Safe Schools to Reduce Vulnerability of Children to Earthquakes

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ABSTRACT :
Like other infrastructure, school buildings are subject to damage and collapse in the event of earthquakes. The recent earthquakes have exposed vulnerability of school buildings disproportionately compared to the other infrastructures. Vulnerable school buildings in seismic regions resulted in the loss of many lives of children and teachers in addition to the potential damage to the property. On the other hand, earthquake resistant schools have serves as various emergency functions in the community and helped people to recover from the calamity in the aftermath of earthquakes. Recognizing the nature of schools as center of community and their contribution to community development, United Nations Centre for Regional Development (UNCRD) conducted a research project in Asia-Pacific region to ensure safety of school buildings through seismic retrofitting and to utilize it for the capacity building and awareness raising of the community. It is observed that the process of making safe schools can be an effective demonstration to introduce the earthquake-resistant technology to the local government officials, engineers or masons and to facilitate implementation of capacity building training programs. Additionally, having seismic retrofitting at schools can be easily recognized by the community and became an opportunity to raise their awareness of disaster prevention and mitigation.

KEYWORDS:
Retrofitting, school earthquake safety, capacity building, technology transfer, awareness raising, Asia-Pacific, UN

1. DISASTER DYNAMICS AND SOCIAL CONDITIONS

Devastating experiences from natural disasters in recent history have raised consciousness of the need for disaster preparedness and prevention in many parts of the world. Based on the data in CRED's EM-DATA database, over 4,000 natural disasters were reported in the last decade. During the period, more than 255 million people were affected by natural disasters each year on average. In 2006 itself, there were 427 reported natural disasters that killed more than 23,000 people affected almost 143 million people and were the cause of more than US$ 34.5 billion damages (EM-DAT, 2008).

The Statistics shows that there are differences in which some regions are more affected by the different types of disasters than others . For almost all disaster types, Asia is the most affected one. Of the total number of people killed and affected by natural disasters worldwide over the last decade, more than 75 percent of the total was in Asia with 84 percent for earthquakes, 89 percent for windstorms and more than 97percent for floods (Hoyois, 2007). Considering the Asian population representing about three-fifths of the world population, Asians are proportionally more prone to natural disasters.

Natural disasters affect countries, both developed and less developed, through mass human casualties and economic losses. However, the extent of the damage is more profound in developing countries due to their high vulnerability in physical, social, environmental and economical way. More than 95 percent of all deaths attributed to natural disasters occur in less developed countries and disaster-induced economic losses, as a percentage of GDP, are 20 times larger in less developed countries than in developed countries (EM-DAT, 2008).

Out of all, earthquakes are the least predictable disasters. While there are many factors that determine the scale of damage such as the time of the event, population density and building structural fragility, the damages vary from country to country and the negative impacts of an earthquake are more acute in developing countries. For example, earthquake with magnitude of 6.6 that struck Bam, Iran on December 2003 destroyed close to 90 percent of the city's buildings, killing 26,796 people (EM-DAT, 2008; OCHA 2004). In contrast, an earthquake of the same intensity that struck the city of San Simeon in California four days earlier damaged 40 buildings and killed two people (USGS, 2003). Explanations for the different outcomes are likely to be found in different degree in previous prevention and preparedness and its policy interventions in the two countries.

Disasters caused by earthquakes severely undermine countries' efforts to achieve the Millennium Development Goals (MDG). With respect to poverty reduction, an earthquake pushes the poor population into greater poverty by taking not only their existing assets but also income opportunities and livelihood. The achievement of universal primary education can be hampered because household asset depletion makes schooling less affordable. Adverse health effects are also inevitable because financial constraint makes clean water, food, and medicine less accessible. Poor population with few or no assets is less likely to be able to escape from a vicious cycle of poverty due to the disasters such as earthquakes.

One basic step towards alleviating the damages from earthquakes is to reduce the underlying risk factors by protecting and strengthening physical infrastructures. As a priority issue, there is a need to put efforts in making housings and critical public facilities such as schools, hospitals, water and power plants, and transport lifelines through proper planning in terms of location, design, construction and maintenance.

A case of initiative making school buildings safe from earthquakes is presented in this paper. It introduces brief context of school earthquake safety followed by the concept of research project which was designed to make school earthquake safety initiatives more comprehensive. Then discussion will be made on observation and findings from the case-study of experiences in Fiji, India, Indonesia, and Uzbekistan. Lastly, concludes are drawn on effectiveness school earthquake safety initiatives in Asia- pacific region..

2. ISSUES WITH EARTHQUAKE SAFETY OF SCHOOL BUILDINGS

The scale of damage by earthquakes depends on number of factors such as the time of the event, population density, and building structural fragility. The past earthquakes exposed vulnerability of school buildings disproportionately compared to the other infrastructures. Most recently, 2008 Sichuan Earthquake brought much needed attention to earthquake safety of school buildings when it caused collapse of over 7,000 school buildings (Relief Web, 2008). Because the earthquake was occurred during school hours, many children were trapped under their collapsed school buildings. One of the worst tragedies was the Juyuan Middle School located 60 kilometer from the epicenter where the entire school collapsed and took nearly 900 lives of teenagers though the buildings around the school suffered damages but did not collapsed (RelifWeb,2008)

Similar cases have been observed in different parts of the world. The 1999 Chi-Chi Earthquake, Taiwan reported 43 schools in Nantou and Taichung were completely destroyed and a total of 700 schools nationwide were damaged in someway (RMS 2000). The 2001 Gujarat Earthquake in India caused over 11,600 schools destroyed or damaged (World Bank 2001). The 2005 Kashmir earthquake resulted in collapse of 6,700 schools in northwest Frontier Province and 1,300 in Pakistan-administered Kashmir (BBC 2005).

Recognizing that school age children spend majority of their waking hours at school, there is a high possibility that an earthquake struck while they are at school. When an earthquake hit Spitak area of Northern Armenia during school hours in 1988, many children lost their lives due to collapse of school buildings. For example, 285 children out of 302 in total died at one school (Noji et al., 1990). This resulted in almost 2/3 of total deaths of 25,000 were children and adolescents (EM-DAT, 2008; Miller et al., 1993). Another case is 2005 Kashmir earthquake. The earthquake occurred as the school day was beginning, 18,000 children died in schools alone (BBC 2005). Such loss of lives of children caused loss of entire generation from the communities which affected the development of the communities in the long term.

In case of China, considering the most seismologists confirmed that China's building code was adequate, the school collapses were due to poor-quality construction or the builder's shoddy compliance with building code. Many other factors, such as luck of construction standard, inadequate design and construction or luck of maintenance can also contribute to increase in vulnerability of school buildings. In order to save valuable lives of children and teachers and to reduce potential loss of property, there is an urgent need to improve the design and construction of new and existing school building by promoting concept of school safety, developing guidelines and related laws for building construction and retrofitting, building capacity of engineers, technicians or masons, and raising awareness of students and teachers in school, and communities.

3. ROLE OF SCHOOLS IN DISASTER RISK REDUCTION

Aside from emergency situation, schools play a vital role in every community. The extent and nature of the contribution of schools go beyond traditional forms of education to school children. Their contributions to their communities' development vary from cultural to economical, informational to environmental and vice versa. In terms of earthquake risk reduction, schools help to build capacity of community and to promote prevention and mitigation. Moreover, teaching disaster risk education at school develops awareness to children, which comprises thirty percent of population in less developed country (UN/DESA 2006). With any intervention to protect schools and other school safety programs, children convey strong message to the communities to take actions for disaster risk

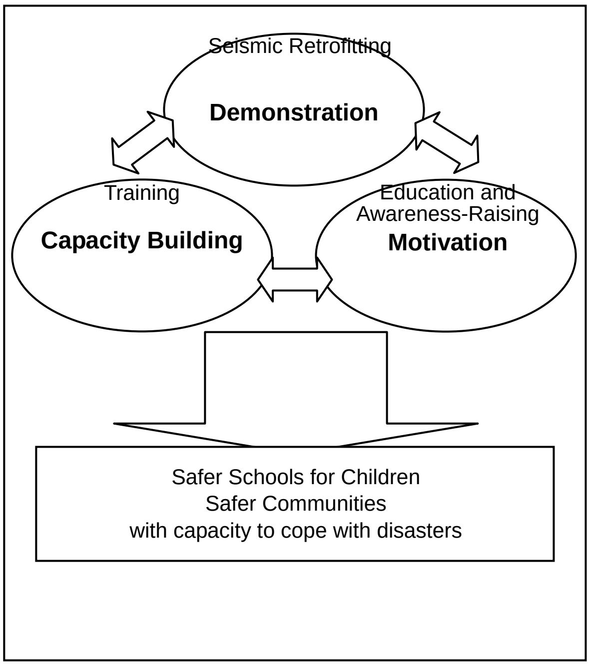
reduction in long term.
Since schools are usually distributed evenly throughout the country, they become ideal facilities to serve as evacuation centers, emergency medical clinics, supply stations, temporally shelters and other emergency functions in each community in the aftermath of the earthquakes. During the 1995 Kobe earthquake, seismic resistant schools became evacuation center for more than 180,000 citizens and helped them to recover from the calamity. Not only the earthquake resistant schools, but a strong leadership of teachers in the relief activities and evacuation center management were widely recognized (MEXT 1997) in managing the post disaster situation.
Realizing the importance of strengthening school earthquake safety, several initiatives has been taken in countries such as Canada, India, Nepal, United States (put the countries in alphabetical order) just to name a few. At international level, as apart of implemention of Hyogo Framework for Action 2005-2015 and the United Nations Decade of Education for Sustainable Development (2005-2014), UN/ISDR with cooperation with UNESCO coordinated The World Disaster Reduction Campaign 2006-2007 "Disaster Risk Reduction Begins at School" aiming to encourage the integration of disaster risk education in school curricula and the safe construction and retrofitting of school buildings to withstand natural hazards.
The United Nations Centre for Regional Development (UNCRD) is currently promoting the School Earthquake Safety Initiative (SESI) through a project "Reducing Vulnerability of School Children to Earthquakes" in the Asia-Pacific Region in line with the HFA and other international commitments. The project aims to make schools safe against earthquakes and build disaster resilient communities through a process of self-help, cooperation, and education. The project includes retrofitting school buildings in a participatory way with the involvement of local communities, local governments and resource institutions, training on safer construction practices to technicians, disaster education in schools and local communities.

4. SCHOOL EARTHQUAKE SAFETY INITIATIVES

Established in 1971, UNCRD conducts research and training in local and regional development in the field of human security, environment, and disaster management for sustainable development. The project is undertaken in four earthquake prone countries in Asia-Pacific: Fiji, Indonesia, India, and Uzbekistan. Considering the size of population and needs, some cities are selected for the case study implementation of school retrofitting works under the school earthquake safety program. Suva in Fiji, Bandung in Indonesia, Shimla in India, and Tashkent in Uzbekistan were selected as the project cities.
The goal of this project is to ensure that school children living in seismic regions have earthquake safe schools and that local communities build capacity to cope with earthquake disasters. In order to achieve this goal, the project set three objectives as follows:

1) To ensure the seismic safety of schools through retrofitting of school buildings, disaster education, and training of teachers and students.
1) To build safer communities through demonstration of school retrofitting, training of masons and technicians, community workshops, and educational campaigns.
2) To disseminate a culture of safe schools and safe communities through regional and international workshops.

The project consists of four components: seismic retrofitting of school building, capacity building of communities, education and awareness-raising, and knowledge and experience dissemination. One local organization from each project country or city is appointed to coordinate the project activities in respective country or city. Additionally, local and international experts are selected to provide expert service in: retrofitting, training for capacity building, and education for disaster risk reduction.



4.1 Seismic Retrofitting of School Buildings

With the purpose of promoting earthquake safety of school, the project carries out seismic retrofitting of a few selected schools as model cases. As the first step, a guideline for selection criteria is developed to prioritize schools for the preliminary vulnerability assessment for the project. The selection criteria includes the location of schools, the type of construction, vulnerability of school buildings, the potential role of the school to serve as a center of the community before, during, and after the disasters. Then, appointed local engineering experts of each project country or city visit 10 selected schools based on the criteria, conduct preliminary vulnerability assessment to identify a few most vulnerable schools for the retrofitting intervention. Again, they conduct detailed seismic analysis and develop retrofitting design. Local contractors take part in the retrofitting work under the supervision of national engineering experts. The engineering experts also develop country-specific guidelines on earthquake safe construction which in cooperates solutions to the practical problems experienced during school retrofitting.

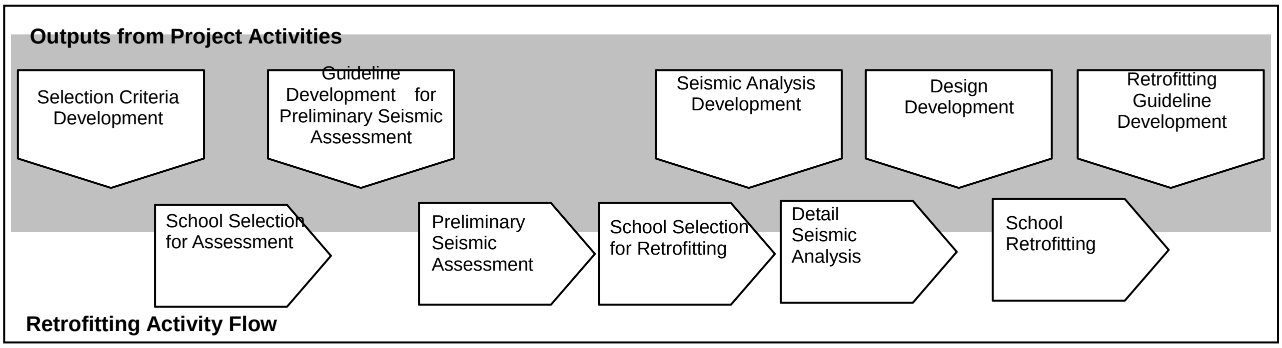


Fig2. Flow Chart of Retrofitting Process with Outputs

4.2 Capacity Building of Communities

Seismic retrofitting of school building in local communities can act as a demonstration of proper earthquake-resistant technology to residents. In the process to seismic retrofitting, the project provide training workshop for local engineers and technicians on earthquake design and construction and on-the-job training to local masons or carpenters. Local engineering experts and training experts take a leading role in training workshops and on-the-job training. Consideration is given to local practices, material availability, indigenous knowledge, and affordability of earthquake technology during trainings.

4.3 Disaster Education and Awareness Raising

With the purpose of raising awareness of disasters, the project focuses on education for disaster risk reduction (DRR) and awareness-raising activities through schools. Local educational experts develop educational materials for DRR such as booklets and posters, guidebooks for drills for earthquake disaster preparedness and response, guidebooks for training for teachers, and manuals for school disaster safety management. These educational materials gain verification and are updated through teacher's training and students' drill which are scheduled to be held twice at target schools during the project period. The project also utilizes the target schools as a place to hold community seminars by inviting parents of children and members of surrounding communities.
Local educational experts also assess the current curriculum to seek the opportunities to integrate DRR into school curricula and develop integration modality and plan for the improvement of school curriculum to take the DRR measures into account in consultation with national or local government officers from Department of Education of their respective country.

4.3 Knowledge and Experience Dissemination

Considering this project as a model case to ensure that school children living in seismic regions have earthquake safe schools and that local communities build capacity to cope with earthquake disasters, regional and international workshops provide opportunities to share experiences and to disseminate lessons learnt from the project country or city to wider audience after the completion of most activities.
In addition to regional and international workshops, local experts develop guidelines for seismic retrofitting, training and education for DRR for the further implementation as UNCRD with consultation of international experts develop

general guidelines to disseminate lessons internationally.

5. FINDINDS

5.1 Seismic Retrofitting of School Buildings

The process of seismic retrofitting of school buildings began with preliminary assessment of existing school buildings in the project country or city in order to prioritize schools to be retrofitted. In all four countries, observations were made that majority of schools fail to meet the earthquake safety standards. In Fiji, the local engineer experts assessed school buildings by Structural Performance Score (SPS) and the result showed all buildings assessed failed to meet the earthquake safety standards. Among them, over 80 percent schools are categorized in the least and worst grade in terms of earthquake safe performance(Rokovada 2006). In case of Uzbekistan, under the national program "State National Program of Development of School Education for years 2004-2009", more than 10,000 school building were assessed. The result showed 25 percent of building of schools was at risk of significant damage and 10 percent was at risk of collapse by earthquakes (Khakimov et al 2006).

The project takes three to five schools for retrofitting as model cases in each project country or city. In order to have best model case of retrofitting, target schools were selected based on the needs and effectiveness to disseminate the technology and need of seismic intervention. In addition a factor of applicability of technology for large number of schools, construction typology is also considered while selecting the model schools for intervention. Moreover, understanding of and consensus from relevant stakeholders of schools such as the education department, the school management committee and the community were important aspects of smooth and effective implementation.

The preliminary assessment of school buildings by this project ensured needs for development of guideline for assessment as well as its wider implementation. The school selection process claimed necessity of stakeholder involvement in project implementation. Further consultation with relevant government bodies including Department of Education were designed to convince them of the importance of retrofitting and engage in the process. In Bandung, Indonesia, that resulted in new fund allocation for school retrofitting within the department and local government agencies. Although the modality and progress of the project differs among project countries, project activities in all countries led to the common objective of making school children safe and that communities build the capacity to withstand the future earthquakes.

5.2 Capacity Building of Communities

Adequate seismic retrofitting or construction of school buildings require people with capacity to design, construct, and maintain. In terms of disaster risk reduction, International Strategy for Disaster Reduction defines "Capacity Building" is as:

> Efforts aimed to develop human skills or societal infrastructures within a community or organization needed to reduce the level of risk. In extended understanding, capacity building also includes development of institutional, financial, political and other resources, such as technology at different levels and sectors of the society (ISDR, 2008).

Capacity building mentioned here particularly focuses on development of skills and knowledge of local masons, technicians, and engineers who involve in school building construction or retrofitting. With the purpose of capacity building, the project had local counterparts organize training workshops and develop training manual for local masons, technicians, and engineers. Observation shows that the role of masons, technicians, and engineers differs from country to country or rather from place to place. In some places, there is clear distinction among them, not in other places. Therefore, in the process of planning of training workshops and training manual development, the targets and their capacity have to be carefully identified considering the local need and resources.

Local counterparts held two to three days training workshop on seismic retrofitting design and construction targeting local technicians and engineers who involve in school construction and maintenance. In cooperation with the local government and academic institution, the workshops were comprised of lectures by experts, group work, and field trip. Content of lectures included earthquake risks, earthquake impacts on buildings, vulnerability of existing buildings and retrofitting technologies applicable to the local context. Although participants are not expected to build the skill of design by just these training alone in short time period, it is found from the feed back survey result the workshops contributed to refresh and give new insight of seismic design and construction . It is expected that this will prompt to make full fledged design training on seismic safety and raise technical awareness of retrofitting. Such training workshops provide opportunities for participants to interact each other and experienced engineers and professionals from local academic institutions to transfer their experience and knowledge to young ones.

Local training experts undertook development of training manuals on retrofitting for masons/carpenters who involve in actual retrofitting work. Series of consultative workshops are being held to examine the applicability in the process of development. Consideration is given to local practices, material availability, indigenous knowledge, and affordability of the technology. As a part of capacity building, earthquake resistant construction manuals are being developed in each country targeting to technicians, carpenters and masons. The manuals are designed to have easy-to-follow graphical illustration

Capacity building is a long-term, continuing process, in which all stakeholders participate. Though training workshops or training manuals on retrofitting aim capacity building of communities, they will remain ineffective and lack sustainability without consideration of continuing program of skill development. It is emphasized from the project experience that the government is the best actor to institutionalize the training program in their organ so as to provide the learning opportunity for technicians and engineers in long. In regards to training manuals, they need to be implemented in wide range of training programs aimed for building construction and maintenance . The local training institutions or vocational schools should take a lead role in the development and of the content and the usage of those manauals.

5.3 Disaster Education and Awareness Raising

Earthquake resistant school buildings reduce earthquake risks of children at schools a large extent. However, structural mitigation of school buildings will not achieve a full effect without proper preparedness of children and teachers. Risk awareness and knowledge development empower children to save their lives, to protect member of the community, and to take a vital role to promote safety and risk reduction. According to interviews with school children in project countries, many of them have experienced and know the basic characteristics of most natural hazards including earthquakes. However, when questioning about preparedness, not many of them have clear answers to questions such as how to prepare for earthquakes or what to do when an earthquake occurs. The interviews identify the needs for awareness raising and knowledge development of school children.

As stipulated in HFA, efforts are to be put in mainstreaming of disaster risk reduction (DRR) into school curricula which contribute to bring children well prepared for disasters. The actions are also promoted by World Disaster Reduction Campaign of “Disaster Risk Reduction Begins at School” and UNCRD initiative in school safety program is line with those guiding principles and campaign,. As a part of the project, current status of disaster education in school system was analyzed with the support of respective officials of national and local government. Although analysis has revealed that there were no pre-thought strategies on disaster education in project countries and lack of expertise and capacity to formulate appropriate strategy for disaster education at national and state level where curriculum is being generally developed, this initiative provides a good opportunity for initiating curriculum upgrading for DRR integration (Pandey 2007).

As a pre course of Disaster Risk Reduction (DRR) integration into school curricula , DRR can be introduced to school children through educational materials and informal activities. Collection of existing disaster education materials shows that a great amount of materials have been produced by government, NGOs and international organizations. Despite the amount of disaster education materials produced, observation indicates that teachers and children have not utilized them to a maximum extent. The accessibility and usability of education materials remains a major conceren in terms of practical applicability . Participation of school children in drills, contests or disaster awareness events also contributes to raise their awareness. Project partners have organized event such as such as Fiji National Disaster Awareness Week or commemorating event for Anniversary of 1905 Kangra Earthquake in India, in all for project country and cities. These events which are more open to public benefit not only children and teachers but also communities.

Furthermore, school retrofitting can be also coupled to awareness raising and knowledge development. In Tashkent, Uzbekistan, parents were invited to school under retrofitting construction for a seminar where local experts gave a lecture on potential risks of their children at school and school retrofitting as a mitigation measure. This led them to consider their risks at home and motivated them to ensure safety of their housings from earthquakes. A similar public seminar was also held at the completion ceremony of school retrofitting in Bandung, Indonesia. As in Tashkent, parents and other community members who attended the ceremony were fond to have increased interest in earthquake risks and mitigation measures to contain the risk of school s but also for their houses. School retrofitting is found easily recognized by communities and it can be a good tool to convey message to the public.

5.4 Knowledge and Experience Dissemination

The project began with kick-off meetings inviting people from relevant government authorities, academic institutions, private sectors, NGOs and communities to introduce the project as well as to obtain their understandings and supports. Holding meetings which include all stakeholders at the beginning of the initial stage helps to identify local context, needs, opportunities and constraints might appear during the project implementation. Series of national and local workshops and consultative meetings have been held in each project country and city. These workshops and meetings provide opportunities to shear opinions, knowledge and experience of each stakeholder. More

understandings of stakeholders and their cooperation result in smoother and more effective implementation of the project.
Knowledge and experience shearing and dissemination should go beyond local or national level. Counterparts from each project country and city were invited to give a presentation at two workshops: International Workshop on Keeping Schools Safe from Earthquakes in Nepal, and Regional Workshop on School Education and Disaster Risk Reduction in Bangkok. Their experiences were shared with and recognized by other participants from different countries. Participation in such workshops and interaction with others who work for the same purpose also encourage them to pursue their work. As project processes, knowledge and experience should be also documented for further dissemination.

6. CONCLUSION

Disasters caused by earthquakes exert harmful influence on sustainable development, especially less developed countries. One way to alleviate the damages from earthquakes is to reduce the underlying risk factors by strengthen physical infrastructure. This paper particularly focused on school buildings which contributed loss of lives of many children in the past, by observing a project on "Reducing Vulnerability of School Children to Earthquakes" by UNCRD.

In order for adequate retrofitting of school buildings, it is necessary to build a capacity of people to design, do retrofit work, and maintain. In addition to structural mitigation of school buildings, it requires proper preparedness of children and teachers to save their lives from earthquake at schools. School earthquake safety will be achieved by collective effort of structural mitigation, capacity building, and education and awareness raising. Despite the differences in context, all requires involvement of all relevant stakeholders through the whole process and consideration to locality.

Promoting school earthquake safety has potential to contribute to build safer communities at large. Children who become more aware of earthquake risks and its preparedness through education may bring back the message to their home and communities. Masons/carpenters, technicians, engineers with capacity in earthquake resistant technology may utilize the technology to housings and other buildings. Government officials may promote school earthquake safety program at state or national level.
The project is still in the process of its implementation. Many activities, such as retrofitting work of school buildings, development of training manuals, and development of educational materials, are under implementation. Further observation of such activities and examination of replicability of the project will provide a good insight towards development of right approach of making schools safe in earthquakes countries .

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