School Earthquake Safety Program is an Effective Tool for Seismic Vulnerability Reduction through Community Participation: Experiences from Nepal

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Abstract

During 1997-2000, the National Society for Earthquake Technology – Nepal (NSET) implemented The Kathmandu Valley Earthquake Risk Management Project (KVERMP), in cooperation with GeoHazards International (GHI) and the Asian Disaster Preparedness Center (ADPC), as a part of the Asian Urban Disaster Mitigation Program (AUDMP) with core funding from the Office of Foreign Disaster Assistance (OFDA) of USAID. Several government, non-government, academic and private institutions, individuals, as well as international institutions, including UNCRD, provided technical and financial assistance in the implementation of various project components.

Reducing public schools' earthquake vulnerability was one of the objectives of KVERMP. Accordingly, the School Earthquake Safety Program was initiated that targeted to assess the structural vulnerability of the prevalent school building types, and to implement a retrofit of one school building as a pilot project. The pilot project was completed in 1999 very successfully. This led to increased interest from the public schools to participate in the program, and with increasing national and international support for the school program, NSET continues assisting communities in Kathmandu Valley and outside in seismic retrofitting of their buildings. School Earthquake Safety Program is one of the priority initiatives included in the Kathmandu Valley Earthquake Risk Management Action Plan prepared under KVERMP. In its effort towards the Action Plan implementation, NSET has secured institutional support grant from OFDA. This allowed NSET to continue SESP under the Kathmandu Valley Earthquake Risk Management Action Plan Implementation Project (APIP). There has been a strong participation by the national government agencies, district and municipal governments, and more importantly, by the local communities. Similarly, there has been a very high level of cooperation and interest from the Kathmandu Valley schools and school officials, as well as business sector in this program.

This paper describes the School Earthquake Safety Program, nature and extent of community participation, and the lessons learned while implementing the program.

1 INTRODUCTION AND BACKGROUND

The Kathmandu Valley Earthquake Risk Management Project (KVERMP) was implemented during September 1997 – February 2001 jointly by the National Society for Earthquake Technology – Nepal (NSET-Nepal) and GeoHazards International (GHI), as a part of the

Asian Urban Disaster Mitigation Program (AUDMP) of the Asian Disaster Preparedness Center (ADPC), with core funding by the Office of Foreign Disaster Assistance of USAID.

A project design workshop in March 1997, attended by representatives of most of the government and non-governmental institutions in Kathmandu Valley related to disaster management helped to define KVERMP's objectives as: 1) to evaluate Kathmandu Valley's earthquake risk and prescribe an action plan for managing that risk; 2) to reduce the public schools' earthquake vulnerability; 3) to raise awareness among the public, government officials, the international community resident in Kathmandu Valley, and international organizations about Kathmandu Valley's earthquake risk; and 4) to build local institutions that can sustain the work launched in this project.

KVERMP included a wide variety of activities aimed at beginning a self-sustaining earthquake risk management program for Kathmandu Valley. Project components included the following: 1) development of an earthquake scenario and an action plan for earthquake risk management in the Kathmandu Valley, 2) a school earthquake safety program, and 3) awareness raising and institutional strengthening.

The project was implemented with strong participation by national government agencies, municipal governments, professional societies, academic institutions, schools, and international agencies present in Kathmandu Valley, in advisory committees and various workshops, seminars, and interviews. The process of earthquake risk management is continued now by NSET by implementing, since September 2000, the Kathmandu Valley Earthquake Risk Management Action Plan Implementation Project (APIP). OFDA is providing financial support to NSET for the implementation of APIP, which also contains SESP as one of the major components. APIP will be continued through August 2003

While the whole of KVERMP and APIP process and almost all of the project components strongly incorporated community-based approaches, in this paper we try to highlight the content, implementation process and experiences of the School Earthquake Safety Program (SESP). Some lessons learned during the process are also presented.

2 SCHOOL EARTHQUAKE SAFETY PROGRAM (SESP) CONCEPT DEVELOPMENT

2.1 WHY SCHOOLS?

Public schools in Nepal, both their buildings and their occupants, face extreme risk from earthquakes. This is because of the fact that the majority of the school buildings, even those constructed in recent years, are generally constructed without the input of trained engineers in design or construction supervision. Management of the public schools is largely the responsibility of the local community: the government provides the curriculum, and the salary of the teachers. The rest has to be managed by the community. Usually very low budget is available with the school management system. Such condition increases the likelihood that poor materials or workmanship are used in the construction of the school buildings making them structurally vulnerable to earthquakes. High vulnerability of schools was evidenced during the 1988 Udayapur earthquake (M 6.6 Richter) in eastern Nepal. Six thousand schools were destroyed in this event, luckily during non-school hours. Such massive damage to the school infrastructure disrupted the affected community: approximately 300,000 children were not able to properly attend schools for several months after the event.

The other 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, especially in rural and sub-urban areas. Hence, there is a greater chance of propagating earthquake awareness from school to the families, and from families to the communities

b) Public school buildings can serve as emergency shelters. Usually they have open grounds that could be used for establishing tents for shelter or field hospitals following an earthquake

c) Children of public schools are the future of Nepal. Usually they come fom low-income group hence constitute the more vulnerable community.

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

e) 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.

f) Schools play a crucial role after an earthquake in helping a 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. Functioning schools provide a feeling of normality to a community, helping people get back on their feet after a disaster.

g) Schools are also particularly tractable for earthquake safety programs. Schools structures are typically very simple and relatively small, unlike other critical facilities. Therefore it is inexpensive to build new schools in an earthquake resistant fashion and it can be affordable to retrofit existing schools. Also, by raising awareness in schools, the entire community is reached because the lessons trickle down to parents, relatives, and friends.

2.2 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.

2.2.1 Assessment Methodology

First, the project team created a questionnaire that could be filled out by school headmasters. This questionnaire included topics such as size of buildings, density of students, year(s) of construction, whether or not an engineer was involved in the building design or construction, 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 conducted the survey and data on 430 schools were returned to the project. The conclusions were extrapolated to the entire building stock of the existing public schools of Kathmandu Valley.

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

2.2.2 Alarming Findings

The following were the findings of the survey.

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

b) The remaining (less than 40%) of the buildings uses more modern materials such as brick in cement mortar or reinforced concrete. Even though modern materials are stronger, these modern Nepali schools are not necessarily safer. Traditional artisans build almost all of these schools without any inputs from an engineer. School buildings built with modern materials are typically taller, have larger rooms and larger windows and doors than buildings built with traditional materials. These features make many modern buildings as dangerous as the traditional ones.

c) Of the nearly 700 school buildings, only three buildings were constructed meeting the stipulations of the Nepal National Building Code (draft). An additional four to five percent buildings had some seismic resistant design features, such as reinforced concrete bands at the lintel level. The vast majority of buildings were built without considering seismic forces at all.

d) 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

2.2.3 Main Problems of Existing School Buildings

In summary, the main characteristics of the public school buildings of Kathmandu Valley are the following.

a) Almost all buildings are non-engineered,
b) Most buildings were constructed using informal production mechanisms,
c) The buildings are constructed using mainly the traditional materials (low-strength masonry, flexible floors and roofs mostly of timber),
d) Most are elongated (rectangular) in plan
e) Most buildings are load bearing masonry structures, and
f) Most are highly vulnerable to earthquakes.

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.

2.3 THE INITIAL DILEMMA

Many advisors of KVERMP and well-wishers of NSET warned not to initiate any program on 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.

On the other hand, NSET looked at improvement of seismic performance of existing school and residential buildings, structural and non-structural, as an alternative that deserved high priority for exploration. The country has about 25,000 public schools, and it will take very long time for each of them to have new earthquake-resistant building unless some radical means are found and implemented.

Subscribing to the concept of incremental seismic safety, NSET opted to explore further the feasibility of structural intervention for reducing existing vulnerability of the school buildings. The results are described in the following sections.

2.4 BENEFITS FROM INTERVENTION

Two scenarios were considered, no intervention and intervention cases, for seismic improvement of school buildings. In the no intervention scenario, the expected loss is more than 29,000 school children dead or injured, and more than 77% of the buildings incurring direct building loss the cost of which has been estimated at around US$ 7 million (Table 2). The resulting societal trauma, need for rescue and relief, degradation in life standard would be of unimaginative scale. BY intervening structurally, we can save the lives of some 24,000 children and protect our school buildings, one of the biggest assets of a community. Besides, it will also provide an opportunity for social dialogue, increased awareness, preparedness planning, and masons' training thereby the opportunity for replication- hence inculcating a culture of safety. The imperative is to act now!

2.5 COMPARATIVE EVALUATION OF THE TWO OPTIONS - RETROFITTING VERSUS DEMOLISH & RECONSTRUCTION

Table 3 presents two options available for seismic improvement of school buildings and makes a comparative evaluation of the options. The options are i) demolish and reconstruct, and ii) retrofit. The first option seems easy from technical point of view. It is also attractive but there remains very high excitement, societal impact and opportunity to learn more in second option. On economic ground also the first option is far expensive than the second option (refer Table 6). It is not only cost but also, magnitude and duration of disturbance to existing school functions will also be very high in first option (more than 1 year in comparison to 3-4 months in second one).

Table 2: Comparative Evaluation of the Benefits of Structural Vulnerability Reduction of School Buildings

<table>
<tr><th colspan="2" rowspan="2">Criteria</th><th colspan="3">Intervention Scenario at different Intensities of Shaking (MSK)</th><th colspan="3">Non-Intervention Scenario at different Intensities of Shaking (MSK)</th></tr>
<tr><th>VII</th><th>VIII</th><th>IX</th><th>VII</th><th>VIII</th><th>IX</th></tr>
<tr><td colspan="2">Building Loss</td><td>%</td><td>%</td><td>%</td><td>%</td><td>%</td><td>%</td></tr>
<tr><td rowspan="3">Level of Damage</td><td>Collapse</td><td>0</td><td>0</td><td>11</td><td>0</td><td>11</td><td>66</td></tr>
<tr><td>Un-repairable Damage</td><td>0</td><td>0</td><td>46</td><td>4</td><td>65</td><td>11</td></tr>
<tr><td>Repairable Damage</td><td>61</td><td>100</td><td>43</td><td>73</td><td>24</td><td>23</td></tr>
<tr><td colspan="2">Life Loss</td><td></td><td></td><td>5000</td><td></td><td>?</td><td>29,000</td></tr>
<tr><td colspan="2">Direct Economic Loss due to Building damage</td><td></td><td></td><td></td><td></td><td></td><td>US $ 7M</td></tr>
<tr><td colspan="2">Societal Trauma</td><td colspan="3">Low</td><td colspan="3">High</td></tr>
<tr><td colspan="2">Requirements for Rescue / Relief</td><td colspan="3">Low</td><td colspan="3">High</td></tr>
<tr><td colspan="2">Earthquake awareness / preparedness planning, establish dialogue</td><td colspan="3">Very High</td><td colspan="3">None</td></tr>
<tr><td colspan="2">Mason Training Opportunity, Replication Potential</td><td colspan="3">Very High</td><td colspan="3">None</td></tr>
</table>

Table 3: Comparison between Retrofit and Reconstruction Options

No.	Criteria	Demolition & Reconstruction	Retrofitting
1	Involved Costs	High	Low
2	Time for Building strengthening	More than a year	3-4 months
3	Disturbance to School Function	High	Low
4	Problem associated with Disposal of Scrapped Materials	Big Problem	No Problem
5	Technology (adaptability)	Usual (hence no excitement)	New (hence high excitement, but need to train)
6	Societal Impact (Replicability)	Low/Medium	High

Table 4 compares cost required for demolition and reconstruction and retrofit option for buildings constructed from different construction materials. It also presents economic benefits of retrofitting over demolition and reconstruction. Even if existing buildings are repaired and maintained besides retrofitting, the saving will be 58 to 75% of reconstruction cost. Lowest benefit will be in building with weak materials as compared to newer buildings with good construction materials (cement, steel). While making such comparison, it is assumed that the buildings under intervention are non-engineered, and that the skilled masons can undertake the retrofitting works with community participation, and under guidance from a trained technician.

Table 4: Comparison between Retrofit and Reconstruction Costs

Building Type	Demolition and Aseismic Reconstruction (to the same standard as present) (NR/ m^2)	Seismic Retrofitting (Including Repair & Maintenance, R&M), (NR/ m^2)			Benefit of Retrofitting over Reconstruction	
		Retrofit	Repair & Maintenance	Total	Retrofit without R&M	Retrofit with R&M
Masonry in Mud Mortar	2,500	725	375	1100	75	60
Masonry in Cement	3,118	710	180	790	77%	75%

3 SESP PROGRAM

3.1 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 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 (SSC), with several sub-committees, at each SESP site. The Chairperson of the School Management Committee heads SSC. The sub-committees established under SSC 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 awareness raising 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.

3.2 PROGRAM COMPONENTS

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

3.2.1 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. Charts in Annex 1 and 2 show the weights given to these criteria.

3.2.2 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 only 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 provide in-kind or cash or materials contribution, 4) the communities establish the School Earthquake Safety Committees (SCC) with the chairperson of the School Management Committee heading it. IT requires also that the school would have established Construction Management Subcommittee, Mason Training Subcommittee, and Earthquake Response Planning Subcommittee, and a School Earthquake Safety Club (students).

3.2.3 Technical Assistance during Construction

NSET carries out survey, design and assists the construction committee to implement the construction. Usually, the local masons are engaged in the construction; contractors are avoided.

NSET also provides construction supervision. During construction, the masons are trained in aspects of earthquake safety. A mason who had been trained earlier is posted at each construction site at NSET's cost. He supervises the day-to-day construction and trains the local masons on-the-job.

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

Box 1: Applicable Methods for Retrofitting School Buildings

The methods identified as applicable for the seismic improvement of reinforced concrete, and masonry buildings. Firstly, it is recommended to amend conceptual deficiencies (configuration, load path) in existing buildings. Secondly, enhancement of strength (jacketing of framing elements) and ductility (following ductile detailing) are recommended for reinforced concrete framed buildings, and enhancement of the integrity between structural elements (using stitches, splint and bandage, floor/ roof bracing) and enhancing ductility are recommended for masonry buildings.

3.2.4 Training Curriculum Development, and Earthquake Kit preparation

Kit for the teachers has been prepared, and a training curriculum has been developed. During the training, the teachers are guided to prepare simple earthquake safety program for the school.

Box 2: Use of Appropriate Technology and Localized Solution

Kabhresthali is a village located in the northern fringe of Kathmandu Valley at the foot of the Sheopuri mountain range. The Kabhresthali public high school was recently reconstructed to earthquake safety under SESP. Together with the local people, NSET engineers decided to reconstruct the dilapidated stone-masonry building. But opinion differed: the community wanted to reconstruct in brick masonry, while the engineer thought it to be the ideal site for the use of stonecrete blocks that could be manufactured locally, by breaking the dismantled stone into smaller pieces and molded into cement blocks.

It required lots of patience for the engineers to convince the community on the appropriateness of the technology.

First, they were told about the benefits to be derived: a) trucking of bricks from kilns located in the south of the valley is expensive, and sometimes impossible because of the poor quality of the road to Kabhresthali, and b) stonecrete blocks can be molded locally, at household level, especially during periods of field fallow, using stones that were scattered all around the village and sand that abounds in the nearby stream. Members of the School Construction Committee were taken to Kirtipur where the community was proud to have accepted the technology a year ago. This created the required peer pressure and paved way for enhancing confidence.

Further, the molded stonecrete blocks were tested in the laboratory of the local government-run engineering institute. Kabhresthali people were very delighted to learn that the stonecrete blocks were several times stringer than the usual bricks.

The school building was constructed at much lower cost. The economy resulted not only at the low cost of locally molded stonecrete as against the imported bricks, but also because of the relatively lesser time necessary for laying the blocks.

At present, the people of Kabhresthali not only demonstrate the technology to the newcomers, but also mould these blocks during off-season. A new livelihood option has thus been initiated.

With the new technology of block making and building construction, Kabhresthali will get each year safer from earthquakes.

3.2.5 Additional Program Components

SESP has undergone several changes and additions. More new players are becoming partners in implementing earthquake-resistance into the construction of public school buildings in Nepal.

3.2.5.1 Collaboration with other partners

NSET has entered into a MOU with a NGO Room to Read (RTR) for mutual collaboration for the incorporation of earthquake safety elements in the school buildings constructed by RTR. The collaboration has extended wider to cover areas of mason training, earthquake safety of the school and also financial assistance to the communities where NSET-assisted schools are being retrofitted.

Similar collaborative arrangement is being contemplated with other NGOs and INGOs that are investing in the construction of school buildings in Nepal.

3.2.5.2 Collaboration with government

The government of Nepal is negotiating a financial assistance from funding agency for implementing secondary education improvement program that will invest significantly in infrastructure improvement of public schools. The Department of Education has asked NSET for cooperation in integrating earthquake safety into the project activities.

With such collaborative programs, NSET expects to widen the outreach of its SESP to other parts of the country very soon. This is necessary because the whole of the country faces high earthquake hazard.

4 PROGRAM ACHIEVEMENTS

4.1 AFFORDABILITY OF SEISMIC IMPROVEMENT OF SCHOOL BUILDINGS ESTABLISHED

The School Earthquake Safety Program has so far accomplished seismic retrofitting of four brick masonry buildings belonging to the following schools:

1. Bhuwaneshwory Lower Secondary School, Nangkhel, Bhaktapur District
2. Bal Bikash Secondary School, Alapot, Kathmandu District
3. Upayogi Primary School, Sirutar, Bhaktapur District and
4. Gadgade Primary School, Nagarkot, Bhaktapur District

Additionally, the Program could reconstruct to the standards of Nepal National Building Code two very hazardous buildings belonging to the following schools:

5. Bhuwaneshwory Lower Secondary School, Nangkhel, Bhaktapur District
6. Vaishnavi Secondary School, Kirtipur, Kathmandu District
7. Kabhresthali Lower Primary School, Kabhresthali, Kathmandu District
8. Himalaya Primary School, Bhaktapur District (nearing completion)
9. Nateshwory Primary School, Bhaktapur District (nearing completion)
10. Shree Krishna Secondary School, Dhapakhel, Lalitpur District (NSET is providing technical assistance to this school; financial assistance comes from SNV, Netherlands)
11. Vidyodaya Primary School, Jochhen, Kathmandu

Two more schools of Dhading district under the Room to Read program received technical assistance from NSET. The assistance included survey, design, construction supervision, mason training, training of parents and community leaders and limited financial assistance:

12. Amarkhu Secondary School, Dhading
13. Tin Kanya Primary School, Dhading

The program implementation provided to develop a better idea about the prevalent building typologies, the inherent problems, and the likely solutions for enhancing their structural safety. The experience gained is being consolidated in the form of a Hand Book for Seismic – Resistant Construction and Retrofitting of School Buildings in Nepal.

Box 3: Remembering what the grandfather said .. … …

Everybody was happy at the smooth pace of construction works at Bhuwaneshwory Lower Secondary school. NSET was assisting the local community to retrofit the existing brick masonry building that was about 15 years old. NSET engineers were happy that the masons were bending the bars and laying the bricks exactly as they instructed. But they were glad also because the mason earlier asked, "O. K. Sir, we do as you instruct. But could you please explain why you want things this way and not the other way. Please explain the difference." That was the demand for training, the NSET engineers understood, and started the mason-training program.

Classroom lectures for the masons started being held in the evening, in one of the classrooms of the school. The classes were visited not only by the masons, but also by parents and elderly people.

One evening, an elderly person attended the lecture. He was given special seat at the front as everybody respected him. He was the oldest mason, already in his eighties.

At the end of the lecture, he told the NSET engineer how his grandfather taught him the skills of building construction. He summarized:

- *Always put a wooden (tie) band around the building at sill level, lintel level and at the floor level. Carve it in "naga" (snake). It will protect your house.*
- *Secure every third or fifth or seventh joist to the wall plate by driving a lock wedge driven through the joist.*
- *Multistory high buildings, Arches, existence of numerous windows, brick wall without good "teeth joints", use of brick pieces in the middle of wall width, masonry wall without bands, buildings with heavy upper stories, building in mud mortar are relatively weak.*
- *For larger buildings, the quality of materials is as important as the quality of construction. Better to consider both.*
- *For smaller, low-cost dwellings, 1) do not make more than 1 story if constructed with a combination of burnt and un-burnt bricks, 2) dress the stones for construction of stone-masonry buildings in the hills, 3) make the roof as light as possible, 4) use lime mortar for bricks, 5) limit height of brick masonry buildings to 34 hat (50 ft), 6) assure good connection between walls at joints, the whole house should behalf like one structure during an earthquake, 7) construct in one wyeth rather than using pieces to increase the wall section in masonry construction, , 8) avoid columns in brick masonry; better use a timber column*
- *Build at those places where the past earthquake did not have much affect*
- *Dig the foundation right up to the rock*

The young NSET engineer asked himself a question – who is teaching whom?

4.2 MASON TRAINING

The whole execution of project is designed as a tool of developing skilled manpower in earthquake resistant construction in local level. In all the process of seismic retrofitting and reconstruction, Engineers of NSET-Nepal work with masons showing them the details and explaining the complete procedures. Focus was placed in explaining the meaning of the processes of curing of concrete, proper reinforcement details, what does the earthquake -

resistant elements do? How the retrofit elements such as splints, bands, corner pins, etc function to withstand the earthquake force.

Besides the training in the form of explaining as you go, separate training classes were organized in evenings. The main target group was the craftsmen of the respective village, but the classes are typically open to all interested. The technical knowledge of earthquake resistant construction is given to them systematically. Participation of villagers and craftsmen was always higher than the number of masons directly involved in the construction process in the village. This was due to the raised level of awareness on earthquake. They have seen their future in this 'modern' Technology that they should be equipped with. They were very enthusiastic.

Obviously, the common people, during the training session, show high concerns over the matters that how their own houses are built, and the weaknesses of the prevailing construction practices. 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 seismic resistant techniques, they also asked the methodology to convince and teach others about it.

The training courses follow hierarchical procedure starting from problem identification to end at testing of methods of learned. Several tests are conducted to support the knowledge in relation to effect of placement of reinforcement rod in beam/slab, quality of work governed by material and workmanship like excess water effect, curing effect etc

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

About 25 masons from the five school communities have been trained in the skills of seismic retrofitting, earthquake – resistant construction and quality control. Four of these masons have been trained as Trainers. In fact, these four masons from Nangkhel Village were given the responsibilities of supervising the construction works at four different schools under the program. Additionally, 20 other junior masons and construction labors were given the training.

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

4.3 AWARENESS RAISING, TRAINING OF TEACHERS, PARENTS, AND CHILDREN

SESP was implemented with maximum participation of the government institutions (Central Region Education Directorate, District Education offices of Kathmandu and Bhaktapur Districts), District Development Committees and Village Development Committees, the school management systems, and the parents and the students. The government agencies provided funds and policy guidance, while the actual implementation of construction works was handled by the school management committees with technical inputs and supervision from NSET. Such implementation mechanism, together with the formation of Central -, District -, and school level advisory committees, considerably widened the outreach of the program and its ownership.

An Earthquake Kit has been developed for training the teachers and the parents on earthquake preparedness planning and establishment of evacuation and fire drills in the schools. Several meetings were held with the local communities and the school officials NSET will continue its efforts in implementing such training program in the schools.

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.

4.4 KATHMANDU-KOBE EXCHANGE PROGRAM

Kobe-Kathmandu Collaborative Exchange Program on Earthquake Safety is a logical continuation of SESP in Bal Bikas Secondary School, Alapot, Kathmandu District. Greatly influenced by the performance of the local community, teachers and students of Bal Bikas in terms of their dedication to enhancing earthquake safety of their school, NSET and UNCRD (Disaster Management Planning Hyogo Office) facilitated this program. The program aims to enhance cooperation between the students of Kobe and Kathmandu through learning experiences and sharing knowledge in disaster mitigation. The goal is to raise awareness for disaster preparedness among students, teachers, and other embers of the community. The program consists of:

1) Exchange of Culture Box: it is critical to understand each other's culture to promote international cooperation in earthquake safety. Cultural aspects can not be ignored in disaster risk reduction activities. Thus, the cooperation between the students of two countries started with exchange of culture boxes. This activity has been a great success in awareness raising and deepening the understanding of each other's cultural background.
2) Retrofitting of School Buildings: The students of Maiko High School, Kobe raised funds to retrofit public schools in Nepal as part of NSET's SESP. Although the amount was nominal, the impact it has created in the heart of the related communities of Nepal is tremendous.
3) Disaster Education Program: Curricula for disaster and environmental studies have been exchanged between Maiko High School and al Bikas School. This includes the curriculum on disaster studies, piloted by the Maiko High School of Kobe. The Headmaster of Bal Bikas visited Maiko High School for developing a closer understanding the curriculum and its delivery mode. The program will continue in future.
4) Student Exchange Program: NSET and UNCRD supported the visit by the first "ambassador" from Maiko School to Kathmandu to share the experiences of Kobe students during the Great Hanshin-Awaji Earthquake and how they are now dedicated to enhancing the safety of students. The visit greatly facilitated closer understanding between the students of the two schools. Suggestions were received for further exchange on a wider scale.

4.5 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 private houses without intervention from NSET-Nepal. Except some minor features, newly constructed houses adopt all basic earthquake resistant construction technology like bands, wall stitching, vertical tensile reds 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.

4.6 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.

Considering the high level of interest from the community, NSET organized several meetings with the parents and the school management committee. Such meetings were costly in terms of time, but they helped consolidate mutual trust, helped explore additional potentials for cooperation, and solve outstanding issues.

5 EVALUATION OF ACHIEVEMENTS

5.1 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. Additionally, people asked why cinemas, private schools and colleges were not examined. 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.

5.2 INITIAL SKEPTICISM WAS SHORT-LIVED

Low level of awareness and uncertainty of earthquake event brought criticism during initial stage of the program implementation. NSET being an NGO was another reason for an initial apathy because of generally tarnished image of several of NGOs. However, open financial policies and transparency exercised, limiting the role of NSET as technical/management assistant, giving the local school management committees the decision-making responsibilities helped develop the required level of mutual trust, and the program ultimately received all out cooperation from all concerned.

5.3 RETROFITTING A SCHOOL IS AN IMPORTANT AWARENESS RAISING OPPORTUNITY

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 villagers could have their earthquake awareness raised. Strengthening the school was important and attractive, but more attractive outcome of the project was retrofitting the school, AND training the masons, AND convincing the masons that the good techniques are better than the poor techniques AND raising the awareness of the villagers, AND teaching the children and teachers what to do during and before an earthquake. All these extras come for a small relative increase in the cost of retrofitting, and they could be possible only because of the retrofitting.

5.4 "WHAT IS ACCEPTED BY THE COMMUNITY" IS MORE IMPORTANT THAN "WHAT IS NECESSARY?"

The knowledge, program, technology and training to be given to the community for disaster management should be compatible to what they accept, and practice. It implies that the community-based disaster management package should start from low-cost and low technology options for mitigation and preparedness so that people not only understand the logic, but also accept and use it. SESP consistently adopted simple technical approaches, which made the initiatives cost-effective and understandable to the laypersons. It also helped to focus the project on implementation of risk reducing actions, our major aim. SESP was accepted and also replicated by the related community also because of the comprehensiveness of approach. Efforts on physical improvement were combined with intensive interaction and two-way dialogue with the community, training and education, and establishment of mutual trust and confidence.

5.5 COMMUNITY-BASED APPROACH IS KEY TO RISK MANAGEMENT EFFORTS

Despite the traditional fatalistic outlook, issues of disaster management are becoming popular with the people. The traditional thinking of only the government being responsible for relief and prevention 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. Moreover, most communities do not have enough financial resources. Therefore, making disaster risk reduction programs self-sustaining is rather difficult, and requires innovative thinking. At the same time, since the benefit-cost ration 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.

5.6 TRANSPARENCY PAYS

A School Reconstruction Advisory Committee was formed to provide necessary advice. It was headed by the Chairman of the District Education Committee, and included representatives of the local village level government, prominent people and the members of the school management committee. All aspects of the reconstruction activities, including finance and other problems were discussed in the fortnightly meeting of the advisory committee. This committee provided the necessary political support to the project and helped increase its outreach.

A 5-member School Retrofitting Committee, consisting of the chairman of the school management committee, the headmaster, the NSET engineer, and two local representatives, implemented the project. This committee made all decisions with NSET's guidance. The committee operated a bank account with the headmaster and the NSET engineer as the joint signatories. This committee also helped achieve transparency, help to optimize the limited resources, fostered mutual trust.

The whole process was conducive for peoples' participation. While the local community provided 25% of labor as in-kind contribution, the reconstruction was done totally by the local community with NSET providing only the technical inputs and helping in fund-raising.

5.7 TRAINING PROGRAM FOR MASON IS ESSENTIAL FOR A SUCCESSFUL SCHOOL EARTHQUAKE SAFETY

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.

6 RELATED PUBLICATIONS

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NSET3 2000; Seismic Vulnerability of The Public School Buildings of Kathmandu Valley and Methods for Reducing it: a report on the School Earthquake Safety Program of the Kathmandu Valley Earthquake Risk Management Project; NSET, Kathmandu, 2000

NSET4 2000; A Vocabulary of Disaster Terms (English – Nepali); Prepared under the WSSI Fellowship Program (Draft), NSET, Kathmandu; 2000.

Shrestha, H. M.; 2001; Construction Management for Earthquake Risk Reduction Works in Schools of Kathmandu Valley: a Thesis submitted to the M. Sc. Program in Construction Management; Nepal Engineering College; Pokhara University; Nepal

Safer Cities 1, Case studies on mitigating disasters in Asia and the Pacific, ADPC, January 2002.

Annex1: School Screening for Earthquake Safety Intervention

1. Name of School: ___________________________________**2. Code No**.: _____________

3. Location: District ____________ VDC/Municipality-Ward ____________________Tole ___________

(Please draw a sketch of general Route map with salient features at the back of paper.)

4. Total no. of blocks: _______

5. Building Details:

	Block no.	Story	Wall		Floor		Roof		Building	Plinth
			Material	Condition	Type	Condition	Type	Condition	Condition	Area
Proposed blocks										
Other Blocks										

6. Short Description of Building: _____________

7. Building Components to be Repaired/ Replaced: _____________________________

8. Additional Features to be added: ____

9. Temporary classes run option: ____

(Specify how can it be managed)

10. Commitment of Contribution by i) Headmaster/Teachers _______ Remarks

ii) Management committee __________

iii) Local Community __________

11. Mode of Contribution

i) Cash ☐ ii) Labor ☐ iii) Material __________

Amount ________ Charge free % _______ Amount __________

12. Accessibility

i) Inaccessible to vehicle ☐ ii) Accessible by fair weather road ☐ iii) Accessible throughout the year ☐

Lead distance (km) ______

13. Socio- economic aspects

i) Caste __________ ii) Settlement type: New ☐ Old ☐

iii) Community group: Homogeneous ☐ Heterogeneous ☐

iii) Profession of Locals (Priority on majority) a) ____________ b) __________ c) ______

iv) Economic class of students' family ____

14. Availability of Resources

i) Materials: Brick ☐ Cement ☐ Steel rod ☐ Timber ☐ Formwork ☐

ii) Labors (no): (a) Masons _______ (b) Unskilled labor __________

15. Industries in the vicinity: ____

16. Historical description of building: I) Heritage site ☐ ii) Other (Specify): ______________________

17. School visibility: ____

18. Comments (4-5sentences): ____

____

Annex 2: Screening scoring Chart

Criteria	Results			
	Judgment	Score	Symbol ("*")	Score
Commitment for the Participation	Strong	50		30
	Very Good	40		
	Good	30	*	
	Fair	20		
	Weak	10		
	No	0		
Condition of existing building	Bad	20		10
	Fair	10	*	
	Good	0		
Craftsmen available at local level	Yes	10	*	10
	No	0		
School Visibility	Yes	10		0
	No	0	*	
Temporary class room option	Yes	10	*	10
	No	0		
	Total score			

Surveyed by:

Draw a sketch of general route map with salient features