Nepal-Gujarat Masons Exchange And Training Program: A community based Sub-regional Initiative

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Abstract

January 26 2001 Bhuj Earthquake devastated large areas in Gujarat killing thousands and rendering millions of people homeless. Sustainable Environment and Ecological Development Society (SEEDS) India, was among those who initiated to reduce hardships of the victims by supplying them with relief materials. After a series of interaction with the victim community, other agencies involved in the rescue and relief including Gujarat State Disaster Management Authority (GSDMA), SEEDS Patanka Navajeevan Yojana (PNY) was formulated. PNY intends to facilitate the earthquake victims to rebuild their homes, plan and implement various activities pertaining to sustainable rehabilitation with active community participation in Patanka.

Institutions and individuals from India and abroad have supported this rehabilitation initiative undertaken by SEEDS. NGOs-Kobe and GAP Inc. have generously contributed for the rehabilitation. Various agencies have shared their expertise and experiences in community based earthquake resistant construction. These agencies include Geo Hazards International USA, The United Nations Center for Regional Development, Japan, Fredrich Ebert Stiftung Germany, National Center for People's Action in Disaster Preparedness India, the Earthquake Disaster Mitigation Japan.

SEEDS was facing some challenges in implementing simple earthquake resistant construction techniques appropriate to Patanka. National Society for Earthquake Technology – Nepal (NSET-Nepal) agreed to facilitate SEEDS's efforts based upon past experience in this field. This NSET-SEEDS joint venture the "Nepal Gujarat Masons Exchange and Training program" (NGMET) was initiated in August 2001 and will continue till the completion of PNY. This paper traces the beginning activities, the achievements so far; lessons learnt, including the potential of replicating the project in the South Asian Region.

1 Background

Both Nepal and India have a history of recurring earthquakes, which lead to periodic death and damage. The extent of damage is generally very high because the majority of buildings in the region are built without considering seismic safety requirements. More than 95 % of the buildings in the region are believed to be *non-engineered*. These non-engineered buildings are constructed both in urban and rural areas, by traditional craftsmen, who usually do not take any training in seismic safety, play important role in building construction.

NSET-Nepal is working towards institutionalization of seismic safety culture at grassroots level through community-based programs like School Earthquake Safety Program and Ward Level Disaster Management Program since 1992. We strongly believe that seismic safety can be achieved only by rising public awareness, transferring ownership of appropriate technology to the grassroots level and by involving all stakeholders including the communities in disaster management issues.

NSET has gathered some experience in community based initiatives in earthquake preparedness and mitigation, especially the School Earthquake Safety Program (SESP) in the past 5 years under the Kathmandu Valley Earthquake Risk Management Project (KVERMP). These activities are continued at present under the Kathmandu Valley Earthquake Risk Management Action Plan Implementation Project APIP. An important aspect of SESP is the training of Local Masons. It is a hands on training imparted to the local masons during seismic retrofitting and reconstruction of public school buildings in Nepal. So far, NSET has been able to train about 20 skilled masons who could train other masons

Following the Gujarat Earthquake of 26 January 2001, SEED India started implementing the Patanka Nawageevan Yojana, an earthquake reconstruction of the village Patanka of Patna District of Gujarat. Patanka, one of the 79 villages of Gujarat that was totally divested by the earthquake. More than 170 houses out of 253 were completely collapsed and most of the remaining was damaged beyond repair.

The post- earthquake reconstruction program at Patanka under the "Patanka Navajeevan Yojana", was considered as an opportunity by NSET-Nepal to learn from the Gujarat experience of rebuilding. Unfortunately, Nepal couldn't learn much from the aftermath of the 1988 earthquake when much of urban reconstruction went without the improvement of seismic strength.
NSET's based its decision to join SEEDS in PNY with NGMET on the following considerations

- Earthquake do not recognize political boundary

The "Nepal Gujarat Masons Exchange and Training Program" (NGMET) was formulated as a joint program by NSET-Nepal and SEEDS to replicate the past experience of NSET-Nepal in identifying and implementing simple earthquake resistant construction technology transfer at the grassroots level through awareness and training.

2 Objectives and Strategy

Masons are the pivoting key actors in translating the designs into reality. Optimum, efficient and effective use of building materials is not possible if the masons are unaware about the technology they are working with. There are many ways to train new as well as practicing masons. Masons Exchange Program is one of the new approaches in technology transfer. NGMETP was conceived to share the experiences of trained and experienced masons from NSET-Nepal to fellow masons from Gujrat and vice versa. Exchange visits of Gujrati masons to Nepal and Nepali masons to Gujrat were also expected to fortify the learning process as well as acquire new techniques to make safer buildings. Following objectives and strategies were taken under NGMETP.

2.1 OBJECTIVES

In general objective of the program was to start mitigation and preparedness through training and awareness at community level, in specific the objectives were:

- Train at least 20 local masons from Patanka in earthquake resistant construction technology while rehabilitating and or reconstructing the houses demolished by the earthquake.

- Organize at least three exposure visits of masons from NSET-Nepal and Patanka.

- Document and disseminate the outstanding achievements and explore its replication in the needy communities elsewhere.

2.2 STRATEGY

To meet the above-mentioned objectives the following strategies were taken

- Use of reconstruction process as an opportunity to institutionalize safer building culture
- Share of experience to the maximum at grassroots level
- Use of manual methods in construction rather than mechanization in reconstruction works.
- Due consideration to serviceability (Functional requirements) of building.
- Prime importance to locally available construction materials.
- Reuse of materials in reconstruction.
- Use of local manpower
- Technical instruction to craftsmen (local people) in form of advice with full understanding of reason behind it.
- Conduction of interaction program between Engineers and local villagers on the mitigation techniques.
- Mason training program to upgrade local craftsmen's skill in quality construction and develop skillful working manpower in earthquake resistant construction.

3 Activities

3.1 ANALYSIS OF EXISTING SITUATION

Two masons and one engineer arrived Patanka on 9th August 2001. The main objective of this visit was to assess the existing rehabilitation process, identify and prioritize existing issues. Planning the appropriate interventions and initiating them was the activities planned for the first exchange visit. The Nepalese team visited Patanka along with the PNY technical personnel to know the ongoing reconstruction process.

3.1.1 Construction Status

The first model building undertaken by PNY had reached the lintel level and other six buildings were at different stages of construction. The community members were in a hurry to build their buildings and wanted PNY to initiate all the buildings of the eligible victims at once. But the human resources of PNY and the masons available within the community did not permit this. Further the technology being used also required some alterations and improvements. The joint observation discovered some issues requiring immediate proper intervention. The identified issues were:

3.1.2 Lack of Proper Understanding Between Project Team and The Beneficiaries

Each victim within the community was desperate to construct his/her house as soon as possible, which is very natural in this context. On the other hand the PNY technical team had its own limitations. The time available to share about the problems and plans to solve them with the community was very little. The team had initiated to undertake six houses as a faith building program with the community. This itself had to be dome in such a hurry that the team some how even escaped the planning of the materials and resources required for the ongoing

construction. This resulted in under utilization of the building materials resulting in poor quality of construction. The situation was becoming more and more complex. The victims did not understand the problems of the project team and the project team also some how could not honor the desperate desire of the victims. Frequent interaction on the problems and the potential option is the only solution to this kind of misunderstanding among each other.

3.1.3 Inadequate Level of Skill of the Practicing Masons

PNY was organizing one-day workshop for the practicing masons to upgrade their skill level. The training program included only the masons employed by the owner. The owner was required to pay for the wages of the masons being trained. The owners were not happy as they thought it was an extra cost to them. The owners did not like to spend more for training their masons. On the other hand the masons would not attend the training without getting paid. Obviously the one-day orientation training was not enough for the mason to acquire the basic skill of earthquake resistant construction. An alternative method to train the masons was an acute need of the hour.

3.1.4 Complexity of the Technology Being Used

All the building in Patanka were mostly stone masonry house built with mud mortar. Timber was extensively used for the roof structure and the minimal openings they had in their houses. Modern materials like cement and steel were introduced only after the earthquake. The masons in Patanka were not familiar with the properties of cement and the right way to use it. Further, the use of vertical steel and reinforced concrete bands in these small buildings was amusing them. On the other side there was enough room to simplify the construction techniques.

Making the masons to clearly understand the techniques and reason behind them was necessary to improve the construction quality.

3.2 THE INTERVENTION APPROACH

After developing a clear understanding on the existing issues the NSET- team came with a two pronged action to improve the ongoing construction activities. First the two Nepalese masons joined the construction process and worked with their Gujarati counterparts to transfer the skills of earthquake resistant construction of masons buildings. Their skills they had acquired in Nepal under the SESP of NSET. For example, toothed ends of stone masonry wall were replaced by proper stepping for later add – in of a walls. This provided a better bond in between the masonry units. Similarly, optimum use of bond and through- stones, including filling of cement mortar in the gaps avoided honeycomb in the walls. These few small interventions served as ice-breaker and established the foundation of trust between the Nepalese and local masons and the house owners.

The Nepalese engineer detailed the plan for subsequence interventions along with the PNY Team. The interventions made to address the identified issues are briefed in the following sections.

3.2.1 Community Interaction

The Nepali engineer developed a format to monitor the consumption of materials at site. This worked as a simple and easy tool to monitor as well as assure the quality of construction. Addition of the Nepali team though for a short duration eased the workload on the PNY technical team allowing them more time to interact with the community. Further the interaction was made on each issue raised by the community without getting diverted to another topic. This helped to develop a better understanding of the project team with the community. The existing indifferent attitude of the community now slowly turned out into a better coordination and understanding of the existing problems.

3.2.2 Upgrading Skill of the Masons

The masons seemed to understand every bit of earthquake- resistant construction technology explained by the engineers in the training sessions. But somehow this was not reflected in their work in the construction. This was disappointing as all the stakeholders were involved. There is no doubt on the competency of the engineers on understanding the technology. But the difference in the understanding level of the engineers and the masons was one of the reasons behind the dissatisfaction. The most important component of technology transfer is the proper communication in between the trainee and the trainers. This which requires an analytical approach. Several communication skills acquired through the experience of the Nepali engineer were implemented while the masons were working in the houses. The skilled masons from Nepal were used as a vehicle of the technology transfer process. The combined effort was effective in upgrading the skill level of the practicing masons in Patanka.

This was a short-term and immediate action taken to improve the ongoing construction. But it was not sufficient to produce the number of masons required to rebuild Patanka. A long-term plan on training of masons was conceptualized. The NSET-Nepal engineer produced an outline of the training program along with the PNY Technical team. Use of three-dimensional models along with other relevant audiovisual materials was proposed. One of the major components was the shake table on which the effectiveness of the seismic resistant components could be very well demonstrated. It was decided that the masons from Patanka would be trained to construct the building models, 1:10 in scale, that would be subject to testing in the shake table experiment. The engineer then facilitated the PNY team to fabricate a Shake Table Ahmedabad.

NSET- Nepal

Bageswor -India

Shake Table Demonstration by PNY Team

Subsequently, three masons and led by an engineer from PNY came to NSET-Nepal, Kathmandu and acquired the skill of fabricating the materials required for the model. They constructed one model: a prototype of Patanka house and conducted a demonstration test in front of NSET officials accompanied by journalists of Nepal. The event was widely covered by the daily newspapers including television channels in Nepal. The PNY team also conducted a shake- table test in Bageswor, Uttranchal, India. All these events not only imparted the required skill but also motivated them to keep on working on the technology. Back to their workstation they transferred the skill to other fellow workers and the improvement cycle was even more vitalized. The technical assistance from NSET-Nepal has so far upgraded the skill of 60 Gujarati masons including 20 from Patanka.

3.2.3 Upgrading Construction Quality

3.2.3.1 Workmanship

It was observed that the working masons including the beneficiaries did not clearly understand the importance of seismic- resistant components and the techniques of construction. Under- consumption of cement and presence of honey -comb in the newly -built walls evidenced it. Even after the intervention started, the people were not following the instructions properly. The Nepali masons were strict to dismantle the wrongly- built walls and reconstruct it properly. It was necessary to make the owners understand the effectiveness of the technology being used. At the same time the masons also needed to understand the techniques of incorporating seismic- resistant components properly.

3.2.3.2 Quality Control

NSET-Nepal team leader started with quantity assessment of the materials required for various stages of the buildings. It was revealed that a building completed with 42 bags of cement would consume not less than 75 bags if properly built. He developed a format to calculate the quantity of building materials based on length of the foundation. This worked as a basic tool to calculate the materials required for various components of building once the size of the building was finalized. This was used immediately to monitor the ongoing construction activity.

3.2.3.3 Bar- Bending

The masons were finding it difficult to bend the bars precisely. A set of bar bending die and a workbench was prepared. Nepali masons then took the lead to transfer the skill of bar bending by using the tools. Plough was easily available with each household, as they were farmers. The plough was used to make a workbench for bar bending. This made the work more easy and produced accurately -bent uniform reinforcement bars. A single vertical reinforcement bar at the center was placed instead of a bar at the end of each wall. This also simplified the construction process and eliminated the errors.

3.2.3.4 Stonecrete new construction material

Stonecrete block was introduced for the first time in Patanka. Stonecrete block is a masonry unit that can replace the stone masonry wall. Stones of irregular shape and size are embedded in lean concrete and compacted in a standard size of mold. It has to be cured with clean water for about two weeks. These units are laid in cement mortar to build a wall. Stonecrete block walls are normally used to optimize the wall thickness and reduce the construction cost without decreasing the strength and durability. The same process of making stonecrete blocks can be adopted to cast stonecrete walls eliminating the process of fabricating stonecrete blocks. One of the Patanka residents preferred the idea of stonecrete wall and used it to construct his building. Stonecrete wall was found to be about 30% cheaper as compared to the prevailing walling system.

3.2.4 Seismic Strengthening Of Existing Buildings

There are about thirty buildings built immediately after the earthquake without incorporating seismic resistant components. These buildings need to be retrofitted to make them safe against earthquake. Further, some damaged public buildings can be retrofitted. PNY has plans to retrofit these buildings. Enhance the skills of Gujarati masons in earthquake resistance construction seismic retrofitting is an important element. It is clear that without retrofitting skill the masons would not be fully trained. SEEDS and NSET-Nepal have agreed to undertake retrofitting skill transfer through NGMETP. The details are being worked out and will be implemented at an appropriate time.

3.2.5 Training Programs

NSET-Nepal has developed a training module to train new masons as well as for skill upgrading of practicing masons. NSET-Nepal has also provided SEEDS a tentative outline of the training program. This outline is being jointly developed to make training manual appropriate to Patanka. SEEDS is preparing detailed program of reason training event in the near future.

A shake table to demonstrate the effectiveness of earthquake resistant components in a building was recently fabricated in Ahmedabad with technical input from NSET-Nepal. This will be one of the major tools to train the masons in earthquake resistant construction technology. SEEDS conducted a successful demonstration of the shake table on July 22 with technical input from NSET-Nepal and in association with KASSAR Trust, the local NGO in Bageswor in Uttaranchal, India.

3.2.6 Exchanges Visit

The first team of Nepali masons worked for a couple of months as it was necessary to streamline the ongoing construction activities. The engineer from NSET-Nepal returned after streamlining the intervention and organizing logistics to the masons in coordination with PNY technical team.

A visit to Kathamndu was organized for a team of Gujarati masons. An engineer led this team which included one supervisor and two masons. The main objective of this visit was to interact and learn from the experience of various stakeholders involved in the seismic retrofitting works being implemented in Kathmandu by NSET-Nepal. They visited different school building projects under School Earthquake Safety Project (SESP) acquired relevant information. This was very useful for the team as they had the opportunity of working in an entirely different situation. The team returned with a high spirit and a feeling of dignity and increased self-confidence. This worked as a motivating factor to improve on what they were doing in Patanka.

During the Earthquake Safety Day 2002, one of the directors of SEEDS along with the PNY project architect visited Nepal. The main purpose of this visit was to present a joint paper on the activities of PNY in the symposium organized by NSET-Nepal in Kathmandu. The team also visited the Earthquake Safety Day Exhibition ongoing in Kathmandu. Demonstration of series of Shake Table Test was the main attraction of the exhibition. The team was highly motivated by the experiment and decided to fabricate a shake table in Ahmedabad to carry out similar demonstration to train their masons in Gujrat. NSET-Nepal heartily accepted to provide technical assistant for this endeavor.

A new team of Nepali Masons replaced those in Patanka. This was done so as to expose an maximum number of masons for mutual benefit. They carried out similar activities. Their main task was to train maximum number of masons and assist in monitoring and supervision of the ongoing construction.

A team comprising of the president and two engineers from NSET-Nepal visited Patanka during the third week of December 2001. This visit was done at the eve of the first Shake Table test organized in Radhanpur by SEEDS in association with National Center for People's Action in Disaster Preparedness (NCPDP), India, other NGOS and professionals working in the field of Earthquake Engineering. An interaction program with the masons being trained was conducted in Patanka to assess their upgraded skill level. The program reveled that they had developed better understanding and this was reflected in their work. However, there was still some room to be improvement though the construction quality achieved more was much better than as compared to the initial stage.

The General Secretary of NSET-Nepal visited Patanka on the last week of December 2001 to get the first hand exposure of the ongoing rehabilitation activities. The duration was matched to the second Shake Table test in Radhanpur.

In February 2002 the NSET-Nepal engineer visited Patanka. Main objective of this visit was to work out details of the foreseen masons training program and facilitate the fabrication of Shake Table for the demonstration of effectiveness of earthquake resistant components. A training outline was developed which would be worked out in detail by the PNY team in coordination with the Nepali engineer.

A team of three masons led by an Engineer from Patanka came to Nepal to acquire the practical details of fabricating shake table and demonstration procedures during the second week of June 2002. The team learned to make the bricks and blocks to make the model for the demonstration. They made a model of a typical Patanka house and conducted shake table test in front of NSET-Nepal Officials and a couple of journalists. The event was covered by most of the major Nepali Daily Newspapers including one of the TV Channels. This team also departed Nepal with a sense of dignity and a lot of encouragement including an increased level of self-confidence.

4 Impact

It was quite difficult to define precise indicators for the impact assessment during the conception of the program and it was tried as an experiment. This experiment of the new approach worked out to be one of the effective ways of technology transfer. The ever increasing and encouraging positive impact on PNY was one of the major factors of continuing NGMET in the second phase.

At this level, the positive impact of NGMET can be clearly observed at three major levels. One of them is in the community level, the other is in the attitude of the masons trained and the most important is construction quality and safety level of the buildings reconstructed.

The community members have now a better understanding and faith on the construction technology introduced. They have accepting the fact that better construction process is important than having internal a thicker wall. The wall thickness in many cases are reduced to 14” from 18” thickness with stone masonry in cement mortar. This has not only reduced the rehabilitation cost but also would certainly contribute to the overall economy though in a small scale. This acceptance on the technology and availability of the skill human resources will certainly result in better sustainability of the technology.

The masons, who were initially confused and reluctant to the technology, are now confident on their work. Their performance in much better, However, The masons are becoming more and more popular. Their acceptance and demand by the community is not limited to Patanka, which has widened their employment opportunities. This is reflected by the fact that the people outside Patanka re looking for masons trained in Patanka to construct their buildings.

Most importantly, the construction quality, strength and durability including the safety level of the buildings, have been drastically improved. It is true that even without NGMET the masons would have incorporated the seismic resistant components in the reconstructed buildings. However, one could always doubt on the effectiveness and efficiency of such components

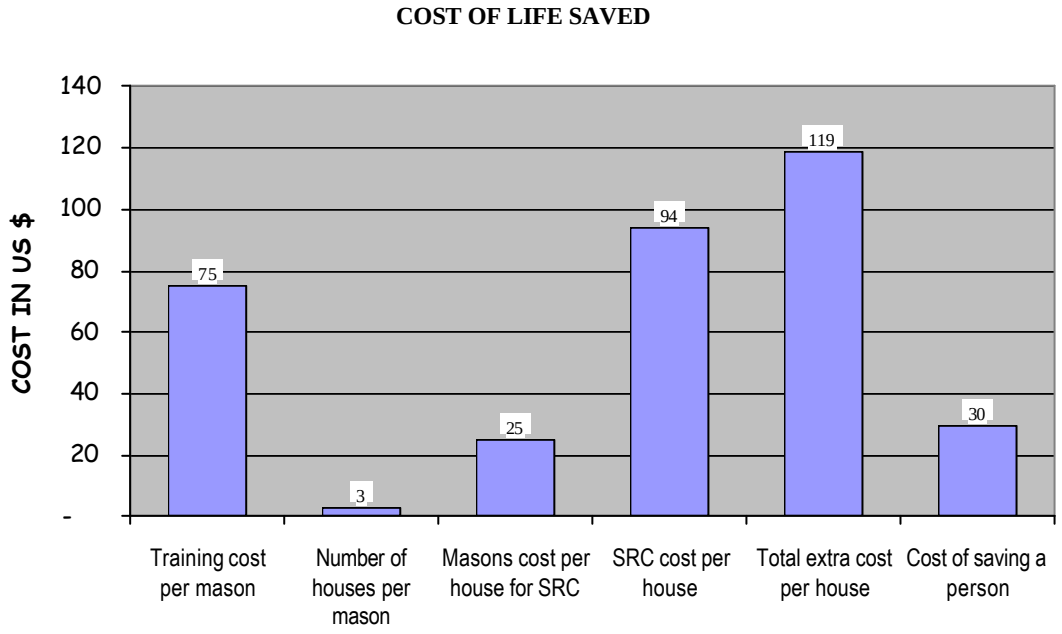
provided in the dwelling units. It was observed that the damage ratio of these buildings would be reduced from an existing more than 100% to about 35 %. In this case the resources spent on this part would not be as beneficial and effective as it has been possible with NGMEP. Certainly, it will be unrealistic to claim that the damage ratio is achieved to an absolute zero level. But in case the same intensity earthquake repeating in Patanka may be reduced to a single digit, which is a great achievement.

5 Achievements

PNY has so far facilitated 110 household families to reconstruct their houses. They are now happily living in the earthquake- resistant houses.

60 Masons in of Gujrat have been trained for earthquake resistant construction technology through NGMETP. 20 of them are from Patanka itself and the remaining 40 are outsiders, mostly the Patan District. This group of trained masons will not only enhance their employment opportunity but also contribute to the quality of construction, strength, durability and safety level of the buildings to be built even after PNY. As in Nepal, they will continue building houses with the new technology. It gives a better enhance for sustainability of the process. Thus the technology introduced has been better sustainable.

The major achievement is the increased level of safety of buildings in a very small cost. This was possible only with the training of masons which cost a mere US $ 75 per person. One mason on an average was engaged in 3 houses. Thus the extra cost incurred by the training component of NGMET per house was only 25 US Dollars.



The average cost of construction per house is US $ 1000 including US $ 94 for the seismic-resistant components. The extra cost of building spent to attain the seismic safety including the mason-training component of NGMET totals to 119 US Dollars. This amount spent will save the persons living in the house. Assuming only four members per a household family, the cost of saving a life is as small as US $ 25.00

6 Replication Potential

Masons play a vital role in the quality and safety of building construction including the effective and efficient use of building materials and construction technology. No matter how good and safe the design may be it is the masons who translate the paperwork planners architects and engineers into the ground. Effective communication and proper understanding between the masons and the engineers is a primary requirement for effective and efficient use of construction technology. Engineers need to learn to use the language that the masons can understand as the masons can not be expected to speak the engineer's language. This is because they have a completely different level of understanding. This is the major factor affecting the technology transfer process. NGMETP has proved to take this point into full attention so as to convert a dream into reality. Gap in between the understanding level of engineers and masons of the entire south Asian reason is very prominent. Thus it has a great potential of replication this process. Obviously it may require being adapted to suit the context of the area being replicated.

7 Major Lessons Learnt

The mass construction activity in such a community rehabilitation and reconstruction is not merely a technical issue. It is interlinked with the social, economic and above all human behavior and attitude.

Effective implementation of such a community participatory project should be dealt with a holistic approach and not confined to technical aspects alone. In other words, it is a process-oriented endeavor rather than product oriented project.

An effective technical intervention is possible with the technological exchange approach at the grassroots level.

Language is not a barrier to the technology exchange.