings. The half-reinforced masonry buildings is a unique structural system which consists of brick column, reinforced concrete beam, and precast concrete hallow floor planks with wire mesh.

Most of the public buildings are constructed using RC and HRM systems while most of the residential houses and school classrooms were made of HRM with 4 or 5 story and URM with only 1 or 2 story.

A significant number of casualties and injures in the rural areas were associated with the total collapse of the HRM and URM buildings. Figures 1 and 2 show the collapsed buildings of an elementary school at Dujiangyan and figures show some commercial and residential buildings at Dujiangyan (3-8), Yingshow (9-10), and Mianzhu (11-12). Since there are no ductile elements to resist the lateral force caused by earthquake in the HRM and URM buildings, it usually caused total building collapses and made human losses and injuries.


Fig.1


Fig.2


Fig.3


Fig.4


Fig.5


Fig.6


Fig.7


Fig.8


Fig.9


Fig.10


Fig.11


Fig.12

Figures 13-14 show the collapsed buildings of the 3rd People's Hospital at Hanwang township of Mianzhu. These four story HRM buildings collapsed during the earthquake when they supposed to be operated with

normal function to help people and save lives after this catastrophe.


Fig.13


Fig.14

There are some engineered RC buildings suffered severe damages or collapsed, such as buildings of Hsuanko High School (HKHS) at Yingshow Township (Wenchuan county) near epicenter. Figures 15-24 show the damages of HKHS including the details of some RC members.


Fig.15


Fig.16


Fig.17


Fig.18


Fig.19


Fig.20


Fig.21


Fig.22


Fig.23


Fig.24

Factories and Towers

Figures 25-27 show the damaged factories and figures 28-31 show the undamaged towers in the earthquake affected region. Figure 32 shows the clock tower, on which the time stopped at 14:28pm when earthquake happened, at Hanwang township.


Fig.25


Fig.26


Fig.27


Fig.28


Fig.29


Fig.30


Fig.31


Fig.32

Bridges

Damages of bridges are lesser as compared to the damages of the structures. Totally 33370 km of road was damaged. Among these, 4840 bridges and 98 tunnels were totally or partly damaged. There are three severe cases, which are Baihwa Bridge, Hsiaoyudong Bridge and Miaotzuping Bridge, from our observation.

Baihwa Bridge is a 500 m long viaduct with 30 m height, and plays a critical role on the route from Dujiangyan to Wenchuan. Construction finished in 2004, Baihwa Bridge is a RC slab beam continuous bridge supported by twin column pier with cap beam on expansion joint and twin column without cap beam at other places. As shown in figures 33-38, there are about 50 m long bridge slab collapsed on the location of the turning section after earthquake. Due to the safety reason, the un-collapsed part of Baihwa Bridge is exploded to reduce the threat to the emergency path underneath the bridge.


Fig.33


Fig.34


Fig.35


Fig.36


Fig.37


Fig.38

As shown in figures 39-46, Hsiaoyudong Bridge was a four-span RC arch bridge. The strong motion of the earthquake caused two spans of Hsiaoyudong Bridge collapsed and severely damaged the rest of the spans. The destruction of the embankment, abutment and the barrier, the buckling of the arch, as well as the shifting of the road surface are also observed to witness the enormous pressure of the strong earthquake motion.


Fig.39


Fig.40


Fig.41


Fig.42


Fig.43


Fig.44


Fig.45


Fig.46

Miaotzuping Bridge is located at the water reservoir area (Zipingdu dam) near Dujiangyan, as shown in figures 47-50. This beautiful bridge is 1436 m long with 100 m height composed of main bridge (long span box girder bridge) and 19 approaches (T-girder bridge). The construction of the bridge is completed but not opened to traffic yet. There are shifting on both longitudinal and horizontal directions causing the damages of side stoppers. Besides, the earthquake caused one of the T-girder approaches collapsed due to possible insufficient support length of cap beam for falling prevention.


Fig.47


Fig.48


Fig.49


Fig.50

The rest of the bridges on Highway 213, all suffered different degree of damage such as shifting, cracks on bridge support, and destructions of side stoppers (as shown in figures 51-56). However, there is less damages on pier such as cracks or bucklings found from our observation. Since the bridges play a very important role on transportation and it is critical for emergency rescue and response tasks, the slightly damaged bridges were temporary retrofitted by Bailey bridges with speed and weight limit (figure 57) or detoured using tubes and grading (figure 58) to make

an emergency route.


Fig.51


Fig.52


Fig.53


Fig.54


Fig.55


Fig.56


Fig.57


Fig.58

The following observations can be obtained from these damaged bridges:

(1) The support length of the pier to prevent the bridge slab from falling is not long enough. (2) There is no shear key but only side stopper, and most of the stopper is not strong enough to remain intact but they did stop the bridge from falling laterally. (3) There is barely bearing system, especially no isolator or rubber bearing, on top of the pier to support the bridge as well as to dissipate the earthquake energy.

Observations of Geotechnical Damages

The observations of geotechnical damages in the affected region include liquefaction, landslides, and roads and tunnels damages.

Liquefaction

Usually a liquefaction site is very difficult to be found, because the dome of spring sand is not very large and it may be destroyed by people. The liquefaction is also found after Sichuan earthquake. As shown in figures 59-62, the soil was disturbed on the river bed or river side of Ming River, causing the cracks or settlement on it.


Fig.59


Fig.60


Fig.61


Fig.62

Landslides

Numerous landslides were observed all the way when we drove into mountainous area since earthquake caused steep hillsides to shear away and crash into river valleys below. As shown in figures 63-66, the landslides not only damage the roads but also form the “quake-lake” sometimes. Many slopes remain unstable and are at high risk of endangering the populated area.


Fig.63


Fig.64


Fig.65


Fig.66

Road and Tunnel

The roads in mountainous area remains damaged due to the destruction by mud, rock slides, blocked tunnels or collapsed bridges. As shown in figures 67-70, the construction workers or soldiers clean up the road as soon as the falling rocks or debris blocked the road to make sure the emergency route is accessible and safe.


Fig.67


Fig.68


Fig.69


Fig.70

Observations of Response

Electricity

In general, electricity facilities sustained relatively little damage compared to structures, most of the high-volt tower survived from the earthquake, however, some tower suffered damages due to landslide and most of the poles fallen because of the strong ground motion. People use bamboos as temporary poles for the electricity in the mountain area (figures 71-72).


Fig.71


Fig.72

Response and Recovery

Immediately after earthquake, more than 100,000 China Army, police and fire fighters from other provinces come to Sichuan to help. Three days later, rescue teams from overseas join the missions and save thousands of lives together. Central government allocates billions for rescue and relief efforts in quake-hit regions. Loads of materials and people sent to help the massive recovery. The damaged roads to the mountainous region were made accessible for emergency transportation. Figure 73 shows the people line up waiting for reliefs and figure 74 shows the farmers working on the rice field in disaster zone. Figure 75 shows enormous emergency tents at refuge area.


Fig.73


Fig.74


Fig.75

There are around 5 million people left homeless by the earthquake. Therefore, China's Ministry of Housing and Urban-Rural Development called on local authorities to build 1.5 million temporary homes (shelters) with 20 m^2 each for 3 persons. Figure 76 shows the trucks from other provinces carring the material for temporary housing to Sichuan. Figure 77 shows the material for temporary house pile up next to the tents. Figure 78 shows the community of finished temporary house at Dujiangyan and Figure 79 shows the under-construction temporary house near Pongzhou. These housed will accommodate many people for 3 years during the reconstruction of the city.


Fig.76


Fig.77


Fig.78


Fig.79

Acknowledgements

We gratefully acknowledge Sichuan Association for Science and Technology (SCAST), and Sichuan branch of the Taiwan Affairs Office of the State Council for their kindness, enormous help and friendships when the team conducting earthquake reconnaissance investigation.

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