THE DAMAGE CHARACTERISTIC OF MOBILE COMMUNICATION SYSTEM IN THE GREAT WENCHUAN EARTHQUAKE

LU Ming[1], LI Hongjing[2], WEN Zengping[3], TIAN Jiayong[1], XIONG Lihong[4], DU Xiuli[5], YU Aiqin[6]

[1] *Professor, Institute of Crustal Dynamics, China Earthquake Administration (CEA), Beijing 100085, China*
[2] *Professor, College of Civil Engineering, Nanjing University of Technology, Nanjing 210009, China*
[3] *Professor, Institute of Geophysics, CEA, Beijing 100081, China*
[4] *Professor , Institute of Engineering Mechanics, CEA, Harbin 150080, China*
[5] *Professor, Civil Engineering College, Beijing University of Technology, Beijing 100022, China*
[6] *Senior Engineer, National Center of Earthquake Disaster Prevention, CEA, Beijing 100029, China*
Email: luming6@yeah.net, harbiner@163.com, wenzp@cea-igp.ac.cn

ABSTRACT :

Based on the investigation of the earthquake damage of the mobile communication system and its building supporter in Dujiangyan city, the damage phenomena of the mobile communication equipment and the damage characteristic of its building supporters are summarized in this paper. The damaged building's influence on mobile communication system is analyzed. The mitigating earthquake damage measures for the construction and re-construction in the earthquake disaster area are proposed, including the selection of building supporter and its machine room, the fastening of the equipment and the anti-seismic regulation legislation of communication system.

KEYWORDS:

Wenchuan earthquake, mobile communication system, building, damage

1. INTRODUCTION

Communication system is one of the key lifeline systems, plays the most important role in earthquake emergency response. With the development of the communication technology, significant change has taken place in communication mode, the majority component moved from cable communication and telegraph to mobile communication, which is quickly popular in modern society. According to the statistics, the scale of Chinese communication network and customer occupied the first place all over the world, the sum of mobile phone user has extended 400 million, among which China Mobile provides communication service for 250 million users and China Unicom for the rest. By the end of 2005, the communication network coverage has extended all county throughout this country, so does continuous coverage on main traffic artery and almost indoor coverage in key urban area. Mobile communication becomes a more important part of people's lives; meanwhile it increases the dependence from people upon the communication network. The implement of reporting earthquake information, delivering emergent message, and coordination on emergency search and rescue resources almost rely on communication network, thus earthquake emergency response presents strong dependence on mobile communication system.

In large area of both serious region and most serious region, the communication system lasted fault for long time during several days after the main quake. The communication system was total damaged in the zone of 9 degree earthquake intensity, such as in town Yinxiu and in county Beichuan. The mobile communication of China Mobile was lost either. But it found out various damage degree in city Dujingyan

and county Qingchuan where earthquake intensity is 9 degree. Only some of communication stations in these regions were total damaged. China mobile in city Chengdu administrative region is in the zone of earthquake intensity of 6-8, its more than 700 communication stations were in fault immediately after the main quake(14:28, 12th May,2008 local time), and led to interrupt communication service in large area of city Chengdu. For the fault of communication facilities of China Mobile and China Unicom, it increased the difficulty on the deployment and performance of urban search and rescue teams in reasonable way. The emergency response was lack of information on positions of worst-hit area, damage degree and casualty, it is the situation as same as appeared in Tangshan earthquake in 1976.

2. PRE-EARTHQUAKE INFORMATION OF COMMUNICATION SYSTEM OF CHINA MOBILE IN CITY DUJIANGYAN

China Mobile and China Unicom conduct the business of communication service in Dujiangyan city. The damage investigation involves the China mobile's communication network in Dujiangyan city, which is a part of China Mobile communication network in Chengdu administrative region. There are 138 communication stations in Dujiangyan city, but the central switch lies in Chengdu city. The decision on location of communication station focused on the design of coverage area distribution. The machine rooms supporting communication stations are all rent. There is no strict restriction on environment, structure and earthquake proof ability when selected the machine room.

The investigation found out that the communication station's building supporter are various structures, such as frame structure, multistory masonry and two story masonry.

Most communication stations are at the top story with all equipment in a room. All equipments except for storage batteries were not fastened at the feet.

The distribution of indoor cables is regular, optical fiber cables and electric cables are wiring along the iron frame.

Which the wiring outside communication station is relative substandard, for example the optical fiber cables laid on the enclosing wall and hanged outside building supporter without any fasten measure.

3. EARTHQUAKE DAMAGE ON CHINA MOBILE COMMUNICATION SYSTEM

3.1. Earthquake damage of communication station at traffic administrative bureau in city Dujiangyan

Earthquake intensity in Dujiangyan city is 9.

Building of traffic administrative bureau is 6 story frame structure with 7 degree earthquake proof fortification. Its filler walls are consisted of masonry block. And the structure suffered moderate damage by the quake.

The longitudinal wall facing the street is without damage on the surface, while from first to third floor another longitudinal wall and both outboard cross walls appeared obvious crack and partly collapsed. Serious collapse of filler wall appeared in the staircase, and some part of reinforced concrete column formed plastic-hinge. The walls and columns on fourth floor and above have no obvious damage. (See Figure 1 and Figure 2)

Optical fiber cable outside the machine room ran over the enclosing wall. The collapse of enclosing wall

causing by earthquake led to the optical fiber cable cut. (See Figure 3 and Figure 4) The communication optical fiber cable hanged at outboard cross wall without any fastens point from the top to the bottom. The earthquake poured out a few of blocks of fillers wall between first floor to third floor, which caused the optical fiber cable and other electric cables broken. (See Figure 5 and Figure 6)

The machine room of communication station located at fifth floor facing the street and with inside cross wall. It is equipped with unify cabinets which Huawei Optix 2500＋Mrtro 3000 installed. The feet of cabinets have no any fastening points on the floor, but the displacement was not heavy, its equipments are still in good condition. So did another 6 cabinets which 6 QSM900 installed and power supply cabinets (See Figure 7). Two groups of 12 accumulators laid active on platform before the quake, and slid down on the floor in the aftermath. Another group of 12 accumulators installed in iron frame, and was in good condition with small displacement. 2 empty cabinets were only container that fell down. (See Figure 7-9)

Cables inside machine room are fastened along and protected by the iron frame in consistent with safety demands, and still in effect. The communication optical fiber cable had no signal in post quake test, indicating that signal had interrupted outside the machine room. (See Figure 10)

Transmitting Antenna located at roof of building, signal is transmissible through the feeder.

This communication station cannot recover service after quake since the signal was interrupted.

3.2. Earthquake damage of communication station at Suiyuan hotel in town Yutang of city Dujiangyan

Earthquake intensity in town Yutang of city Dujiangyan is 9.

The communication station located at room rent from Suiyuan hotel. The building of Suiyuan hotel constructed in early 1980s. This 5 story masonry building (brick-concrete structural building) had less structural quality for low mortar strength of brickwork joints. The building was seriously damaged in the quake, it appeared the connectivity crack on part of load bearing wall in the first and second floor, and less or more crack on load bearing wall of the second third and fourth floor. (See Figure 11)

The communication station laid in fourth floor. There are transmission equipment, communication primary equipment and air conditioning in the machine room. The cabinets with equipment had no fastening point on the floor, their displacements are not heavy, and equipments were in good condition. While air condition lean forward nearly falling. (See Figure 12)

Cables inside machine room are fastened along and protected by the iron frame in consistent with safety demands, and still in effect. Transmitting Antenna located at roof of building without any fault. (See Figure 13-14)

This communication station cannot recover communication service for the short of power supply.

3.3. Earthquake damage of communication station at mount Lingyan cableway in city Dujiangyan

Earthquake intensity in mount Lingyan of city Dujiangyan is 9.
Mount Lingyan mobile communication station located in two floor masonry building (brick-concrete structural building) within the section of mount Lingyan cableway. The building was constructed in 1990s, with qualify mortar strength of brickwork joints, but the layout rooms are irregularity, led to oversize bay. The building was serious damage by the quake; collapses took place at partly wall, staircase wall and roof of first floor. (See Figure 15-16).

The mobile communication station located at machine room facing the street in first floor. There is transmission equipment, communication primary equipment and air conditioning along the rear of outboard inside, and cabinet had no fasten point on the floor. Since the wall partly collapsed, air condition cabinet was crashed. The cabinets of communication equipment appeared some displacement, but equipments were all in good condition. (See Figure 17-18)

One of three antennas damaged with the fall of roof. (See Figure 19)

Though part of wall and roof collapsed, the cable distribution was fasten firmly without any fault. (See Figure 20)

This mobile communication station relied on portable generator after interrupt of power supply by main quake.

3.4. Lessons leant for earthquake damage on communication system

The quake caused the communication system many damage and losses, but not seriously. Few communication station destroyed directly by structure collapse. The majority communication stations can run normally with simple repair work.

The causes for interruption of communication service are as follows:

(1) Collapse of masonry wall and roof led to damage on communication equipment, cables and antennae. Some communication station's building supporter had low earthquake proof capability, and communication cables hanged free outside the outboard wall, as caused cables cut and damage on communication equipment. The communication antennae are vulnerable while roof of building collapse.

(2) Interruption of power supply. The power grid was serious damaged in city Dujiangyan. Power interruption lasted for several days. It is only 5 hours that the accumulators can maintain communication service; the only source for power supply is from oil electric engine. There are two main causes for hindering of power supply, one is lack of adequate portable generators for sudden even, and the other is land slide made traffic condition too worse to transport generators.

(3) The increasing communication flow extends the communication system's capability, thus blocked and put down the communication system.

4. COUNTERMEASURES TO EARTHQUAKE DAMAGE ON COMMUNICATION SYSTEM

Base on the above lessons leant and earthquake disaster phenomena, it summarizes countermeasures as follows:

(1) On selecting the building supporter of communication station, it should take site conditions, structure type, fortification intensity, construction quality, construction time and floor height into consideration, in order to ensure the safety of communication equipment, cables and antennae. The detail conditions are:

- Building supporter on the seismic responses field of Classes I and II has the upper priority.
- The machine room of communication station should locate in the building supporter with strong earthquake resistant capability, the priority on structure as following: Steel structure, frame shear wall structure and frame structure.
- In case of Brick Masonry structure (Brick-concrete Structure), the constructional columns and the

circle beams should qualified to ensure the quality of Cast-in-place Floor. It is strong suggested exclude the building of precast slab.

- The building supporter of communication supporter should be regular structure on plane and longitudinal section, has uniform stiffness, and symmetrical.

(2) The machine room of communication station should avoid follow issues:

- Irregular protrusive room at top floor.
- Room in first floor and second floor of multiple-story and high-rise building.
- Room at rear of outboard outside cross wall.

(3) Setting and fitted Equipments and Cabinet should be

- Equipments lean against and parallel to interior wall.
- Cabinet for transmission communication and power supply should arrange side by side.
- Cabinets should fasten on the floor and air condition should fix with wall and floor.
- Accumulator should arrange in iron frame and lay down on the floor. Accumulators should fix firmly to avoid sliding when special platform as required.

(4) Cables' vertical distribution should be along the column of steel frame structure, frame construction, and masonry structure instead of wall.

(5) Iron frame should continuous protecting to cables, where cables Climb wall, run cross wall and penetrating wall.

(6) Antennae should be regular shape and avoid installing on protrusive roof. And antennae should be far away from the prominence such as cell room on the roof.

This paper considers the legislation of state earthquake resistance standard and supervision of industry earthquake resistance as key measures for improvement on the earthquake resistance capacity of communication system. Wherefore, it recommends respect state administrative department to develop design criteria on earthquake resistance capability of both communication equipment and capital construction, implement strict supervision and management, in order to improve capabilities of earthquake resistance and emergency response, and reduce the fault rate of communication system.

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Fig.1 outside longitude wall of the traffic administrative bureau

Fig.2 outside longitude wall's damage at the first floor of the traffic administrative bureau

Fig.3 and 4 broken optical fiber cable run cross enclosing wall

Fig.5 and 6 outside cross wall and cables' damage of three floors of the traffic administrative bureau

Fig.7 cabinets with no fasten points are safe

Fig.8 empthy cabinet and accumulators fell down

Fig.9 accumulators in iron frame

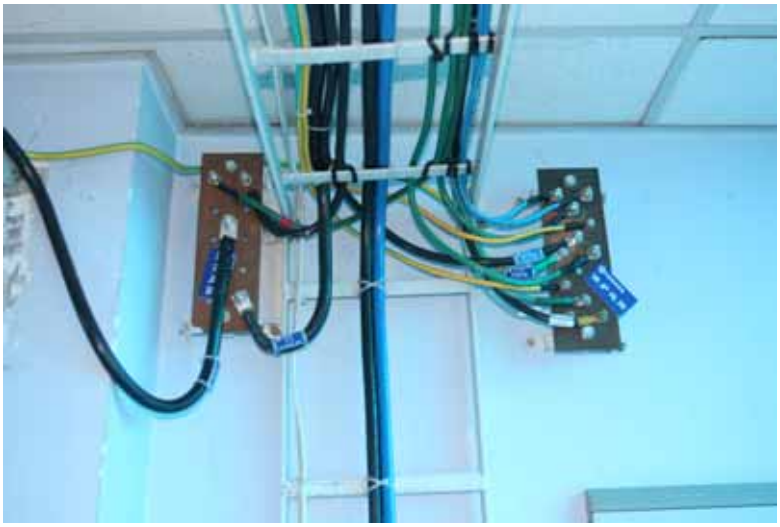

Fig.10 cables fixed on wall

Fig.11 wall damage of first floor at Suiyuan Hotel

Fig.12 communication equipments are in good condition

Fig.13 inside cable distribution of communication station

Fig.14 outside cable distribution of communication station

Fig.15 serious damage of building near the Mount Lingyan cableway

Fig.16 serious damage of inner walls

Fig.17 outside cross wall of the communication machine room inward collapse

Fig.18 air condition crack by inward collapsed cross wall

Fig.19 roof collapse of building near the Mount Lingyan cableway

Fig.20 cables of communication station fixed well