Recent Review of Earthquake Practices on Emergency Response and Influence in Taiwan

B.J. Shih[1], and M.J. Chuang[2], Wei-Sen Li[2] and Siao-Syun Ke[2]

[1] *Professor, Department of Civil Engineering, Taipei University of Technology, Chinese Taiwan*
[2] *Assistant Researcher, Science and Technology Center for Disaster Reduction, Chinese Taiwan*
Email: cmz@ncdr.nat.gov.tw

ABSTRACT :

In 2006, two major earthquakes shook Taiwan and brought destructions and casualties to eastern and southern parts of the island. The first happened on April 1st with magnitude of 6.4 Richter scale and caused a major damage on fire department building at Taitung County. The second hit on December 26th with magnitude of 6.7 Richter scale, the largest earthquake in a century for the south-west area, which influenced not only Taiwan but also Pacific countries far away, because ofthe interrupted service triggered by disruption of undersea optic communication cables. These two quakes pinpoint some essential issues to revise and update the emergency preparedness and planning in Taiwan. From emergency operation system, the experiences provided a real test to verify the reliance and robustness of information system on real-time coordination among governmental sectors. Traditionally, the major types of seismic damages focus on bridges, buildings and lifeline systems by ground shaking or tsunami. The inconvenience from disruption of major telecommunication cables had drawn a lot of attention on the low-redundancy system and the broad responsibility taking in the Pacific area. In this paper, the review of emergency operation will be described as an experience sharing.

KEYWORDS: Earthquake, Emergency Response, Telecommunication Cables

1. Outlines of the Taitung earthquake influences and its emergency operation system.

The Taitung earthquake happened at 6:02 p.m. on April 1st, 2006 with magnitude of 6.4 Richter Scale, which epicenter located at 121.12° east longitude and 22.83° north latitude, with 10-km focal depth. There were more than 35 following aftershocks with magnitude between 3 to 4.8 Richter Scale and focus depth within 20km. Fig-1 shows the epicenter and its seismic intensity distribution. (CWB. 2006)

Right after the quake, The Disasters Prevention and Protection Commission established the Central Emergency Operation Center to issue alarms to emergency response unit at area with intensity of 3 scale or above, to give announcement to government agencies or ministries such as the Ministry of Transportation and Communications, Ministry of Economic Affairs, Department of Health, and Airborne Service Corps, etc., and at the same time, to provide support to the local levels to cope with possible damage and causality.

After the earthquake, there wasa 8-minutepower outage of 7,225 households approximately. Despite there were structural damages of the building of Taitung County Fire Department, the backup power supply immediately switched on and the operation was not intteeruptd. “Emergency Operation Center of Taitung County” was established abided to “The Regulations on the Emergency Operation Center of Taitung County against” Several units including county government agencies Taitung University, Ping Tung University of Science and Technology=private sectors, administrative officials and Airborne Service Corps immediately responded to the emergency for handling incidents and contingency triggered by the quake. (NCREE & NCDR . 2006)

There were total 44 cases reporting injured citizens after the earthquake. Most of them were hit by falling objects s inside their apartment, and the rest were caused by panic escape, therefore, there were no serious injury case reported. Some structural damages happened in this earthquake, but except the damage of the Fire Station of Taitung County (as shown in Fig-2) in which shear and bending cracks were found in shear walls and stairways. These structural damages of County Fire Station led some very short period interruption right after the quake shaking. Besides County Fire Station, only cosmetic damages were identified in minor number ofbuildings. The earthquake also caused power outage of about 7,225 households, but the power was restored in just 8 minutes after an urgent repair by Taiwan Power Company, without any incidents regarding to it. (NCREE & NCDR . 2006)

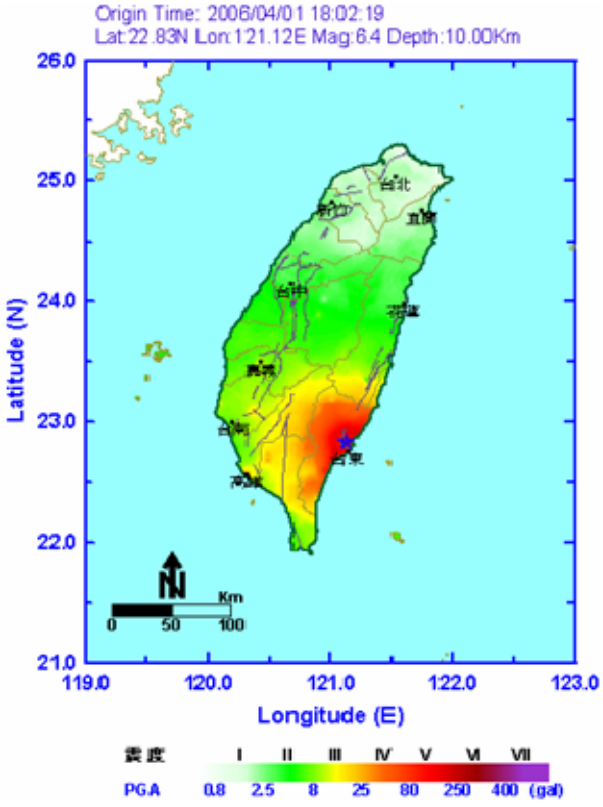

Fig.1 The seismic intensity distribution of Taitung earthquake

Fig.2 Structural damages on Taitung county fire bureau building

After the quake, the county government put its focus on local watershed areas where was listed as the high risk potential area of landslide. As consequence, the airborne service was applied on July 2nd to conduct aerial investigation over Zhiben and Taimali watersheds in order to evaluate the safety after the quake. After the Long-Wang typhoon on October 17th, 2005, some landslides at upper stream of Zhiben river occurred, where a barrier lake was immediately formed to hamper the river flow. Through the aerial investigation and images, it concluded the current state of the barrier lake remained stable, but the close monitoring should be required for possible aftershocks and the restricted access to the areas was also announced to ensure the general public's safety. Although the landlide area at the upstream of Zhiben River Basin had not been worsened after this earthquake, the slope stability in this area was still unable to be confirmed question mark. The slope scouring by typhoon and torrential rains -were still to be the top concerned issue, but the Taitung County reminded people living or working along the downstream areas of being alter to the sudden change of weather report, especially heavy rains. Details are shown in Fig-3.

Fig.3 (A) Barrier lake in Zhiben River (B) The upstream of Zhiben Rver (C) The up stream of Taimali River

2. Briefing of the Hengchun Earthquakes and emergency operation

The Hengchun Earthquake, magnitude- 6.7 in Richter Scale, happened at 8:26 p.m. (local time) on December 26th, 2006 , which epicenter was located in 120.56^{o} east longitude and 21.89^{o} north latitude, with focal depth of 21.9km. Two aftershocks were detected in magnitudes of 6.4 and 5.2 at 8:34 p.m. and 8:40 p.m. respectively. Because their magnitudes didn't exceed the threshold criteria of tsunami warning, the south-western part Taiwan did not raise emergency preparedness for possible tsunami arrival. Fig-4 shows the epicenter location and intensity map. After the main quake, there were more than 132 aftershocks with magnitudes between 4.7 to 6.4, 9 of them were sensible ones, with 6 of them having focal depths less than 30km. (CWB. 2006)

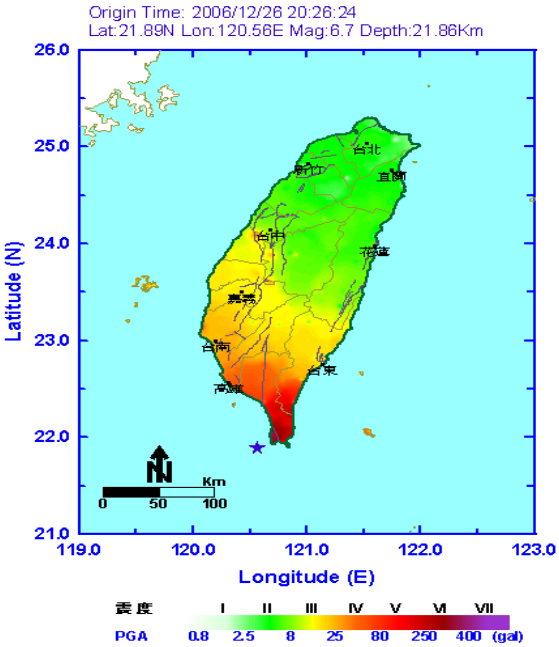

Fig.4 The seismic intensity distribution of Hengchun earthquake

Two casualties were reported after the earthquake and 42 others wounded. The collapse of Zhengxing furniture shop in Pingtung county claimed two lives and injured six, which is the spotlight of news during emergency operation. In Hengchun area, the quake flattened three houses. The quake also 134 damaged schools and 10 of them needed further structure inspection to ensure students' safety. Among damaged campuses, the Shanhai primary school reported falling rocks in playground and structural cracks were easily found in the classrooms. (NCREE & NCDR . 2007). Furthermore, some broken sections were found in the ancient city walls, a culture heritage spot, of Hengchun. (See Fig-6). (NCREE & NCDR . 2007)

Fig.5 Zhengxing furniture shop collapsed

Fig.6 Hengchun ancient city wall collapsed

After the earthquake, the emergency operation center was established by the Fire Bureau of Pingtung County band the Disasters Prevention and Protection Commission and administrative officesof the Pingtung County received the situation report on the quake. The county government then established the "Pingtung County Calamities Operation Center" and immediately formed a advanced command post at Hengchun area. Local assistance foundation (Ping Tung University of Science and Technology) was also immediately stationed in the emergency operation center to handle public requirements. (NCREE & NCDR . 2007)

The adjacent Kaohsiung county established an emergency operation center at 9.00 p.m.. Hengchun, Checheng, Manzhou, and Fangshan village started their joint defence mechanism at the same time, but since the emergency operation center at Hengchun acted as the commanding post, it proceed the front line rescue operation and immediately sent the heavy machines to the collapsed houses to help the operation.

Besides, this earthquake also damaged the undersea telecom cables at Pingtung offshore. Because of its geographical conditions, Taiwan held a key position for the communication line between the Pacific and Indian Ocean, with all main international lines from East Asia and toward the United States and Europe passed

through the eastern and southern offshore of Taiwan. They include APCN2, APCN, SMW3, CH-US, F/RNAL, EAC, and C2C, etc. Seven international undersea cables passed through Taiwan can be seen in Fig-7. This earthquake caused 17 snap-off points, as shown in Fig-8. Right after the earthquake, the Chunghwa Telecom Company started the "Command Center for Natural Disaster" to promptly gathered the related personnels to discuss and handle the situation based on their standard operation procedure. (Zhi-Ming Wu. 2007)

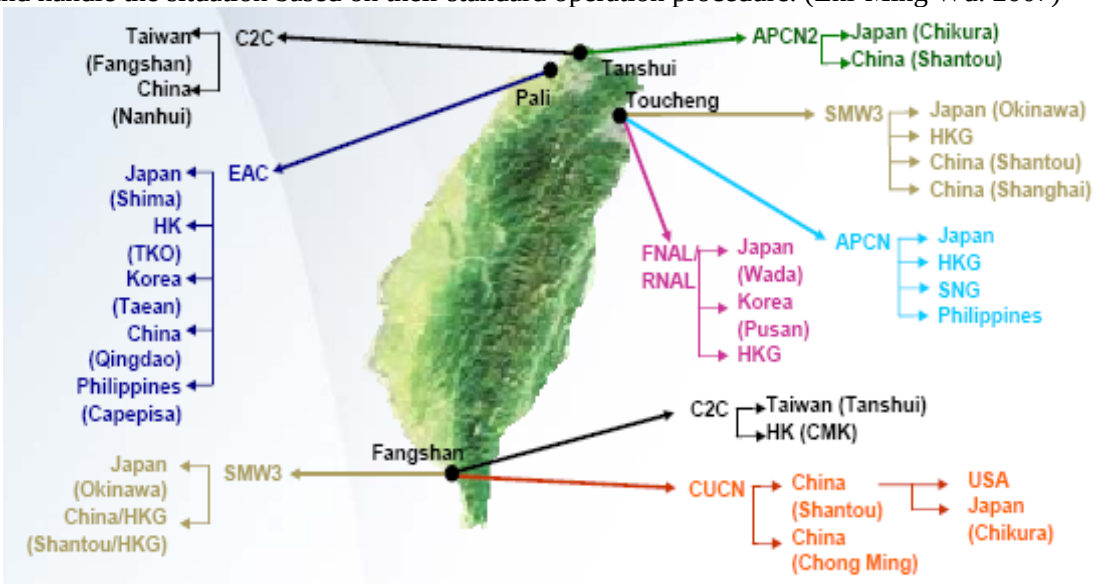

Fig.7 The distribution of international undersea cables passed through Taiwan

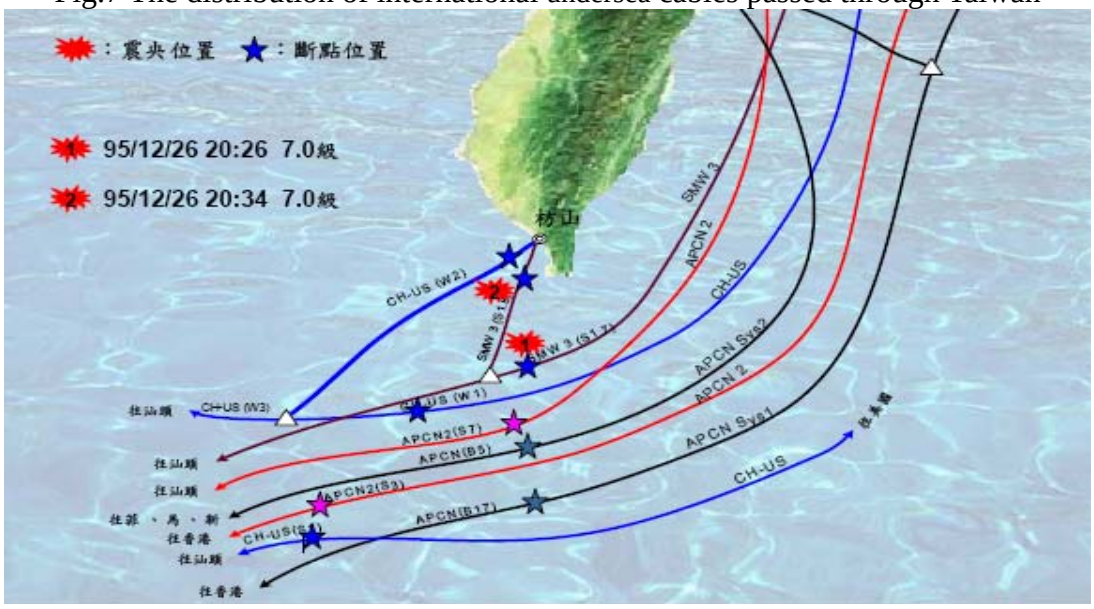

Fig.8 The snap-off points of the undersea cables

The undersea telecom cables snapped by the earthquakes were estimated to be fixed in 3 weeks. All the international communication including internet services, international telephone, the international banking transactions, stock market, currency trading, business communication to millions of customers were interrupted, and even the check-in counter of Taiwan's China Airlines were affected. Companies from South Korea to Singapore managed to partially restore the services by rerouting traffic through satellites and cables that weren't damaged. Seven repair ships were working at the quake zone, while the revenue loss from the earthquake damage at about $3 million plus $1.53 million for repairing the cables was estimated, due to the reports by Chunghwa Telecom Company, Taiwan's biggest telecommunication company. (Zhi-Ming Wu. 2007)

According to the analysis by Chunghwa Telecom Company, the snapped undersea cables were mainly caused by 3 main reasons below:

(1) The undersea cables were snapped immediately by powerful external forces, especially SMW3 which was located at the epicenter, embraced enormous external forces which finally snapped it to six.
(2) The earthquake induced seabed movement and turbid flow which then snapped-off the undersea cables and flushed them away from their original route.
(3) The earthquake induced seabed movement, collapsed soil or turbid flow which then snapped-off and buried the undersea cables which were located at a seabed valley or cliffy slope areas.

3. The reviews of the emergency operations of two quakes .

The reviews of the emergency operations of the Taitung Earthquake and the HengchunEarthquake are summarized as below:

(1) Right after the earthquakes occurred, county governments in both areas reacted promptly to launch emergency operation and get connected with the administrative offices of villages or townships to assist them for identifying the emergent needs. In general, the local governments at county-level enforced the obligations and roles assigned by the Disaster Prevention and Protection Acts. Part of the reason of why the local governments have the capability and capacity to improve emergency operation and response, the implementation of academic assistance does provide science and technology elements in revising regional plans of disaster reduction and emergency response and pour new motivation to the magistrates of county governments to place the disaster-related matters as priority administration.
(2) (2) At both emergency operations, the joint forces could immediately place their members at the emergency operation center to With observation of two cases, the emergency operators were in position to assist the commander to handle general mass requirements, examine the situation, and investigate the calamity effects.
(3) The preliminary estimation results on the scale and the distribution of the casualties and structural damages by “Taiwan Earthquake Loss Estimation System” (TELES) for both earthquakes are shown in Fig-9, which accuracy have been proven by comparing them with the actual investigation results. This system could assist the command center to make an strategic decision and arrange the resources mobilization.

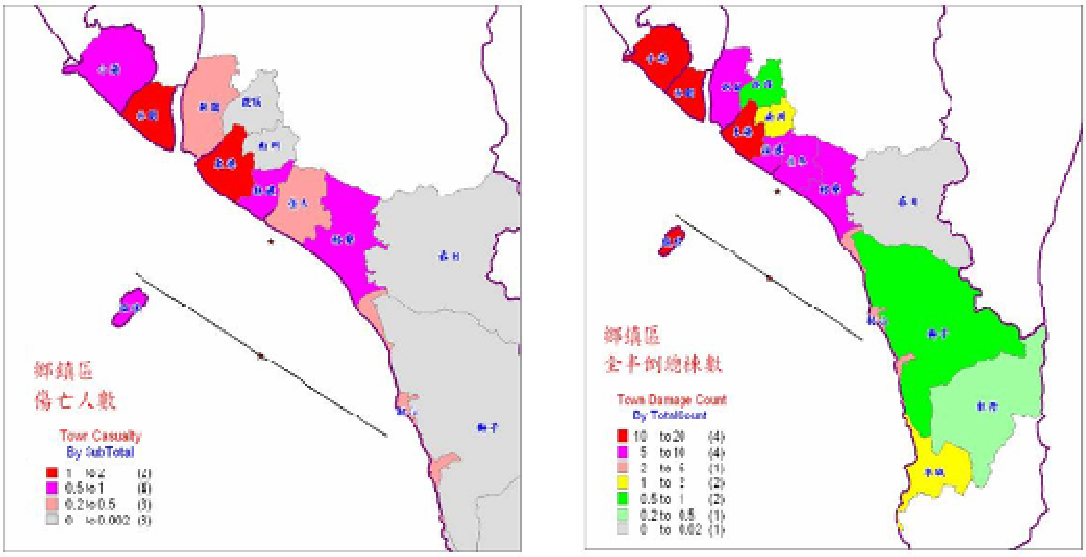

Fig.9 The preliminary estimation results on Hengchun earthquake by TELES

(4) The most damaged structure in the Taitung earthquake was the fire bureau building, yet the command center was still established there. It is suggested that a reserve supporting mechanism should be prepared in the future to make sure the emergency operation system can operate normally when disaster occurs. Besides, an overall seismic evaluation should be proceeded to all vital structures which are needed be versatile in disaster situtation such as fire bureau, police station, or hospital, etc., to avoid them to be damaged by earthquake and deprived of their proper functions.
(5) Black-out were happened at some areas in both earthquakes which then caused some elevators to stuck. In large earthquakes, black-out can lasts in several minutes or days, and a large number of elevators will be stuck at that occasion. Those incidents will be an extra load for the rescue units, therefore, enchanced

strategic plans for disaster relieve regarding to electric power should be planned to be applied practically.

(6) After the earthquake occurred, there was telecommunication jam which lasted about 30 minutes, which brought some troubles in the mobilization processes of Pingtung county government units. Fortunately, the telecommunication problems could be restored, so the communication and mobilization processes could be continued. Telecommunication jam seems to happened regularly after earthquake occured, therefore, in the future it is suggested to establish a special line for emergency operation to avoid the telecommunication problems after disaster occurs which can be used by each elements to directly contact the command center. The nuclear power plant no.3 and Mudan reservoir are located adjacent to Hengchun, but when the earthquake hit there were no news from both vital facilities until they were called by Pingtung county emergency operation center. Although there were no damages on both facilities, but in the future a well communication system for those vital facilities should be brought, and a communication mechanism should be done initiatively.

(7) The Pingtung county emergency operation center were managed to promptly provide accurate informations for mass media, which could avoid rumours to spread. This accomplishment shall be referenced by other cities or counties.

(8) After the quake occured, the Airborne Service Corps co-operated with Taitung county government to send helicopters to support the evaluation on the effects of the disaster and also the investigation on the barrier lake. The three dimensional data gathered could help the county government to jugde the situation and avoid rumours. This collaboration shows the importance and the effects of mutual supports between the central and the local government.

4. Conclusions and suggestions

Both earthquakes were not categorized as huge earthquakes, therefore, the disaster effects could be controlled effectively and the emergency operations could be proceeded smoothly, but this emergency operation system should be strengthen in advance to take precautions if a larger earthquake occurs in the future. Related science and technology should be applied in order to substantially enrich the newest data required by the emergency operation center which can also increase the correlated time-critical responses. The preliminary estimation can be used to assist in deciding the aerial and satellite photography areas, calculate the loss estimation and resources distribution and mobilization, etc., to proceed a prompt calculation and effective arrangement in the shortest time possible.

Besides, in consideration of the importance of disaster data intergration and analysis ability, and to co-operate with the e-Taiwan project, we integrate the related information and resources to make sure the command center can control the situation and response effectively. An overall seismic evaluation should be proceeded to all vital structures which are needed be versatile in disaster situtation such as fire bureau, police station, or hospital, etc., to avoid them to be damaged by earthquake and deprived of their proper functions.

REFERENCES

CWB. (2006) The Database of Seismicity in Taiwan. CWB in Taiwan. http://www.cwb.gov.tw

NCREE & NCDR . (2006). Reconnaissance Report on Earthquake in Taitung on April 1 2006. Center for Research on Earthquake Engineering (NCREE) & Science and Technology Center for Disaster Reduction (NCDR). Report No.:NCREE-06-006, May 2006.

NCREE & NCDR. (2007). Reconnaissance Report on Earthquake in Hengtsun on December 26 2006. Center for Research on Earthquake Engineering (NCREE) & Science and Technology Center for Disaster Reduction (NCDR) Report No.:NCREE-07-001, February 2007.

NCREE & NCDR. (2007). Learning from Earthquakes -- The ML 6.7 (MW 7.1) Taiwan Earthquake of December 26 2006. Center for Research on Earthquake Engineering (NCREE) & Science and Technology Center for Disaster Reduction (NCDR). Report for EERI http://www.eeri.org/lfe/taiwan_region.html. January 2007.

Zhi-Ming Wu. (2007). The Responses of Chunghwa Telecom in Accordance With the Hengchun Earthquake and Its Suggestion to Future Construction of Submarine Cable. *A View on Taiwan as the Pivot for Communication in Asia Pasific Area From the Hengchun Earthquake.* Hosted by Chunghwa Telecom, Taipei, April 11th, 2007