SCHOOL EARTHQUAKE SAFETY PROGRAM: A STRONG TOOL FOR EARTHQUAKE RISK MANAGEMENT IN DEVELOPING COUNTRIES

[1]Surya Prasad Acharya, [2]Ram Chandra Kandel, [3]Amod Mani Dixit

[1] *Civil Engineer, National Society for Earthquake Technology-Nepal (NSET);*
[2] *Director SESP, National Society for Earthquake Technology-Nepal (NSET);*
[3] *Executive Director, National Society for Earthquake Technology–Nepal (NSET);*
Email: sacharya@nset.org.np

ABSTRACT :

School Earthquake Safety Program (SESP) a community based earthquake risk reduction/ management program, is being implemented by National Society for Earthquake Technology-Nepal (NSET) since 1997. The program components include physical assessment of the school buildings, structural risk mitigation measures, awareness rising, training to local mason, teachers, students and community people and emergency preparedness planning for schools. The components, approach, strategy and the methodology that were developed at various stages of program implementation has continuously evolved during the process and have made this program unique and exemplary. The program is being implemented in collaboration with the central as well as local Government institutions, CBOs, technical expert groups, Donor community and with extensive involvement of the community in all the process. Till now, this program has been implemented in 95 Government Schools in Nepal which has proved itself as an appropriate tool for Earthquake Risk Reduction in the community due to involvement of various stakeholders in entire process, its' approach and methodology, components and replication potential. It has also served as demonstration project for study, research and orientation on technology transfer mechanism on risk mitigation measures. Till now the program has been implemented directly by NSET in 95 schools of Nepal and in many other schools through the partner organizations. This paper describes the strategy, approach, components, experiences, technology transfer mechanism, nature and extent of community participation and lesson learnt during program implementation in Nepal and in the region.

KEYWORDS: Risk- reduction, Awareness, Community, Training, Technology Transfer

SCHOOL EARTHQUAKE SAFETY PROGRAM (SESP)

1. CONCEPT DEVELOPMENT

Public schools in Nepal, both buildings and their occupants, face extreme risk from earthquakes due to vulnerable physical structures and lack of awareness and preparedness. Majority of the school buildings, even those constructed in recent years are generally constructed without considering safety measures for earthquake risk. The responsibility of managing the facilities and running of public school lies under the local community. The Government contribution in public school is a very small amount for stationeries and salary for teachers. Remaining entire cost for building construction, repair and maintenance and other activities is to be managed by the local community. Such condition increases the potential to use poor materials or workmanship, inadequate/ under size structural elements making the buildings structurally vulnerable to earthquakes. This situation encourages the community for vertical and horizontal expansion of the existing poorly constructed buildings making them more vulnerable than they already are. High vulnerability of schools was evidenced during the 1988 east Nepal earthquake of magnitude 6.6 Richter resulting six thousand schools to collapse and thousands being damaged. Such massive damage to the school infrastructure disrupted the affected community- approximately 300,000 children were not able to attend schools properly for several months after the event, UNDP/UNCHS [1].

1.1. Why Schools

The obvious reasons for KVERMP to focus on public schools were based upon the following facts:

a) Public schools in Nepal are the center of social and cultural life of the community, hence, there is a greater chance of propagating earthquake awareness from school to the families, and from families to the communities

b) School children are also particularly vulnerable to natural disasters. Usually, children going to the public schools are from middle- to low-income groups. These are also the highly vulnerable strata of the society.

c) The loss suffered by a community in the collapse of a school is psychologically much greater than the loss faced by collapses of other building types: schools house an entire generation and a community's future.

d) Schools play a crucial role after an earthquake in helping the community to get back on its feet. Since schools are typically well distributed throughout neighborhoods, they are an ideal location for homeless shelters, medical clinics, and other emergency functions.

e) Schools are also particularly tractable for earthquake safety programs. By raising awareness in schools, the entire community is aware because the lessons trickle down to parents, relatives, and friends.

Realizing this fact, School Earthquake Safety Program (SESP) has been a continuous endeavor of the National Society for Earthquake Technology – Nepal (NSET) during Kathmandu Valley Earthquake Risk Management Project (KVERMP) and the subsequent Kathmandu Valley Earthquake Risk Management Action Plan Implementation Project (KVERMAPIP) since 1997. The primary objectives of the program were to assess the seismic risk of public school buildings in Kathmandu valley, identify the measures of reducing the existing risk, raise awareness among schools and people while implementing the program and train local masons on earthquake resistant construction for technology transfer.

1.2. Vulnerability Assessment Of Public School Buildings

At first, the initial days of KVERMP, the SESP included a vulnerability assessment of Kathmandu Valley's public schools as an example of how to conduct earthquake risk mitigation projects in Nepal. The purpose of this assessment was not to identify individual schools as vulnerable, but to quantify the risk faced by the entire system.

A more detailed inventory and vulnerability assessment of the school buildings on the conventional way would have required several years to complete.

1.2.1 Assessment Methodology

First, a questionnaire was developed which could be filled out by school headmasters after giving orientation to them. This questionnaire included topics such as size of buildings, density of students, year(s) of construction, whether the building was structurally designed and constructed, etc. Additionally, simple questions were asked about structural characteristics, presented through illustrations and descriptions. The project conducted 17 seminars with school headmasters from 65% of the total 643 public schools in the Valley to teach them about earthquake risk, about the necessity of planning for earthquakes in their school, and how to fill out the project questionnaire. Subsequently, the headmasters

were extrapolated to the entire building stock of the existing public schools of Kathmandu Valley.

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1.2.2 Alarming Findings

The following were the findings of the survey.

1. More than 60% of the school buildings are built using traditional materials (such as adobe, stone rubble in mud mortar or brick in mud mortar) that behave very poorly during earthquakes.

2. The remaining (less than 40%) of the buildings are constructed with modern materials such as fired brick in cement mortar or reinforced cement concrete. Even the modern materials are used in construction without considering their properties and strength characteristics and without involvement of professionally experienced person; these buildings not necessarily are safe for earthquake. School buildings built with modern materials are also vulnerable due to more floors and longer spans.

3. Out of the nearly 700 school buildings surveyed, only three buildings were constructed meeting the seismic safety provisions of Nepal National Building Code (draft). An additional four to five percent buildings were constructed with some earthquake resistance consideration but not fully compliant.

4. Many school buildings are not only poorly constructed, but they also lack proper maintenance. Approximately ten to fifteen percent of buildings were in extremely poor condition due to sub-standard material or workmanship, lack of maintenance, or extreme age. Many buildings have floors that are on the verge of collapse or walls that could crumble and fall at any time. These buildings are dangerous to occupy even in normal times. Another twenty-five percent of the buildings were found to have serious maintenance problems, such as decaying timbers or severely cracked walls that, if not repaired quickly, will deteriorate into extremely dangerous conditions.

Table 1: Seismic Vulnerability of Public School Buildings in Kathmandu Valley

Particulars	Details	%
Total number of Public Schools/buildings	643/1100	
Typology of traditional school buildings	Adobe (sun-dried bricks) or Earthen Buildings (mud cake buildings)	5
	Stone/brick masonry in mud mortar	56
	Rectangular block (Brick or hollow concrete block or semi-dressed stone in cement mortar)	28
	Reinforced Concrete Frame (RC Frame)	11
Existing Condition (with extrapolation for 643 schools)	Hazardous for use at present (Pull down and reconstruct ASAP!)	10-15
	Can be saved (with structural intervention, Retrofit, Repair and Maintain ASAP)	25
	Good for vertical load (but not for lateral shaking), need retrofitting	65
Vulnerability Assessment (for intensities IX MSK shaking)	Collapsed Grade	66
	Severe Damage or partial collapse (not repairable/not usable after shaking)	11
	Repairable Damage	23

Major problems so far identified in the various types of existing buildings belonging to the public schools are: a) use of weak construction materials, b) heavy wall and roofs, c) poor quality control of construction process, d) untied gable wall, is the lack of integrity between different structural components/elements.

2. SESP PROGRAM

2.1. Approach

With the aim to provide oversight to the program, NSET has established two standing SESP Advisory Committees at the central and district levels. These committees are chaired respectively by the Regional Director (Education) and the Chairperson of the District Development Committee (district level government). Other members drawn into the committee are representatives from the government and non-government agencies, business community, local technicians and political leaders. These committees meet at least once a year; NSET reports the progress to these committees, and submits annual work plans for their endorsement. Constitution of the advisory committees has helped widen the outreach of the program and its ownership.

NSET encourages the local community to establish a School Earthquake Safety Committee (SESC), with several sub-committees, at each SESP site. The Chairperson of the School Management Committee heads SESC. The sub-committees established under SESC are i) Construction Management Subcommittee, ii) Mason Training Subcommittee, and iii) Earthquake Response Planning Subcommittee, and a School Earthquake Safety Club (students).

Because of the involvement of a very wide section of communities and institutions, SESP has proven to be a strong tool for awareness raising and earthquake risk reduction activity.

To measure the impact, SESP conducts a social survey at the start and end of the construction program in the communities. A baseline survey is conducted with 100 randomly selected respondents in each school community. A repeat of the survey is done soon after the completion of the construction program at each school.

2.2. SESP components

Currently, the School Earthquake Safety Program consists of three closely inter-knit sub-components, namely, (1) Seismic retrofit or reconstruction of school buildings. (2) Training of masons, (3) Training of teachers, parents and students on earthquake preparedness and preparedness planning,

2.2.1 Selection of Target Schools

Each year, NSET carries out selection of target schools following a set of screening criteria (Annex 1). The criteria emphasize on the level of commitments of community participation in the program, visibility of the school (replicability potential), availability of temporary class run options, absence of dispute on land and building ownership. Additional consideration made are availability of local masons in the vicinity, potential of local contribution (cash or kind or labor), socioeconomic conditions (financial condition of parents, homogeneity/heterogeneity of community, caste, ethnicity), and availability of construction materials (sand, aggregate, timber) in the vicinity, acceptance to run training of masons, teachers, and possibility of preparing emergency response planning.

2.2.2 Pre-implementation Management Activities

This consists in convening a meeting of the District level Advisory committee on SESP and signing a MOU between NSET and the School management committee setting out the terms and conditions for the implementation of the program. The MOU specifies that NSET would: 1) provide technical support and that the actual resources have to be identified/ mobilized by the local community, 2) NSET would help the community in fund-raising, 3) the community would handle the project management activities, 4) the communities establish the School Earthquake Safety Committees (SCC) and sub-committees.

2.3 Retrofitting/ Re-construction of School Buildings

NSET carries out survey, design and assists the construction committee to implement the retrofitting program. Usually, the local masons are engaged in the construction; and the entire management is done by the community through management support from NSET.

NSET also provides supervision services during construction/ retrofitting and conducts training to the masons in earthquake safe construction and retrofitting techniques. The masons who are trained earlier in the schools are deployed to other construction sites at NSET's own cost. He supervises the day-to-day construction and trains the other working masons practically.

NSET engineers conduct classroom training in the evenings. Usually, such training programs are attended not only by the masons, but also by the parents ,Students and other members of the community

Initially, Many advisors of KVERMP and well-wishers of NSET warned not to initiate any program to address such a huge problem as seismic improvement of public schools. Further, people were skeptic about the feasibility of "retrofitting" in Nepal, considering it excessively expensive and high-tech job.
On the other hand, NSET looked at improvement of seismic performance of existing school and residential buildings, structural and non-structural components, as an alternative that deserved high priority for exploration.

Till now of 28 school buildings have been retrofitted/ reconstructed and 10 more are in progress through technical support from NSET under SESP. Along with the school retrofitting, some institutional buildings as well as local government office buildings have also been constructed employing the seismic safety techniques.

Figure 1 Earthquake resistant re-construction and retrofitting of school buildings

The photograph on the left of figure 1 shows typical construction of School building with earthquake resistant technique and the photograph on the right of figure 1 show the typical retrofitting of school buildings under progress.

3. PROGRAM ACHIEVEMENTS

3.1 Affordability of Seismic Improvement of School Buildings Established

The School Earthquake Safety Program has so far accomplished seismic retrofitting of 5 brick masonry buildings and re-construction of 23 school buildings and retrofitting of 10 other buildings is in progress. The retrofitting of 6 school buildings of two districts in under process. The program has schools covered of 14 districts namely Kathmandu, Lalitpur, Bhaktapur, Kabhrepalanchowk, Sindhupalchowk, Sindhuli, Rasuwa, Dhading, Tanahun, Nawalparasi, Makawanpur, Banke, Udayapur and sunsari of four development regions of Nepal and two new districts yet to be decided.

3.2. Mason Training

The whole execution of project is designed as a tool of developing skilled human resources in earthquake resistant construction at local level. In all the process of seismic retrofitting and reconstruction, professionals of NSET work with masons involved in the program showing them the details and explaining the complete procedures. Focus was placed in explaining the meaning of the processes of proper reinforcement details, earthquake resistant elements in different types of buildings, weakness in prevailing construction, quality and workmanship aspects. Besides training in the form of explaining as you go, separate training classes are being organized in the evenings. During training, it was observed that participation of people of other profession and craftsmen was always higher than the number of masons directly involved in the construction process.

Masons pay much attention to know about for and against aspects of their conventional practices, need to adopt new methods, extent of change, solution to problems that the change may bring about and its harmony with seismic retrofitting and reconstruction of school, which they witnessed. It is noteworthy that once trainees be convinced and equipped with the skills of seismic resistant construction techniques, they also asked the methodology to convince and teach others about it.

Local masons understood the language of retrofit, earthquake-resistance design, the importance of quality control. They could remember the advice of their great grandfathers regarding earthquake resistant design

Through the SESP, about 80 masons from the different school communities have been trained in the skills of seismic retrofitting, earthquake – resistant construction and quality control in construction. Out of these 4 masons have served as trainer in the reconstruction of earthquake affected area of Gujrat India and 4 masons in reconstruction of earthquake affected areas of Pakistan. These have shown their excellence in technology transfer ability for promoting safer construction.

Based on the experiences gained from the mason training, a curriculum/guideline for Mason Training has been prepared.

3.3. Awareness Raising, Training of Teachers, Parents, and Children

SESP was implemented with maximum participation of the central and local governmental organizations, school management systems, students, teachers and the local community.

Series of training and awareness programs are being conducted for students, teachers and community people on earthquake safety at each school. Additional 180 school teachers have been trained on earthquake preparedness in schools beside the teachers of 28 schools where the program was implemented. As a result, now the schools have their own plans to deal with any future emergencies.

All this has resulted in greater awareness in the communities on earthquake disaster risk and risk reduction. A qualitative judgment on the impact will be made following the completion of the second leg of the social impact survey. However, it is seen that new constructions in the settlements surrounding the schools are incorporating seismic-resistant elements, mostly by consulting the SESP masons. A strong replication potential of the program concept, and hence sustainability of efforts, is thus evident.

3.4. Replication

In all the communities where SESP has conducted, the house owners of respective locality have been replicating the construction methods employed in school building to construct their own houses without intervention from NSET-Nepal. Except some minor features, newly constructed houses adopt all basic earthquake resistant construction technology like horizontal bands, wall stitching, vertical tensile bars etc. It shows higher level of perception on what masons are trained. Obviously, it can be said that the process of replication would multiply in future to set a new technological culture in construction. In this aspect, the retrofitting project of school has much higher social value compared to other risk reduction programs that hardly are able to translate technology in real ground in root level.

3.5 Trust Building

All related government institutions, including the Ministry of Education, were involved in the project activities right from its planning phase. The Project subsequently provided regular information to the ministries and other related institutions. Such flow of information and "keeping everybody informed" helped NSET to build up and sustain the trust despite the fact that there were frequent transfers of related personnel in the government offices.

The fact that the schools were also involved in the SESP process right from the headmasters' seminar also created an environment of trust. Even the schools that were not included in the process were invited regularly in the SESP events. Creation of the advisory committee and its meeting provided the transparency that helped build trust. While running retrofitting program under SESP at one of the school in 2002, the community people were much worried about the construction management an quality control issues and wanted to implement the work through awarding it in contract. After starting the work by the community on SESP model through NSET's technical assistance, the community was very happy with the construction on comparatively at low cost due to transparency and active community involvement.

4. LESSONS LEARNT

4.1. Focus on School Earthquake Safety Drew Criticism

NSET and KVERMP were initially criticized for focusing only on public schools. Many people questioned why private schools and hospitals, a critical facility for post-earthquake response, were not chosen. The project team continued explanation for its focus on school did not quell the criticism. However, given the limited resources available, NSET continued the focus on schools, noting that the work on schools was building NSET's capacity to evaluate the vulnerability of other systems in the future. The school survey examined many previously unknown attempted activities: the costs of conducting a survey of building vulnerability, the technical expertise required for this type of survey, the costs involved in strengthening existing vulnerable buildings, the types of techniques to use for strengthening typical Nepalese structures, the interest of the community in strengthening buildings, the ability to attract funds (local and international) to this type of work, and the levels of earthquake risk acceptable in Nepalese society.

4.2. Retrofitting a School is an important awareness raising and Risk Reduction Tool

The lesson was not simply that a school could be retrofit. More important lesson was that for an additional $10-15k, local masons could be trained while retrofitting the school and the community could have their earthquake awareness raised. Strengthening the school was important and attractive, but more attractive outcome of the project was training the masons, convincing the masons that the techniques are very simple to implement and cost effective, raising the awareness among the community people, teaching the children and teachers what to do during and before an earthquake.

4.3. Community-based Approach is Key to Risk Reduction Efforts

Despite the traditional fatalistic outlook, issues of disaster risk reduction are becoming popular with the people. The traditional thinking of only the government being responsible for relief and rescue works is being replaced by realization of the need to start working at the community level. Disaster risk reduction is not the highest priority of the people in view of more pressing needs such as infrastructure, sanitation, health, education and environment. Making disaster risk reduction programs self-sustaining is rather difficult, and requires innovative thinking. At the same time, since the benefit-cost ratio is very high in view of the prevailing low level of preparedness, ways should be identified to initiate and support community-based disaster management programs.

4.4. Training Program for Mason is essential for Technology Transfer in the Community

The training program helped much to convince the local masons on the affordability and possibility of constructing earthquake -resistant buildings using slight improvements in the locally employed methods of construction. Trained masons from SESP have already started to construct buildings safer from earthquake in different part of the country hence transferring the safer construction technology to others who are not yet trained. Construction of new buildings with Earthquake resistant elements as well the retrofitting of existing buildings is increasing day by day in city. The increasing demand of the trained mason shows the need to train more and more mason on each site.

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