

Post-Earthquake Field Loss Evaluation of Earthquake Hazard

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ABSTRACT

In this paper, the history and the present situation of post-earthquake field loss evaluation of earthquake hazard are reviewed. The contents and the method (including the procedure and points for attention) of loss evaluation of earthquake hazard are discussed in detail. Finally the research tendency is present.

INTRODUCTION

Post-earthquake field loss evaluation of earthquake hazard is to evaluate the disaster induced by an earthquake in a short time (less than 7 days) after a moderate or strong earthquake occurred. The earthquake disaster includes casualty, the buildings damaged, and the lifeline system engineering structures damaged, economical loss, and the number of human homeless. The emphasis is put on the evaluation of which related with national and local economy, and the people's life and property, and the loss evaluation of damaged buildings is the main part of evaluation work.

The purpose of earthquake hazard is: to provide scientific basis for the national and local government to take emergency rescue measures and determine the scale of rescue depending on the magnitude of the earthquake hazard; to evaluate the impact of the earthquake hazard on the national or local economy, and rectify the financial policy of government; to make risk evaluation by comparing the invest of earthquake hazard prevention and the real earthquake hazard, make the invest policy of earthquake hazard prevention optimal; to provide the government with the data of earthquake hazard in making a scientific rebuilding plan.

The earthquake disasters can be divided direct economical loss, indirect economical loss and social loss [2]. The direct loss is the social property loss induced by the earthquake damage or related to the earthquake damage, including the loss of buildings damaged, the indoor property loss, and the loss of other engineering facilities damaged. The indirect loss is the loss induced by the social function loss due to the direct damage of buildings and engineering facilities, including the loss due to enterprises no or less production after an earthquake, the loss induced by the influence of enterprises no or less production on goods circulation, and earthquake hazard rescue expending and son on. The social loss includes people's life and health loss, the influence of earthquake on social livelihood, political activity, family, and psychological health, and the casualty can be quantitatively evaluated statistically, the others cannot be evaluated until now.

From 1966 to 1988, many hazardous earthquakes occurred in China mainland and the earthquake loss were the statistical result of the loss data from the people in the hazardous area, and the data was shown practically to be lack of scientific sense. The loss data was evaluated much larger

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than the real loss in most times. One reason is that there was not a scientific evaluation method for earthquake loss evaluation in that time, the local government wanted to report the earthquake loss data to the higher authorities in a very short time after a hazardous earthquake occurred, so that the simple statistic method was used to calculate the earthquake loss. The statistical loss result is poor reliability, is much greater than the practical earthquake loss. The other reason is that some people in hazardous area wanted to enlarge the loss data and so they can get more money or goods from the government, because the government usually will give the money or goods to the people in the hazardous area after an earthquake. This unreal and enlarged data made the rescue difficult usually, and also made the wrong decision in rescue and in rebuilding of hazardous area.

To make the earthquake loss data more accurate and more scientifically, the China Earthquake Administration (original name is China Seismological Bureau) funded some studies on the theory and method of earthquake loss evaluation. At the same time, send experts to real earthquake field to evaluate the earthquake loss after several earthquakes, this accumulated lot of experience in loss evaluation. The first experience of using scientific method to evaluate the earthquake loss is in the Datong-Yangao earthquake in Shanxi province in 1988. In 1990, “the guideline to field work of earthquake hazard investigation and the earthquake loss evaluation” and the accessory document “detailed rules to earthquake loss evaluation” are published and used in the real earthquake loss evaluation. A computer program named EDEP was developed based on the code and was used nationwide. Also an authority organization called Earthquake Hazard Evaluation Committee was set up to assess and check the result of earthquake loss evaluation. The experience of earthquakes in more than ten years shows that those work made the earthquake loss evaluation have scientific method, and can report the hazard quantitatively in a short, and can provide trustworthy data to the national or local government in making the strategic decision of disaster salvation and homeland reconstruction. In 1998, based on the experience of in real earthquake loss evaluation and the “guidelines” and the “rules”, the “regulations of earthquake loss evaluation” was published and several version of the computer program were developed, such as EDLES 1.0 in 1997, EDLES 2.0 in 1998, EDLES 2.5 in 2000, and MapEDLES 2001.

2. THE CONTENT AND METHOD OF EARTHQUAKE LOSS EVALUATION

2.1 The Content of Earthquake Loss Evaluation

Earthquake loss evaluation includes economic loss evaluation and the casualty evaluation.

The casualty is the most serious disaster induced by earthquakes, which is the focus of social attention and has a great and long-term effect on the society. There are unified criterion of casualty classification: light wounded, the wounded needless of staying in hospital for curing; heavy wounded, the wounded need to stay in hospital for curing; death, those dead during the earthquake immediately and the heavy wounded who was dead in seven days after the earthquake.

The earthquake economical loss includes earthquake direct economic loss, earthquake indirect economic loss and the emergency salvation fee. Earthquake direct economic loss is the main part of earthquake loss evaluation, and there are many aspects need to be evaluated, mainly includes: buildings, lifeline engineering structures, hydraulic engineering structures, underground structures, large-scale enterprises, major facilities and other industrial structures. Buildings includes reinforced concrete buildings (frame buildings, frame-shear wall buildings, frame-tube buildings and so on), multi-story masonry buildings (brick building, concrete block buildings), masonry buildings with inner concrete frame and first story frame, single-story factory buildings with reinforced concrete or brick

columns, common buildings (single-story brick and wood buildings, single-story masonry buildings, wood frame buildings, adobe buildings, cave dwelling and stone buildings) and steel buildings and so on. Lifeline systems includes communication system (communication transmitting facility, television tower, etc.), transportation system (road, railroad, bridges, airport, harbor, tunnel, etc.), electric power system (power plant, transformer substation, electricity transmit line, electric equipment, etc.), water supply system and drainage system (water deposition facilities, sewage deposition facilities, water tower, pump room, pipeline system, etc.), and gas supply system (gas factory facilities, gas storage tank, pressure regulation station, gas supply pipeline, etc.). Hydraulic engineering structures include: large dam, canal, chamfer, river mound, sluice gate, etc. Underground structures include subway, air defense facilities, underground market, etc. Earthquake indirect economical loss includes the loss due to the stop production and reduction of output of enterprises induced by the earthquake, the loss due to the fluctuation of land prize, the economic loss due to the residents and enterprises move to other place, etc. the emergency salvation fee include salvation staff fee, the value of salvation goods and materials, transportation fee, ruins disposition fee, medical treatment fee and funeral fee, etc.

2.2 Method of Earthquake Loss Evaluation

In general, the procedure of earthquake loss evaluation is as following:

- a) To know the disaster preliminarily, and make sure the disaster area and divide the disaster area into evaluation sub-areas

To make sure the position of hardest disaster by the casualty and the serious damage of buildings, to investigate and find out the boundary of disaster area, and divide the disaster area into evaluation sub-areas, the sub-areas number of evaluation is decided by the earthquake scale and then gives the border of each sub-area.

In the countryside, the principle of making sub-areas is that the damage in inner sub-areas should be serous than that in outer sub-areas. For the evaluation area in cities, there are different situations that: the damage degree in the small or moderate city is thought as the same, and so it can be look as an evaluation sub-area, for a large city, the sub-areas are based on the damage of buildings.

- b) To make sure the all kinds of buildings in the disaster area and all the kinds of buildings need to be evaluated.

- c) To make the standard of damage grade of one kind building uniform

To make the standard of damage grade of one kind building uniform based on the principle of building damage grade by the typical buildings chosen from the every kind of building in the disaster area. In China, the damage grades are five: un-damaged, light-damaged, moderate-damaged, serious-damaged and collapse. Different damage grade corresponds to different damage appearance, such as: the position and size of cracks; the degree of wall break down and so on. To make uniform the standard of damage grade of one kind building is an important work in the loss evaluation because it affects the loss evaluation result greatly.

- d) To select the sample points

The natural village is the sample point in countryside evaluation area. The number of sample points should not be less than 24 when the earthquake scale less than 6; when the earthquake scale is 6 to 7, the number of sample points should not be less than 32; if the earthquake is larger than 7 scale,

the number of sample points should exceed 42. If there are evaluation sub-areas, the number in each sub-area must be not less than 12.

The sample points in city should be in the area with lots of buildings, the area of each sample point should be not less than one square kilometer. The sum of architectural area of the buildings in all sample points in city evaluation area should not be less than ten percent of that of buildings in the total area.

The sample points should be well distributed in the evaluation area, and the number of sample points should be augmented extenuatory when the disaster is seriously uneven.

e) To investigate of the damage of buildings

The field-working experts are divided into groups to investigate the damage of buildings at each sample point, and to investigate the casualty statistically. The damage grade of every building should be given clearly and the architectural area of every building recorded.

The buildings investigated at a sample point should not be less than 60 percent of the total buildings by architectural area.

f) To obtain the damage ratio from the investigation of sample points

The damage ratio is obtain by that the architectural area of one kind building at all sample points as the denominator, and the architectural area of the same kind buildings with the same damage grade as the numerator. There are five damage ratios for one kind building, and the summation of them equals one.

h) To decide the loss ratio of every bind of building

To decide the loss ratio of every bind of building is another important work of earthquake loss evaluation, the reasonable value of loss ratio is chosen based on the past earthquake data and experiences, and incorporation of the specific field situation.

i) To obtain the architectural area of every kind of building

The architectural area data can be obtained from the construction department, building management department and the statistic department. But in many case the architectural area data in different kind of building is difficult to obtain, and the sample method can be used to estimate this important data approximately.

j) To calculate the direct economic loss of buildings

For one kind of building, the sum of the product of the architectural area, damage ratio, loss ratio, the rebuilding unit prize of different damage grade makes the direct economic loss of this kind of building. The sum of direct loss of all kind of buildings gives the total direct loss of buildings damage.

k) To calculate the direct economic loss of lifeline system

Lifeline systems mainly include power supply system, transportation system, communication system, water supply and drainage system. There are more complex structures in lifeline system and the function of lifeline system is in system and in network, so the damage of part or component of the system will affect the function of the whole system. There is no effective evaluation method for the earthquake loss of lifeline system. Usually the damage loss of bridges can be obtained referring to method of building, and the loss of pipelines use the product of total length, the number of damage

locations in one kilometer, and the repairing cost of each damage location. The professional person and the charging department should be incorporated in the loss evaluation of high voltage equipment and communication equipment.

l) To evaluate the property loss

The method of indoor property loss evaluation is similar to the method of building loss evaluation. That is to use the indoor property loss value unit area instead of the rebuilding unit prize, and delete the loss ratio. The indoor property loss value unit area should be obtained from the field investigation.

The outside property loss use the reported data from the charging department based on the real damage situation.

m) To evaluate other direct economic loss

Other engineering structures include two kinds of structures: one is the municipal infrastructure, large-scale and medium-sized irrigation works in the disaster area, and the other is large-scale industrial enterprises such as steel, mining, petroleum, chemical plant and nuclear power plant. The loss of those structures and the enterprises should be evaluated alone and the professional person and the charging department should be incorporated during the evaluation.

n) To investigate the emergency salvation fee

The emergency salvation fee mainly includes the stuff fee, emergency salvation goods and materials, transportation fee and so on. It can be obtained in the earthquake field, or it can be estimated approximately based on the related regulation of earthquake loss evaluation.

o) To evaluated the indirect economic loss

The indirect economic loss evaluation is one of the complex problems in earthquake loss evaluation and has no effective evaluation method and needs further study. The loss due to the stop production and reduction of output of enterprises is the easiest one in indirect loss evaluation. It can be decided based on the reported data from the enterprises or the management department of the enterprises.

p) To choose the modification coefficient and obtain the final result

Because the evaluation method is the sample investigation method, all the inhabitant points can not be considered in the field investigation, the estimated architecture area and the rebuilding unit prize of buildings can not be very exact, some disaster area are not investigated because of the transportation inconvenience, so a modification coefficient is needed to modify the evaluation result.

3. DISCUSSION

The method of earthquake loss evaluation developed on the experience of past earthquake loss evaluation and the related study achievements supply a scientific tool for the earthquake field work. In the mainland of China, the loss of all hazardous earthquakes must be evaluated using the method, but some aspects need further study in the future:

a) The loss evaluation of lifeline structures reflect not the system ant network characteristics, that is local damage or the component damage will induce the function loss and economic loss of the whole system and the interaction of systems is not considered.

b) The indirect loss related to all social aspects and can be very large, even there are some studies on the indirect loss evaluation, but there is no effective evaluation method until now.

c) Little attention pays to the economic loss induced by the earthquake secondary disasters, but in some earthquakes, the economic loss and casualty due to the earthquake secondary disaster is much greater than that of earthquake direct disaster, so it needs further study.

d) The high technology supply new idea and new tool for the earthquake loss evaluation, such as GIS, GPS, and RS. Some study work has carried out and further study is needed.

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