



Key Technical Problems and Suggestions in the Construction of Earthquake Insurance System in China

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Abstract

China is a country that suffers earthquakes frequently and heavily. The traditional disaster relief highly relies on government emergency rescue and social donation. With the rapid development of economy and the accumulation of social wealth, the traditional disaster relief model cannot meet the need of social development, but also the country from post-disaster relief to pre-disaster risk control of the macro-policy is not in line. Therefore, it is imperative to promote the construction of earthquake insurance system in China. This paper first combs the current situation and existing problems of earthquake insurance system in Japan, the United States, and New Zealand, Yunnan, China, and summarizes the basic process of earthquake insurance business. According to the insurance business process combined with the actual situation in the country, further analysis found: a) lack of basic data, premium determination difficulties, b) lack of building seismic performance quantitative evaluation criteria, nuclear insurance has no basis, c) lack of building seismic damage quantitative evaluation, claims cannot be accurate and rapid. And other problems have become the key technical problems that China needs to solve urgently to promote the construction of earthquake insurance system. Finally, combined with China's current macro-policy of disaster prevention and mitigation and the reform process of national standardization, the countermeasures and suggestions are given. First, taking the opportunity of China's disaster prevention policy from post-disaster relief to pre-disaster risk control, speed up basic research work on the construction of earthquake insurance system. Then, start the compilation of "Quantitative Assessment (certification) Standard for Seismic Performance of Buildings" and "Quantitative Assessment Standard for Damaged Grades and Losses of Damages Buildings" immediately in order to promote the construction of earthquake insurance system in China.

Keywords: disaster prevention and mitigation, earthquake insurance system, problems, suggestions



1. Analysis of the necessity and feasibility of earthquake insurance system construction in China

1.1 The earthquake disaster is very serious in China.

China is located between the Pacific Rim and the Eurasian seismic belt, squeezed by the Pacific plate, the Indian Ocean plate and the Philippine Sea plate. Seismic activity is frequent, widely distributed, and most of them belong to shallow, strong inland earthquakes. Earthquake disasters are extremely serious in China. According to a UNESCO survey, between 1900 and 1980, there were 1.2 million earthquake deaths in the world and 610,000 in China, accounting for 50% of the global total. In history, there have been eight earthquakes in the world that killed more than 200,000 people, with China accounting for four. In addition, from 1949 to 2000, the death toll from natural disasters in China was about 550,000, of which about 280,000 were killed by earthquake disasters, accounting for more than 50%.

1.2 The traditional disaster relief model is gradually not suitable for modern society.

For a long time, Chinese governments at all levels have shouldered the main responsibility for earthquake prevention and mitigation, and carried out earthquake emergency response in a scientific and orderly manner in accordance with the law. In the event of an earthquake, according to the classification of the earthquake disaster, the hierarchical response mechanism shall be initiated, and the local earthquake relief headquarters at all levels shall be responsible for carrying out earthquake relief work. Especially major earthquake disasters need to start the national emergency response, mobilize disaster relief forces at the national level, deploy relief materials, and all sectors of society will also contribute to support the disaster areas. The advantage of this traditional disaster relief model is that it can give full play to the mobilization ability, organizational ability and leadership ability of governments, and it can bring together all the forces of the country to carry out emergency relief, and solve the basic life problems of the people in the disaster areas in a very short time. This has been particularly evident in recent earthquakes in China, especially the WenChuan earthquake in 2008 and the YuShu earthquake in 2010. However, with the development of the economy, the economic losses caused by the earthquake are often billion, and the consequences of casualties are even more incalculable. Although the investment is in line with the goal of minimizing casualties and economic losses and maintaining normal social order, the huge investment in disaster relief and reconstruction has put a great burden on the central and local governments.

Under China's traditional disaster relief model, the government is overburdened and the administrative body is overworked. The international post-earthquake relief funds come from many sources, including government expenditure, social charity donations and commercial insurance. The commercial insurance claims account for about 30% to 40% of disaster relief funds, in sharp contrast to this, the proportion of insurance compensation in China after the WenChuan earthquake accounts for only about 0.2% of the direct losses caused by the earthquake. Insurance has not played its due role in disaster prevention and relief, and there is great uncertainty about charitable contributions. Government financial expenditure is still the main source of disaster relief in China. Earthquakes are unpredictable and cannot be expected in the preparation of the government's annual budget. When an earthquake occurs, the government has to compress or divert other financial expenditures to balance the needs of disaster relief, which often interferes with the implementation of the budget and the normal operation of the national economy. When the earthquake causes particularly great damage, it will also affect post-earthquake relief and reconstruction. Secondly, the amount of economic assistance received by the people in the disaster area is mainly determined by the rescue efforts of government agencies and social donations, randomness and chance. More relief efforts tend to life-oriented rescue and mass life placement, and social and economic losses are difficult to get the corresponding proportion of compensation. At present, the largest property of urban residents in China is generally houses under their own names, whose economic value generally ranges from hundreds of thousands to tens of millions of RMB, but residential buildings after the earthquake damage, cannot get a considerable



compensation. This phenomenon will result in a huge gap between the public expectation of property value preservation and the actual relief.

1.3 It is necessary and feasible to establish earthquake insurance system in China.

The implementation of earthquake insurance has positive implications for the Government, the insurance market and the community as a whole. First of all, earthquake insurance can effectively smooth the financial fluctuations caused by earthquakes, and play an important role in sharing earthquake risks and improving the efficiency of disaster relief. Secondly, the implementation of earthquake insurance can open up new markets for the insurance industry and promote the healthy development of the insurance industry. Finally, for the affected people in the disaster area, earthquake insurance can make disaster relief funds in place quickly, strongly support post-disaster relief and reconstruction. For the masses in other areas, earthquake insurance provides guarantee for the possible disaster risk in the future, and promotes social prosperity and stability of the society. On December 19, 2016, the Opinions of the Central Committee of the Communist Party of China and the State Council on Promoting the Reform of the System for Disaster Prevention and Mitigation, was implemented, and requires that the relationship between disaster prevention and mitigation and economic and social development should be handled properly, that the prevention should be given priority to, that the prevention and the rescue should be combined, and that efforts should be made to shift from focusing on post-disaster relief to focusing on pre-disaster prevention. In China, the policy of earthquake catastrophe insurance system is ready.

2. Experience and Enlightenment of earthquake insurance practice at home and abroad

According to incomplete statistics, tens of thousands of earthquakes occur in the world every day, most of which are too small or deep to be detected. The earthquakes that cause disasters occur ten to twenty times per year, and that cause serious harm are relatively random and belong to global catastrophe. For a long time, many countries and regions, especially those with frequent earthquakes are looking for measures to mitigate the impact of earthquake disasters. As a powerful measure, earthquake insurance has been carried out in many countries, and a lot of successful experiences has been obtained. Table 1 shows comparison of earthquake insurance carried out in the United States, Japan, New Zealand and Yunnan of China.

Table 1- Comparison of earthquake insurance in the USA, Japan, the New Zealand and Yunnan province

	<i>The USA</i>	<i>Japan</i>	<i>New Zealand</i>	<i>Yunnan province</i>
opportunity to launch	Was launched after the San Francisco earthquake in 1906, and after the Northridge earthquake in 1994, the mode of operation was significantly adjusted, and then gradually improved.	Was launched after the Niigata earthquake in 1964, and after the Great Hanshin Earthquake in 1995, the basic terms were adjusted greatly, forming the current Japanese earthquake insurance system.	There years after the earthquake in the Wellington and Waialalapa regions of the capital in 1942, the New Zealand government set up a special agency to carry out earthquake insurance. After several modifications, it gradually improved.	After the wenchuan earthquake in 2008, Yunnan province started the pilot study of earthquake insurance, and the policy rural housing earthquake insurance signed in Dali Bai Autonomous Prefecture in 2012



Guarantee objects	Residential house itself, indoor property and extra living expenses caused by earthquake	Residential house and household items	Land, residential house and indoor property	Rural house and death of residents
Insurance attribute	Commercial insurance, with deductible and no limit.	Public product attributes, with limit. Commercial insurance can be purchased if higher compensation is required. The aim is to ensure the stability of the lives of the residents of the disaster area.	Compulsory insurance, with limit and deductible. Commercial insurance can be purchased if higher compensation is required.	Policy insurance, with limit and no deductible.
Premium rates	Differential premium rates, depended on the earthquake risk of the area where the house is located and the earthquake resistance of the house	Differential premium rates, depended on the area in which the house is located, and structural type of house and there are premium rate discount according to the house earthquake performance level.	National flat premium rate	Fixed premium per household
Disaster risk sharing mechanism	Fully market-led, participating in the company co-financing, operation, management and claims.	Market-led, insurance companies, reinsurance companies to fund, operate, manage and claim compensation, more than a certain number, the government bottom	Government-led	Government full authority, supervision and management

Although the establishment of earthquake insurance systems in various countries has gone through a lot of twists and turns, and the insurance models adopted in the end are different, the general process from scratch



is similar. First of all, we all follow the "catastrophe as the cause, legislation first". If we want to successfully establish the earthquake insurance system, the supporting laws are the prerequisite. Secondly, after the establishment of the earthquake insurance system, the insurance coverage expanded on a large scale. The corresponding technical measures of construction industry, insurance industry and other industry are the cornerstone to ensure the sound development of the earthquake insurance system. Finally, the establishment of a multi-channel disaster risk dispersion system is the guarantee of the sustainable development of earthquake insurance. And at different stages, these three parts are of different importance. The support of legislation and policy is very important for the earthquake insurance system in the primary stage, and with the further development of earthquake insurance, the role of strong multi-disciplinary technical support and reasonable risk-sharing mechanism is becoming more and more prominent.

3. Key technical problems in the construction of earthquake insurance system in China

3.1 The earthquake laws and regulations are not very workable.

Since 1997, China began to explore the legislation of earthquake insurance, and various departments have issued a series of opinions, plans, etc., which affirmed the establishment of earthquake insurance system. However, these laws, regulations, opinions, etc. have not made clear provisions on the details of the earthquake insurance system, and are not very workable.

3.2 Earthquake insurance-related technology is ill-prepared.

There are many technical difficulties to be solved in the implementation of earthquake insurance. There is no doubt that earthquake risk prediction is the main one. Risk prediction is generally realized by establishing catastrophe model. Catastrophe model has not standard definition, which is generally understood that with the computer technology, as well as information on existing population, geography, and buildings the potential damage of a certain disaster in a given area is evaluated. Catastrophe model is generally divided into three modules, namely, disaster module, engineering module and financial module. Disaster module is the research of scientists on the disaster itself, that is, the collection of earthquakes that may occur in a given region. The task of the engineering module is to study the damage to buildings in a given area. The financial module mainly converts the results of the first two modules into insurance losses and applies them to different terms.

From the simulation process of the catastrophe model, we can see that there are two key conditions to predict an earthquake risk. First of all, the catastrophe module can reasonably simulate seismic events, and assess the hazard parameters of the site where the area was evaluated at the time of the disaster. As early as 1997, China Insurance Institute and People's Insurance Company of China jointly with China Seismological Bureau, the State Science and Technology Commission and other departments analyzed the distribution of earthquake disaster losses in China, drew the pure rate map of earthquake insurance in China, and constructed the insurance model framework of earthquake risk management. In 1998, Swiss Re, cooperated with Beijing Normal University, to draw the "China's Giant Electronic Disaster Map", which was completed at the end of 2002. The map collects all kinds of historical, geographical and climatic data from the 12th century to the present in China, which can provide a strong basis for insurance companies to enter the earthquake catastrophe insurance market.

Secondly, the engineering module can well reflect the loss of the structure itself, internal property or function interruption caused by the given earthquake. The main basis of the evaluation is the vulnerability curve of building, which is used to illustrate the damage suffered by the building under the effect of earthquake of different intensity. It is usually expressed as a loss ratio (the ratio of repair costs to reconstruction costs). In addition to modeling and analyzing the vulnerability of buildings according to the design specifications, the vulnerability curve can also be obtained by collecting, sorting out, and extracting the statistical analysis of various factors related to engineering disasters from the previous earthquake damage data. China is an earthquake-prone area, and the historical records of earthquake damage are relatively detailed and rich. After the founding of the People's Republic of China, several major earthquakes



occurred, and the earthquake resistant personnel rushed to the disaster area for the first time, collecting a lot of valuable first-hand information, which is very helpful to the analysis of the vulnerability of buildings. However, the seismic damage data are mostly limited to multi-stories masonry and RC frame structures. Since the reform and opening up, with the rapid development of economy and the acceleration of social wealth, there are a large number of high-rise buildings in the city, and the height is increasing, the structure forms is more and more complex, and the construction cost is higher and higher. In sharp contrast, the seismic damage data of this kind of buildings are basically blank, and the vulnerability curve of this kind of buildings can only get theoretical conclusion through modeling analysis according to the design code.

If the vulnerability curve of the structure is analyzed, the damage grade of the structure cannot be bypassed. There are many quantitative indexes of structural damage grade, including strength, rigidity, ductile ratio, displacement, earthquake damage index, etc., and there are also more than two combined indexes. Most of the engineering circles use the displacement angle between floors as a quantitative index to judge the vulnerability of buildings, which is consistent with the idea of China's seismic code. Because it is difficult to fully describe the inelastic performance and damage state of buildings with carrying capacity as the index, and it is difficult to apply the energy index in practice. In China's seismic code, interlayer deformation is used to describe the three-level fortification level of "small earthquake is not damaged, medium earthquake can be repaired, and large earthquake is not collapsed" and the limit values of elastic and elastic-plastic interlayer displacement angles of different structural types are specified. Based on a large number of experimental data, seismic damage data and theoretical analysis, it is generally believed that the structural failure level corresponding to the elastic interlayer displacement angle and the elastic-plastic interlayer displacement angle is intact and collapsed. However, the earthquake damaged grade of buildings is generally divided into five, i.e., "basically intact, slightly damaged, moderately damaged, severely damaged and collapsed". When using the seismic damage data to analyze the vulnerability curve of structures, the vulnerability matrix is also established according to these five grades. China's seismic code system is lack of corresponding grading and quantitative evaluation standards, which makes it very inconvenient to establish vulnerability matrix by theoretical analysis. As a result, there is no unified standard in premium determination and risk control in the insurance industry, and no effective response measures can be taken. The underwriting risk is too large, and the enthusiasm of the insurance industry is not high.

For the smooth development and sustainable development of the earthquake insurance system, China's current standard system needs to supplement and improve the quantitative evaluation standard for the seismic performance of buildings, the classification standard for the damage and loss level of buildings after the earthquake, as well as the fast loss evaluation standard for buildings damaged by the earthquake and other relevant links.

3.3 Earthquake risk-sharing mechanism

California earthquake insurance is the market-led model. The government is not directly involved in the earthquake insurance market, and it can balance the supply and demand through market regulation. The government is neither responsible for the financing guarantee, nor for the risk of earthquake catastrophe. It only provides policy support through a series of tax relief, issuance of government bonds and so on. All the risks are shared by the insurance market and the capital market. After the earthquake disaster, the earthquake insurance fund shall bear it first. When the earthquake insurance fund is insufficient to pay the claim, the insurance company consortium shall jointly bear it, and share the earthquake risk through financial products or reinsurance. The government issues bonds to finance, and finally the insurance company consortium shall jointly bear the compensation again.

Japan earthquake insurance is a "public-private joint venture" model. Seismic Insurance Law stipulates that earthquake insurance adopts the way that insurance companies (direct insurance companies), reinsurance companies and the government jointly bear risks. After the policyholder purchases the insurance in the direct insurance company, the direct insurance company shall distribute all earthquake insurance premiums to the reinsurance company in the form of reinsurance. Reinsurance companies distribute the premiums to the government and the direct insurance companies in a certain proportion, leaving the remaining ones to be



retained by themselves. In this way, the insurance companies, reinsurance companies and the state trinity to jointly undertake the earthquake risks underwritten. The direct insurance company and reinsurance company shall bear all the liability for compensation for the amount of compensation below 115 billion yen. When the amount of compensation is between 115 billion yen and 1925 billion yen, the government and insurance company shall bear half of the liability for the part exceeding 115 billion yen respectively. When the amount of the compensation is between 1925 billion yen and 5500 billion yen, the government shall bear 95% of the liability for the part exceeding 1925 billion yen, and the insurance company shall only bear 5% responsibility.

New Zealand earthquake insurance adopts the government-led model, with the Earthquake Committee, which is a government agency, fully responsible for operation, performance of liability and purchase of reinsurance. The insurance company shall be responsible for the collection and payment of the earthquake insurance, and shall, after deducting the handling fee, hand it over to the Earthquake committee as the earthquake insurance fund. Part of the compensation above the deductible shall be jointly undertaken by the earthquake insurance fund and the reinsurance market. The earthquake insurance fund shall bear the compensation liability of S\$200 million, and the excess part shall have reinsurance compensation. The compensation between S\$200 million to S\$750 million shall be borne by the earthquake insurance fund by 60%, and the reinsurance company by 40%. The compensation between S\$750 million to S\$2.05 billion shall be covered by the excess compensation reinsurance contract. The compensation above S\$2.05 billion shall be paid first by the earthquake insurance fund, and the excess part shall be borne by the government with unlimited liability for compensation.

Yunnan province earthquake insurance pilot is policy insurance. The provincial, state and county governments shall fully bear the pilot premium. In combination with the existing disaster relief system of the government, unified insurance and unified compensation is carried out. The compensation is limited, and the excess part shall not be compensated. In the initial stage of the implementation of earthquake insurance, it can improve the residents' awareness of modern insurance finance, improve the residents' willingness to buy insurance, which play a positive role in promoting the healthy development of earthquake insurance system in China.

4. Recommendations on China's construction of earthquake insurance system

4.1 Recommendations on the legal level.

Since 1997, governments at all levels and insurance associations have issued a large number of policies, regulations and guidance on the establishment of earthquake insurance system in China, but there is still a lack of operable laws and regulations. It is imperative to establish and perfect the legal system of earthquake insurance in China, and make clear the basic problems of earthquake insurance system, such as the subject matter of insurance, the scope of insurance liability, the conditions of insurance, the obligations of the policyholder, the premium rate, the amount of insurance and the limit of compensation, so as to provide legal guarantee for the act of earthquake insurance, and effectively promote the establishment of earthquake insurance in China.

4.2 Recommendations on the technical level.

At present, there are lots of and in-depth researches on earthquake risk in China. However, the quantitative researches on earthquake loss, which is concerned by the insurance industry, are less. The seismic damage data of the multi-stories masonry and RC frame structure are rich and detailed. With the rapid development of economy, there are more and more high-rise buildings and super high-rise buildings in cities, and these kind of buildings are lack of seismic damage data. The earthquake loss quantification of this kind buildings mainly depends on theoretical research and test results. At present, due to the lack of unified seismic performance and earthquake loss quantification standards, the research conclusions are conflict and the discreteness of test results are very large, which leads to the difficulty of building catastrophe model, and fails to provide sufficient technical support to the insurance industry. Therefore, it is necessary to perfect the seismic standard system as soon as possible, and to make up the blank link of the standard system. Scientific



evaluation of seismic performance of buildings and quantification of earthquake losses of buildings provide technical support for the insurance industry to build catastrophe models, predict earthquake losses and reasonably determine premiums, and also provide reasonable basis for post-earthquake insurance claims. From the perspective of construction engineering, we should solve the technical problems faced by building earthquake insurances business, accelerate the establishment of catastrophe insurance system for disaster prevention and mitigation policies, and truly change post-earthquake relief to pre-earthquake prevention.

4.3 Recommendations on the risk-sharing mechanism level.

It is suggested to adopt a multi-level earthquake insurance risk-sharing mechanism supported by the government, to clarify the role and positioning of policyholders, insurers, reinsurers, capital market and the government, to share disaster risks and to improve the enthusiasm of all parties in insurance, so as to truly promote the establishment of earthquake insurance system in China.

5. Concluding remarks

Internationally, the earthquake insurance system has been developed for a long time, and many countries and regions have achieved quite successful experience. In sharp contrast, the construction of earthquake insurance system in China is still in the initial stage, and the whole society's cognition level of earthquake insurance is not high. The huge losses of Wenchuan earthquake and Yushu earthquake have sounded the alarm of catastrophe risk. The national level clearly proposed that macro-disaster prevention and mitigation policy should be changed from post-disaster relief to pre-disaster risk management and control. Based on the experience and achievements of earthquake insurance system at home and abroad, this paper summarizes the problems existing in the establishment of earthquake insurance system in China, and puts forward a series of suggestions, including improving the corresponding legal system of earthquake insurance, supplementing the missing links of the current seismic standard system in China, and adopting a reasonable risk sharing mechanism, etc., so as to speed up the construction process of earthquake insurance system in China and build a social sharing mechanism for disaster losses, which will help the healthy development of China's social economy.

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