

STUDY ON LOSS ASSESSMENT OF BUILDING DAMAGES OF URBAN EARTHQUAKE

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ABSTRACT :

The implement of work on Loss Assessment of Earthquake Damage provided reliable basis for national relief organization and homeland rehabilitation. The current method of assessment of earthquake damage derives from Datong-Yanggao Earthquake (Ms6.1) in 1989, which is suitable for undeveloped rural areas; In recent ten years, the level of decoration is improved quickly in our cities, and most of personal and public buildings used middle and top grade of decoration, the expense of some building even is higher than that of main structure. Therefore, the previous assessment method has some disadvantages for building with higher grade of decoration.

Based on above analysis, a new method for the assessment of earthquake-induced building losses is presented, which includes three parts-one of main structure, decoration and indoor property, it is fit for the actual situation of the loss of urban earthquake. In this paper, based on a large of engineering cost information and expert experience, distribution of proportion of corresponding decoration cost in the total building cost is given, and damage grades of building main structure and decoration are more detailed divided and defined separately according to difference of its usage, economic development level, city scale, decoration grade; in the same time, using ATC method developed by American Application Technology Committee(ATC) and questionnaire of wanting numbers of domestic expert opinion of earthquake engineering domain, Loss Ratio probability distribution of different usage building decoration is obtained based on statistical analysis of investigation results; thus, it provides certain reference and basis for further modifying and perfecting of Loss Assessment of Seismic Disasters of our country.

KEYWORDS:

Loss Assessment, Decoration Cost, Loss Ratio of Decoration Damage

1.INTRODUCTION

According to the statistics, 41 percent of the area is 7 degrees and more than 7 degrees of intensity area, and 50 percent of the city, 67 percent of the more than one million populations of major cities lie in the high-intensity earthquake zone in China ^[1]. The threat to urban economy, society and people's safety of life and property of earthquake disaster can't be ignored. Even someone infers that a medium-sized disaster make the process of an urban modernization delay for 20 years. In the last half a century, several earthquakes happening in the city all around the world have caused destructive attack to the city. For example, in Tang Shan earthquake (Ms7.8) in 1976, the whole city leveled to the ground in no time, the death toll is up to 240,000, and the economic losses exceeded ten billion; Japanese Kobe earthquake (Ms6.9) in 1995, caused nearly 100,000 houses to destroy, 5500 people died, the huge economic losses of 100 billion dollars.

Loss assessment of earthquake disaster is an important basis for the government and communities in decision-making of disaster relief. After the destructive earthquake takes place, the fast and accurate estimate losses of the earthquake disaster in advance is significant for government department, public organization and international community inside and outside the disaster-stricken areas to implement the emergency relief, earthquake relief and reconstruction after the earthquake. The application of the norm loss damage assessment method originated from Datong-Yanggao Earthquake (Ms6.1) in 1989, and got up to very positive meaning at that time. However, it is mainly suitable for countryside and small town area, further perfect in several decades; Yuan Yifan and other experts work out national standard (GB 18208.4-2005) on the basis of absorbing practical

experience in 2005. Lots of key issues during the evaluation have been revised, and taking into account the economic development, “Loss Ratio of the building damage” was made a certain increase (about 5%). Since the implement of this standard, it have been playing an enormous role in the work of assessing loss after all previous calamity, and providing an important basis for the restoration and rebuilding and the decision-making of governments at all levels. Summarizing the experience and deficiency since the implement of the standard, we make a conclusion that there is a certain irrationality, contrasting to foreign disaster damage assessment, that the direct loss assessment of earthquake disaster of our country has not considered the value of house decoration at present, so the further refine and scientific process of earthquake damage losses in urban areas should be made.

2. METHOD OF ASSESSMENT IN DIRECT LOSSES OF URBAN EARTHQUAKE

2.1 Introduction of the loss assessment method

Assess and look from the earthquake losses in the past 20 years, the losses of the building are taken 50% - 70%, the house damage is a lost subject in the earthquake. At present, with the economic development and improvement of living standards of the people, fit up competence to improve quickly in the building of the city of our country, quite a lot the personal house and public house have been adopted and fitted up medium-to-high grade, even some equipment expenses built have exceeded the fabrication cost of the agent structure. However, do not basically consider fitting up losses while assessing in loss in the past of our country, even the national standard (GB 18208.4- 2005) Just stipulate in the clause on 4.6.3 too: Interior decoration should be rebuilt and consider in the house at the unit price or indoor property, but does not basically consider while implementing specifically. Such as for Shanghai, a set of three rooms of houses of Beijing, cost price of the agent structure is between 100,000-150,000, it is very common thing to fit up the expenses as 80,000-100,000^[2]. So, to city assessing area where the economic wealth concentrated, the past assessment method will result in assessing the result and is smaller than the true loss value. Because of the above-mentioned analysis, we propose the following thinking: As to cities and towns and countryside assessing area, building construction still according to original assessment method direct loss - divide^[3], lose with room internal and external property loss two parts assessing for agent structure; To the assessing area of the city, on the foundation of losing in fact agent structure of the assessment and indoor and outdoor property loss, increasing will fit up losses to assess to building construction medium-to-high grade, and make it can press close to the actual conditions with lost urban earthquake even more, the assessment procedure as shown in Fig. 1 specifically.

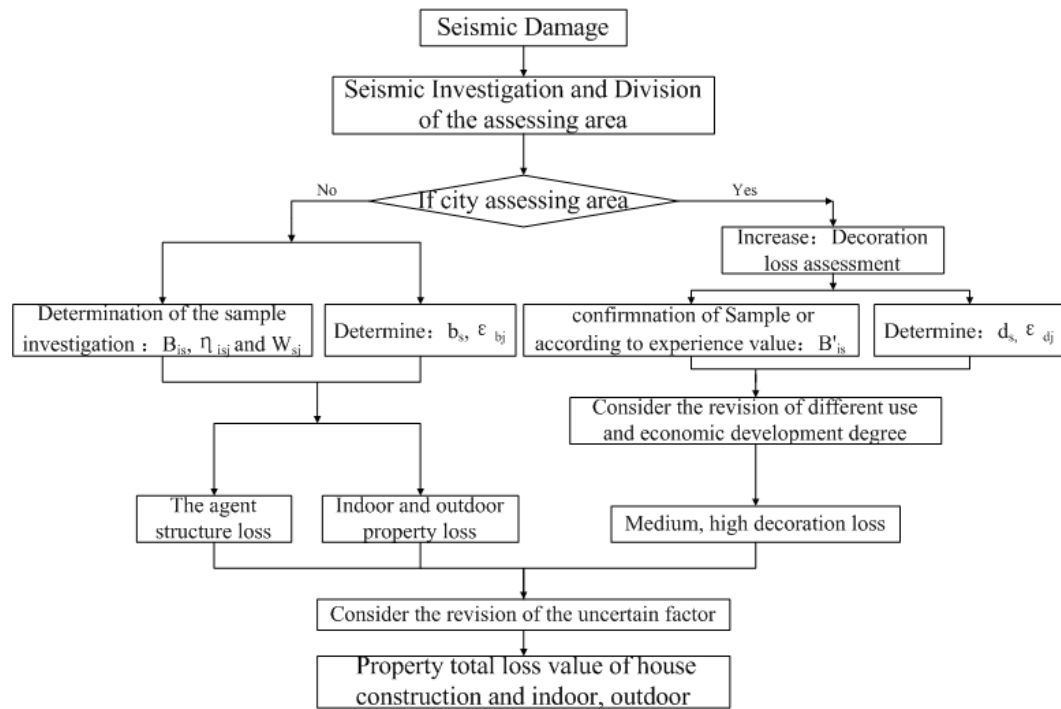


Fig. 1 The flow diagram in loss assessment of building damage in urban area

2.2 Formula

Correspond to the assessment flow diagram of Fig.1, the direct economic losses of city building construction earthquake include three parts of agent structure losses, house decoration losses and indoor and outdoor property loss, their formulae of calculation show as follows:

$$L = \alpha \left(\sum_{i=1}^m \sum_{s=1}^n \sum_{j=1}^5 \eta_{isj} \cdot B_{is} \cdot b_s \cdot \varepsilon_{bj} + \gamma_1 \cdot \gamma_2 \cdot \sum_{i=1}^m \sum_{s=1}^n \sum_{j=1}^5 \eta_{isj} \cdot B'_{is} \cdot d_s \cdot \varepsilon_{dj} + \sum_{i=1}^m \sum_{s=1}^n \sum_{j=1}^5 \eta_{isj} \cdot B_{is} \cdot w_{sj} \right)$$

Here:

L —The sum of the building construction and direct economic losses of indoor and outdoor property;

η_{isj} —destruction ratio of j grade destroys for i assessing area in s building;

B_{is} —The whole area of s building in i assessing area;

B'_{is} —The whole area of medium, high grade decoration house of s building in i assessing area;

b_s —Resetting unit price of s building (Yuan / m^2);

ε_{bj} —Loss ratio of s building when being destroys in j grade;

d_s —Resetting unit price of s building medium, high grade decoration (Yuan / m^2);

ε_{dj} —Loss ratio of s building loss decoration when j grade will be taken place;

γ_1 —consider the decoration loss revision coefficient of the economic development level difference;

γ_2 —consider the decoration loss revision coefficient of different usage;

w_{sj} —Property loss of unit area in the room (Outside) of s building taking place j grade destroy, (Yuan / m^2);

α —The revision coefficient of the total loss value, generally fetch 1.0-1.3.

3. DETERMINATION OF RELEVANT PARAMETERS

The urban earthquake losses that this text puts forward above are assessed in the method, Part one (agent

structure is lost) , the third part (indoor and outdoor property loss) Still according to the national standard (GB 18208.4- 2005) Regulation relevant regulation carry on introduce by second part " house decoration loss " relevant emphatically only assessment, this text Assess the content.

3.1 The division standard of the house decoration damage grade

The destruction intensity of the house is different when the earthquake, losses are different too, the complexity of repairment is influencing the lost size. At home with divide, destroy grade method come, evaluate earthquake of the house begin with the earthquake of Urumchi of 1964 first, went through numerous earthquakes hereafter and practised repeatedly, basically confirmed the division standards of five grades until Haicheng earthquaked in 1975^[4]. In order to evaluate fitting up the lost size, this text is on the basis of summarizing domestic and international a large number of earthquake experience, in line with " take destruction intensity of the bearing component as the core and consider repairing the size of the difficult and apt and cost " Principle, it is correctly "house decoration part " Destruction grade divide last definition (See Table 1) ,In order to assess the work and use.

The ones that need paying attention to are: Destroy grade divide to some extent distinguishing, fit up some in weight to on structural part, meet the situation often, fit up and present and can see the crack partly, after removing and fitting up, the structural component has no crack; The fragility is structural ' Build body structure) Fit up and destroy and destroy the state to correspond to better with the structure, and the flexible structure (steel reinforced concrete, steel construction, etc.) Fit up and destroy greater, even all have some to drop to damage the state basically intactly and slightly sometimes.

Table 1 Division of the damage state of house

Components	None	Slight	Moderate	Extensive	Complete
Structure	Most bearing components are intact, the specific unbearable component is destroyed slightly, repairing can go on and use	The specific bearing component presents and can see the crack, the unbearable component has obvious cracks, do not need or repair and can continue using a little	Most bearing components appear in the slight crack, there are obvious cracks partly, the specific unbearable component is destroyed seriously, need general repair	Most bearing components are destroyed seriously, or there is part that collapses, need overhauling, the specific house repairs the difficulty	Most bearing components are destroyed seriously, the structure is on the brink of collapsing or destroying, it is possible not to repair yet
Decoration	Basically harmless, fit up and can see the crack individually	The veneer appears in the macroscopic crack; A piece of not glass breaks to pieces and falls, repair and can use normally a little on the glass curtain wall	The veneer has obvious cracks and out of shape, the part drops; The glass curtain wall supporting part is out of shape and relatively large, a few glass breaks to pieces and falls	Out of shape seriously, produce many cracks, the majority drops	Brokenness and coming off of the large area

3.2 Loss Ratio of Decoration Damage ε_{dj}

Loss Ratio has nothing to earthquake intensity, and changes with difference of destroy grade. It is for providing for house decoration it destroy loss than ranges reasonable, pass questionnaire investigation form us^[5], release the questionnaire to a large number of domestic earthquake project experts and decorations companies, invite he (she) Last measure that repair of it and spend under destruction grade, compared with total fabrication cost, provide and does not make the losses destroyed in house decoration it with the grade of destroying than the estimation. Then count the weighting, consider that builds the budget and estimates that receives the last result

(see Table 2) in the house .

Value of Loss Ratio is an important link in loss assessment, especially heavy earthquake, destroy range is large; the floor area is great, total losses will have greater changes when value of loss ratio has little changes. It suggests that loss ratio of decoration damage fetches middle-value, medium-decoration fetches the number under middle-value, and high-decoration fetches the number upper middle-value.

Table 2 Loss ratio of House decoration damage (%)

Classification of the house	Damage State				
	None	Slight	Moderate	Extensive	Complete
RC house	2-10	11-25	26-60	61-90	91-100
Masonry house	0-5	6-19	20-47	48-85	86-100

3.3 Replacement unit price of medium, high decoration in the house

Resetting unit price is a very key parameter in the loss assessment of the house, its meaning is: According to the local market cost price at that time, unit area fabrication cost of rebuilding the same type and the standard house. Resetting expenses exclude profit, price of land of developer (land expropriation cost, the fee of taking over land) and expenses increased to improve fortification level, and wouldn't consider the depreciation question of the house at present.

In order to get the house decoration expenses of different city sizes, this text consults some cities "the replacement price standard of pulling down house", "the cost price standard of selling publicly-owned house " and relative regulation of "The construction cost of the house " announced in Hefei, etc. and according to " project cost index", convert to the fixed price for 2007, and provide the ratio range of house decoration expenses to fabrication cost of the subject (see Table 3). This ratio can be got through the on-the-spot sample investigation, if time does not allow, it can consult Table 3 to choose too. House decoration expenses multiply by resetting unit price of various house proportion that Table 3 show obtain mainly: $d_s = b_s \times \eta$.

Table 3 The ratio of house decoration expenses to fabrication cost of the subject (%)

city \ Classification	RC house	Masonry house
Big	26-48	20-34
Moderate	19-38	16-25
Small	15-30	10-20

3.4 Total area of medium, high decoration house B'_{is} is

The whole area of medium, high decoration house can get through sample investigation getting the proportion accounted of the medium, high grade houses in assessing area (Or choose within the range of suggestion value in Table 4 appropriately), Then multiplied by the total floor area of all kinds of houses B_{is} , Obtain: $B'_{is} = B_{is} \times \xi$.

Table 4 Ratio of house decoration ξ (%)

City Scale \ Classification	RC house	Masonry house
Big	31-55	12-25
Medium	17-35	5-11
Small	8-15	2-5

3.5 Revision coefficient

γ_1 -Consider the decoration loss revision coefficient of the economic development level difference

Decoration expenses improves to some extent with regional economical developed intensity, the revision coefficient that can be adopted in Table 5 is revised.

Table 5 Revision coefficient γ_1

Economic development level	Developed	Relatively developed	General
Revision coefficient	1.3	1.15	1.0

γ_2 —Consider the decoration loss revision coefficient of different usage

If the direct economic losses of assessed house destroy is classified according to the use, the house decoration expenses are different because of the difference of their uses , the revision coefficient that can be adopted in Table 6 is revised, otherwise fetch 1.0.

Table 6 Revision coefficient γ_2

Use	House	Hospital	Work	Commercial	Public
Revision coefficient	1.0	0.8	1.1	1.2	1.05

4. CONCLUSION

In the last few years, a lot of experts^[6] (Zou Qijia; Yuan Yifan, 2002) pointed out simultaneously: no matter comparison with losses of other natural calamity (Such as floods), it is, comparatively speaking, seismic loss assessment value of our country still get far more away. No doubt the indirect economic losses are unable to estimate rationally, which is the important influence factor among them at present, but certain deficiency still exists in the estimations of the direct economic losses. I pass the finding: As to the thing that the city assessing area where the wealth is centralized and densely populated, lack the consideration of the value of house decoration in the past real evaluation process.

Because of this, through summarizing a large number of domestic and international seismic materials and project fabrication cost materials, this text has proposed the method that "commenting originally to the assessing area in the city, estimate it on agent structure losses and the foundation of indoor and outdoor property loss, and increase loss assessment of medium, high decoration house", therefore, obtain earthquake directly economic losses caused by earthquake. Prove, compared with original method, employing the method of this text can increase by about 10-30% directly economic losses value of assessment building construction through the embodiment. Provide disaster relief and rescue the implementation of decision promptly to get up the positive meaning after this text will assess the application of the method to shaking.

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