Session 2

Implementation of Earthquake Safer Housing through Technological and Social Approaches

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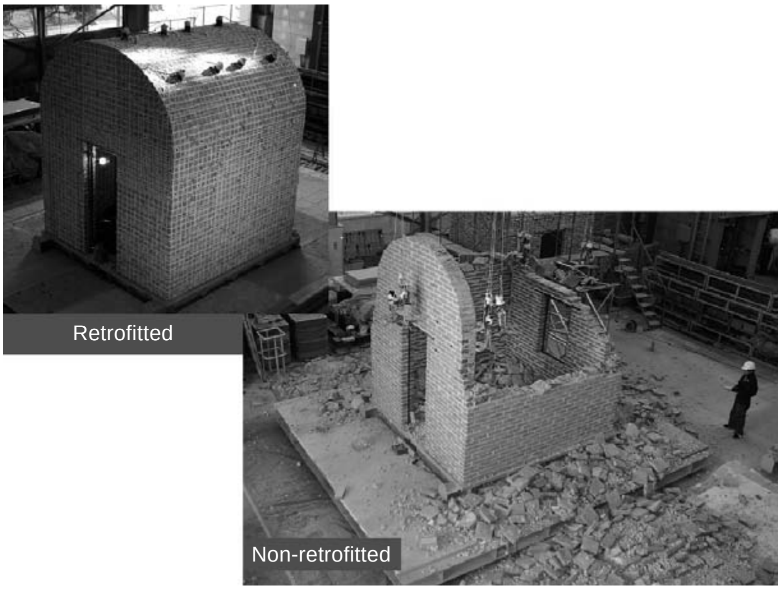
Abstract

Damage due to past and recent earthquakes, such as the 2001 Gujurat, 2003 Bam, 2005 Kashmir and 2006 Java earthquakes, has shown that the collapse of vulnerable houses is the main cause of casualties. These vulnerable houses are mainly masonry structures consisting of adobe, brick masonry, stone masonry, RC frames with masonry infill, among others. Even if a good disaster response system, including rescue operations, and a recovery/reconstruction plan are conceived, earthquake damage—especially human casualties—and economic loses cannot be reduced unless structural collapse is prevented. Therefore, it is vital to guaranty the seismic strength of new constructions as well as to upgrade the resistance of existing ones. In the former case, "good construction codes", i.e. codes that are complied, are necessary. Complicated codes which are difficult to interpret and put into practice are inappropriate. In addition, an efficient system to ensure the code application should also be established. For existing constructions, technical solutions which emphasize local availability, applicability, and acceptability are required. These should be accompanied by a social system which encourages retrofitting among the general population. Such system should aim at increasing people's disaster awareness and at giving incentives to house owners for retrofitting.

Adobe and masonry are the most used construction materials worldwide and also very vulnerable during earthquakes. Considering the key points mentioned above, a technical solution for retrofitting based on PP-band meshes is presented. These bands, commonly used for packing, are resistant, inexpensive, durable and worldwide available. The installation process is very simple and can be performed by the house owner him/herself.

To verify the suitability of PP-band retrofitting technique, short and long term properties of PP-band were examined and good results were obtained. Also, element and structure tests under static and dynamic conditions, i.e. shaking table tests were carried out. In all the cases, retrofitted structures showed excellent performance. The main contribution of the PP-mesh is to enhance the structure ductility and energy dissipation capacity. With these meshes, seismic capacity of masonry houses can be drastically increased.



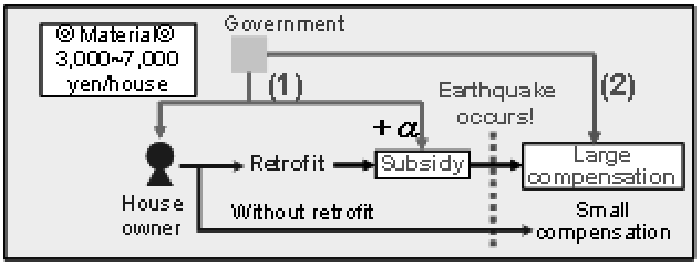
Shaking table test results using full-scale adobe houses with and without retrofit by PP-band mesh

Two approaches are considered for the social system to promote retrofitting. The first is to increase people's disaster awareness. For this purpose, demonstrations at earthquake affected areas have been carried out. In the aftermath of the 2005 Kashmir Earthquake, one local standard house retrofitted with PP-mesh was constructed to show the people how to built earthquake-resistant houses. Retrofitting material cost for the house was about 30US$ and the installation cost was less than 5% of the total construction cost. As part of the demonstration, two 1/6 scale models, with and without retrofitting, were shaken with an improvised shaking table in order to increase earthquake risk awareness. This event was attended by politicians, local practitioners, mass media people, NGO/NPO representatives, and the general public.

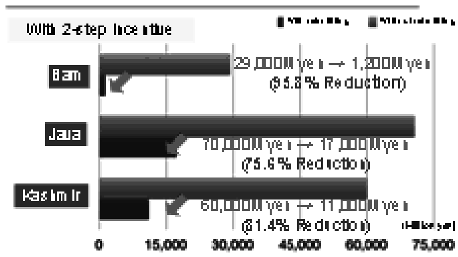
For the second approach for retrofitting promotion, I am suggesting a two-step incentive system as schematized below. With this system, the government promotes retrofitting at two stages. First, before the earthquake occurs, the government provides the PP-band mesh and an additional

Totally collapse non-retrofitted model next to undamaged retrofitted one

subsidy that is given after checking that the retrofitting was appropriately completed. Although the total damage will be dramatically reduced if an earthquake occurs, some few houses may be affected due to ground failure, extremely severe shaking, or others. This few residents, who in spite of having retrofitted their houses are affected by the earthquake, will receive the second step incentive, which consists of receiving twice the compensation money than that received by the residents who did not retrofit their houses.



Two-step incentive system to promote retrofitting of low earthquake resistant structures



Government borne expense reduction with the proposed system

Several simulations have been carried out considering the effect of implementing this system before the Bam, Kashmir, and Java Earthquakes. The results showed that it could have been possible to prevent more than 85% of the fatalities due to these events. Furthermore, the cost borne by the government could have been reduced by at least 75% as shown in the figure above. With this system, the house owner has to prepare almost no money. The number of collapsed and partially collapsed houses could be drastically reduced and the consequent associated costs such as demolition, cleaning, waste disposal, temporary shelter, can also be avoided.

I do hope that this type of approach, considering technological and social aspects, becomes popular and contributes to create a safer built environment which will drastically reduce human casualties and structural damage due to future earthquakes.

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Field of Study
Earthquake Disaster Mitigation Engineering