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Incentives for safer buildings

Lessons from Japan

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Incentives for Safer Buildings – Lessons from Japan

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1. INTRODUCTION

The earthquake is the most deadly natural disaster in our modern society. Table 1 shows the most deadly ten (10) natural disasters in the past 30 years in the world (Famine caused by drought is excluded here as it is regarded as a human disaster, i.e. inappropriate distribution of foods, rather than natural disaster.). More than a half of these deadly disasters are induced by earthquakes. It seems that the earthquake disasters have been more destructive recently, i.e. one deadly earthquake in 80s and 90s respectively, and 5 deadly earthquakes in 2000s. While the twentieth century saw huge progress in seismology and earthquake engineering, it does not seem that such progress has reduced the damage caused by earthquakes.

Due to rapid urbanization and rapid spread of modern life style, it appears that earthquake disasters are becoming more complicated and deadly. As the cities are growing and more crowded than ever and infrastructure is not sufficient, they are becoming more vulnerable. The urban poor who have no choice but to live in hazardous areas are particularly vulnerable. Substantial rapid urbanization took place worldwide in the last 50 years while the return period of a big earthquake would be usually more than 50 years. A medium size earthquake could even devastate a city if it takes place beneath or near the city, like the case of Haiti Earthquake in 2010.

Table 1: Ten most deadly disasters in the past 30 years in the world

Nation	Disaster	Year	Death
Armenia	Earthquake	1988	25,000
Iran	Earthquake	1990	35,000
Bangladesh	Cycl/flood	1991	140,000
Venezuela	Flood	1999	30,000
Iran	Earthquake	2003	27,000
Indonesia, others	Eq/tsunami	2004	over 300,000
Pakistan	Earthquake	2005	over 80,000
Myammar	Cycl/flood	2008	over 130,000
China	Earthquake	2008	90,000
Haiti	Earthquake	2010	over 100,000

In most of deaths caused by earthquakes, people are killed by their own houses. It is ironic that the shelters which are supposed to protect people from various hazards often end up killing them. Most of the world's population lives in vernacular houses that are built of adobe, brick, stone, and wood, and are non-engineered and thus vulnerable to earthquakes. These vulnerable non-engineered houses may be characterized as follows;

- Houses made of locally available and cheaper materials.
- Relatively low quality of construction work
- No or little engineering intervention
- No building regulation or no conformity to the regulation and thereby no check from the formal sector

In Japan, wooden houses are traditional and still common now, many of which are also vulnerable against earthquakes. In the case of 1995 Great Hanshin-Awaji Earthquake, which claimed more than 6,000 lives, 80% of the total death toll was caused by crushing or suffocation mainly due to collapse of the wooden houses. Although the Building Standard Law of Japan stipulates technical requirements for wooden buildings, due to practical reasons, technical requirements are rather simplified compared to the engineered buildings such as RC and steel structure.

Because earthquakes cannot be predicted precisely even by applying the most advanced science and technology, it is essential to make the vulnerable houses, particularly non-engineered ho-

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uses, safer in order to reduce the number of victims and the amount of severe damage caused by future earthquakes. The more resilient the existing houses are against earthquakes, the lower the death rate will be in the event of an earthquake, and the less drastic will be the disruptions to economic and social activities in the affected areas. No matter how effectively emergency management and relief activities are conducted, the lost lives can never be regained.

Most tragedies and difficulties in disaster management are attributed to loss of lives and homes due to destruction of the houses. Particularly, the loss of home means loss of family life and memories and prolongs the evacuation life which is very harsh and stressful. Once the home is lost, it would be very costly and time consuming to reconstruct their home. The governments are also forced to spend tremendous resources to construct emergency shelters, temporary houses and permanent houses if many houses would be destructed.

These non-engineered houses can be, however, strong against earthquakes when they are constructed with appropriate and practical techniques that are affordable to ordinary people. A big challenge here is that the house owners lack the motivation to invest to secure the safety of their houses, particularly to retrofit them, even though the houses are quite vulnerable to earthquakes and even though they are aware of it. The house builders and masons lack interest in securing sufficient safety mainly because house owners are not concerned most with the structural safety of the houses. The governments are not strictly committed to enforce the building codes. In many countries, technical requirements for the non-engineered buildings are not well established nor fully enforced because people are not concerned with the structural safety of the houses. It is thus crucial to convince people that the investment in safer housing will eventually prove to be worthwhile.

This paper aims therefore to discuss how people can or cannot be convinced for safer buildings. This paper first introduces how the building regulations have been revised to secure building safety in Japan. Secondly, it introduces various policies and strategies to motivate people for safer buildings. Thirdly, it discusses why people are not easily motivated for safer buildings, particularly retrofitting, and finally proposes a new strategy for safer buildings.

2. EFFORTS FOR SAFER BUIULDINGS IN JAPAN

(1) Building Standard Law

Historically, the highest concern with regard to the building safety is fire safety rather than earthquake safety. While urban fires took place frequently, large earthquakes took place infrequently, once every dozens or hundreds years. Building regulation to reduce damage caused by fires was first established in Edo, former Tokyo, more than 300 years ago, because the buildings in Japan were made of mainly woods and papers, which are quite flammable and easy to catch fires. Urban Building Law was enacted in 1919 to provide minimum requirement for structural safety for the first time. However, it did not consider seismic loads. It was amended After Great Kanto Earthquake 1923, which claimed the lives of more than 100,000, to reflect the lessons of the disaster. For example, the amended Law provided technical requirements against earthquakes, and prohibited brick masonry, which had been introduced from Europe to Japan earlier, because most of brick buildings collapsed during the 1923 Earthquake. Most of cities in Japan were devastated during the WWII. There was a huge need to reconstruct buildings orderly and efficiently. Thus, the Building Standard Law (BSL) was enacted, aiming to safeguard the life, health, and property of people by providing minimum standards concerning the site, structure, equipment, and use of buildings.

With regard to the structural requirements, the BSL has been revised several times following large earthquake disasters after the WWII, reflecting lessons and findings of these disasters. For example, the tie hoop spaces were reduced in the revision of 1971 to improve ductility of RC columns after the Offshore Tokachi Earthquake in 1968. "Shin-taishin", a new design method, which is the current design principle against earthquakes, was introduced in 1981 after the Offshore Miyagi Earthquake in 1978. According to this new design method, (1) The building should not be damaged by snowfall, storm or earthquakes of a medium scale that can infrequently happen, and (2) The building should not collapse or fall by snowfall, storm or earthquakes of a large scale that can very rarely happen.

In Japan, wooden houses are traditional and still common now. In the case of 1995 Great Hanshin-Awaji Earthquake Disaster, which claimed more than 5,000 lives as the immediate death, 90% of the total death toll was caused by crushing or suffocation mainly due to collapse of the wooden houses. Even the remaining deaths, most of which were caused by fire, were attributed to the collapse of the houses where people were trapped and then burnt. In the central area of Kobe City, where a detailed research on damage was conducted, 95 % of collapsed houses, mainly wooden, were built before 1981, when the seismic requirements of the Japanese Building Codes were revised. It can be summarized that the older the houses, the more they would be vulnerable to earthquakes because they may not meet the current structural requirement and some of them may have been deteriorated due to inappropriate renovation maintenance.

It is generally believed that the newly constructed buildings would meet the requirements of BSL and therefore the buildings constructed after 1981 must be safe enough against earthquakes. It should be pointed out, however, a number of houses constructed after 1981 may not meet the current seismic safety requirements either, due to poor consideration on seismic safety and poor construction work. Aging of houses also imposes a serious problem in seismic safety as the common structure of houses is wooden, which is susceptible to degradation due to bad or lack of maintenance.

It is estimated that thousands of people will be killed by collapse of the vulnerable buildings due to any probable large earthquake in coming years, apart from deaths by fires and collapse of transportation. Therefore, the Japanese Government has decided to promote retrofitting of vulnerable houses. The current goal of retrofitting is as follows. In 2003, the total number of housing units in Japan was 47 million (excluding vacant houses), of which it was estimated 11.5 million houses or 25% would not meet the current structural requirement, or vulnerable against earthquakes, according to Ministry of Land, Infrastructure, Transport and Tourism (MLIT). The Japanese government therefore setup its goal to reduce the ratio from 25% to 10 % by 2013 within 10 years so that the casualties caused by earthquakes would be drastically reduced. In the next section, introduced are various policies and strategies to promote improvement of building safety, particularly housing safety, in Japan.

(2) Policies and Strategies to Improve Building Safety

(a) Act for Promotion of Retrofitting

The Japanese governments enforced the Act for Promotion of Retrofitting, immediately after the 1995 Earthquake, aiming to promote retrofitting of important facilities and existing vulnerable houses, based on the lessons learnt from the Earthquake. According to the Act, the owners of buildings that are used by a large number of people are urged to make efforts to have their buildings undergo seismic performance evaluation and seismic retrofitting. Concerning certified seismic retrofitting work, provisions of the current BSL other than those related to earthquake resistance may not be retroactively (Without such a certificate, renovation works must meet the current BSL retroactively). The local governments must provide guidance, advice, or instruction concerning retrofitting of buildings. From 1995 to 2008, such certificates have been issued to 4,900 public buildings and 690 private buildings.

(b) Housing Quality Assurance Act

The Housing Quality Assurance Act (HQAA) was enacted in 1999 to assure housing quality, including structural safety, to protect the interests of housing purchasers, and to resolute promptly disputes related to houses. The building supplier is now responsible for the quality of house for ten years after the delivery. The Housing Performance Indication System was introduced for 9 components such as structural safety, fire safety, thermal and acoustic environment, and consideration for the aged and handicapped. The HQAA was amended in 2006 so that building suppliers or sellers of new houses must have sufficient financial resources to execute defect warranty liability, either by deposit or insurance.

(c) Amendment of BSL

It turned out in 2005 that some newly constructed buildings did not meet the BSL requirements and thus very unsafe against earthquakes due to fabrications of structural calculation by some authorized architects, who illegally intended to reduce the construction cost. The BSL was amended in 2006 to strengthen the building confirmation (permit) and inspection system after this scandal. For specific high-rise building, peer review process for structural calculation was introduced. A guideline for building confirmation, interim inspection and final inspection was developed for stricter review. In order to ensure professional design capacity for specific buildings, the Kenchiku-shi (Architect) Law was also amended to create a new classification of "1st-class structural design Kenchiku-shi" and "1st-class equipment design Kenchiku-shi". They must have experiences for more than 5 years and complete the specified training course.

(d) Financial assistance to those who retrofit their buildings/houses

After enactment of the Act for Promotion of Retrofitting, the national government initiated the program to subsidize those who have retrofitted their buildings, which are either collective houses or specific buildings that are used by a large number of people. The detached houses were then included in the subsidy program in 2002. This subsidy program has been revised several times so that the subsidy ratio was increased and the targeted houses have been widened.

The current subsidy program can be summarized as follows. The national government subsidizes the local government which subsidizes those who have conducted the seismic performance evaluation of their house or building constructed before 1981. In this case, a third of the cost for evaluation must be borne by the building owner while a third would be borne by the local and national government respectively. The national government also subsidizes the local government which subsidizes those who retrofitted their house or building. In this case, the owner must bear 77% of the cost for retrofitting while the local and national government would bear 11.5% respectively. If the house or building is located along the emergency roads or evacuation roads, the ratio of subsidy would increase from 11.5% up to one third respectively (1/3 by the owner, 1/3 by the local government, and 1/3 by the national government). If the local government wishes to provide a higher ratio of subsidy, they can do so. It is planned that, form the next fiscal year, even if the local government has not such a subsidy program, the national government can provide subsidy directly.

In addition to the subsidy program, the national government has also revised the taxation program so that the income tax would be deducted by 10% for those who retrofitted their house (max. 200,000 yen or US$ 2,300). Low interest loans are available from the Housing Finance Corporation for retrofitting. The Japanese Government established a unique insurance policy against earthquakes. It is a kind of re-insurance system by the Japan Insurance Corporation, which was established only for this earthquake insurance by private insurance corporations and the Japanese government. It is heavily subsidized by the national government, which may cover up to 95% of the insurance. The houses which were constructed after 1981 or retrofitted may enjoy the discounted premium (10-20% discount).

(e) Development of technologies to promote retrofitting

The national and local governments are encouraging technology development to secure housing safety against earthquakes, particularly for retrofitting. They include affordable and practical retrofitting methods, securing safe space in a house, and anchorage of furniture. The Japan Building Disaster Prevention Association published "The Standard for Seismic Evaluation" and "Guidelines for Seismic Retrofitting". It also developed "Simplified Seismic Diagnosis" for wooden houses. Following simple questions in the questionnaire, people can easily understand whether their house is roughly safe or not. Once it turns out that their house is not safe enough, they would be encouraged to consult with the expert for more detailed seismic evaluation.

(3) Effectiveness

Have these Acts and related policies really promote retrofitting of vulnerable houses? As of March, 2009, it was reported by MLIT that about 38,300 housing units and 4,800 specified buildings had received subsidy from both the national and local government for retrofitting since 1995. These numbers are very low, compared with the numbers of the houses and buildings which do not have sufficient structural safety. As mentioned earlier, 11.5 million houses were estimated to be unsafe in 2003.

The result of the 2005 public poll conducted by the Japanese Cabinet Office revealed that although about tow thirds think that their houses would be hit by a strong earthquake within 10 years, only 10 % conducted seismic diagnosis and only few respondents retrofitted their house. Therefore, even the Japanese generous policies to provide financial assistance for retrofitting are failing in motivating people. Without such policies that are quite costly, the developing countries may have more difficulties to promote retrofitting. Why are not people motivated for improvement of housing safety or retrofitting? The next section discusses how people make a decision to retrofit their house or not to do so, and proposes how the policies should be developed.

3. INCENTIVES FOR SAFER BUILDINGS

It can be simplified that the choice on retrofitting, or improving building safety, is made based on comparison between the current loss (CL), i.e. the loss caused by retrofitting, and the future probable loss (FL), i.e. the expected loss caused by probable future earthquakes. The cost for retrofitting would be "the current loss," while the cost for not retrofitting would be the future probable loss, i.e. loss of the house and loss caused by collapse of the house, including the loss of family. Therefore, the choice is made as follows.
- If a person conceives CL < FL, retrofitting is reasonable. (He/she may be motivated for retrofitting)
- If a person conceives CL > FL, retrofitting is not reasonable. (He/she may not be motivated for retrofitting)

In realty, CL is higher than FL in most case as the probability of earthquake occurrence is very small, usually being less than 1% within coming years in any country. Furthermore, according to the Prospect Theory (Kahneman & Tversky), people are risk-seekers, i.e., tend to avoid certain losses, seeking uncertain loss, when the choice involves losses. As the choice regarding retrofitting can be regarded as the choice between the current sure loss and uncertain loss, it is analogized that people would prefer not to invest for retrofitting even if the expected loss would be conceived as same as the retrofitting cost or even more.

Besides, the future value of loss is psychologically much discounted (Loewensteuin and Prelec). Besides, their house might outlive the next large earthquake. In Japan, where the average lifespan of houses is around 30 years, it would be plausible for many people to think "my house would not be destroyed by a big earthquake but by a bulldozer for new construction." There are many aged people who live in an old house alone without their children in Japan. They particularly tend to think so as they think they may not outlive the next large earthquake most probably. In short, as far as the loss due to the unsafe house lies in future with uncertainty, many people would not be motivated for retrofitting.

Unsafe houses magnify damages resulting from earthquakes, particularly in urban areas where the collapsed houses may hinder evacuation, relief and firefighting activities. The collapse of the unsafe houses is by far the major factor of the huge expenditure of the governments for recovery and reconstruction after earthquake disasters. Then, a question arises whether it is justifiable to spend such a lot to the affected people who did not keep their house safe, not conforming to the minimum requirements. Under the current disaster management policies in Japan, as in many other countries, those who had unsafe houses would receive more financial assistance in case their house would collapse, while those who made efforts to maintain their house safe would not receive any financial assistance but had to pay for good maintenance or retrofitting. This situation discourages people from making efforts to make their houses safer; instead, they expect that the future loss will be mediated by government assistance. As a result, governments have to spend more for relief, recovery, and reconstruction - expenditures that would not be necessary if the houses had been safe. This vicious cycle is illustrated in Figure 1.

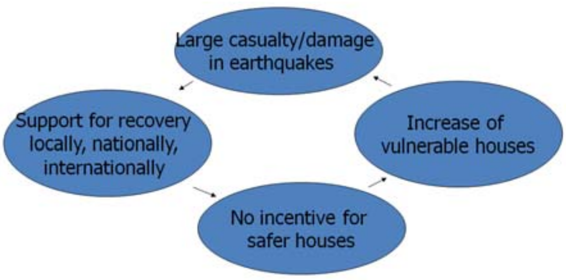

Figure 1. Current vicious cycle resulting in unsafe houses

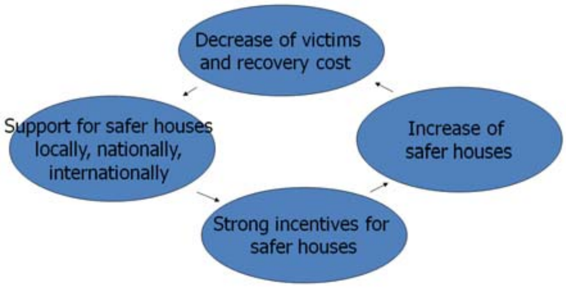

Figure 2. Proposed cycle for safer houses

This vicious cycle should be stopped and reversed as illustrated in Figure 2. For this purpose, I propose that any earthquake disaster management policies should be restructured to be in favor of those who keep their houses safe (“safe people”) and not in favor of those who keep their houses unsafe (“unsafe people”). The governments should show strong commitment to promote safer buildings and to assist those who maintain safe buildings. For example, the governments would provide the safe people with most of the reconstruction cost of the house in case their house would collapse due to unknown reasons. It should be noted that such a case would hardly happen as the BSL ensures that any building should not collapse by any earthquake. The governments could allow “safe people” to pay lower property taxes and require “unsafe people” to pay higher property taxes. Earthquake insurance could come at much lower premiums for “safe people” than for “unsafe people.” If people would understand that the government would support “safe people” by any means, then people would be motivated to invest for safer houses.

The resources that would have been required for relief, recovery, and reconstruction, due to damages to the unsafe houses, could be utilized to change the vicious circle to the proposed circle. If unsafe houses are retrofitted before an earthquake strikes, then governments will need to spend little for relief, recovery and reconstruction. In developing countries with meager budgets, however, it would be difficult to allocate funds for promotion of retrofitting. Hence I propose that the donor countries and international organizations financially assist the national governments that promote retrofitting, as the cost for international relief and recovery activities, as well as the loss of lives, will eventually be reduced by such commitment.

Reference

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