PROMOTING SAFER BUILDING CONSTRUCTION

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ABSTRACT

The maximum loss to life and property in the Asian Region, due to frequent occurrence of natural disasters, dictates the need for the evolution of safer habitat, which can respond and resist the loads, forces and effects due to the natural disasters. This becomes imperative in the context of huge socio-economic loss to nations. Therefore, all efforts are to be promoted and nurtured for safer building construction to take care of normal loads and forces and the effects of natural disasters.

This can only happen when an enabling environment is created for effective techno-legal and techno-financing regime for effective building regulatory mechanism for creating safe habitats. With large part of the communities belonging to low income strata, with people driven construction processes, appropriate grass root level technology transfer initiatives should be put in place for creating awareness, appreciation and application models for using disaster resistant and cost effective building technologies. The multi pronged strategies to create safer habitat, as a people's movement would need massive community participation and use of media, governmental and technology back up delivery support.

1. Introduction

The Asian Region is extremely susceptible to natural disasters and attended hazards, be it due to earthquakes, cyclones/typhoons, landslides, floods or droughts. The developing countries are increasingly exposed to the risks with rapidly growing population. The annual economic loss due to disasters has been showing a major increase in the decades from 1950 to 2000. In 1950, slightly more than half the urban population at risk from earthquakes lived in developing countries. In the year 2000 the numbers have increased to 85%. The average economic loss was $ 4.9 billion in 1960, increasing to $ 9.5 billion in 1970, had shot up to $ 15.1 billion in 1980 and with a five times multiplier in 1990 this has come to $ 76 billion. The Kobe earthquake registered loss of $ 191 billion. The cost of weather related disasters in 1998 exceeded the cost of all such disasters in the decade of the eighties.

The socio-economic costs of such disasters have long-term repercussions on societies. Creation of safer habitat to deal with the vulnerability risks due to natural disasters, therefore, assume significant importance. The January 2001 earthquake in Gujarat caused deaths to over 10,000 people, while the earthquake of slightly larger intensity in February 2001 in Seattle caused death for 1 person that too of heart attack. Earthquakes do not kill people. Unsafe buildings do. The Gujarat and Seattle examples clearly bring out the reason for this differential impact - while in Gujarat no serious effort has been taken to create safer habitat, in spite of the fact that Anjar (in Kutch) had a major earthquake in 1953, replicated again in 2001, Seattle had an excellent track record for safe building construction to take care of the earthquake risks. This was possible due to a well-documented earthquake resistant construction based building code with strict enforcement. The damages to the buildings have been marginal, the life loss next to nil. In comparison in Gujarat nearly 0.8 million houses have been fully or partially damaged and life loss considerable. India with over 1 billion of the world's 6 billion population is one of world's disaster prone country with 85% of the country's land being vulnerable to one disaster or the other. Nearly 190 of 590 districts of India are multi- disaster affected. Gujarat had the CDEF effect with cyclone, drought, earthquake and flooding affecting one area after another. Orissa had the super cyclone, followed by drought and then the floods in one cycle after another.

While many countries have developed sophisticated national / state (province) / city level building codes with special disaster resistant design and construction codes, the implementation/enforcement at the local

level has been more of an exception than the rule. While the codal provisions have been 'recommendatory', these did not have the 'mandatory force' for its enforcement. In short, most of the developing countries in the Asian region suffer from the lack of an effective techno-legal regime and techno-financing regime. Further, in the developing countries context in the Asian Region, nearly 70% belong to the economically weaker sections and low income group neighbourhood. This group deals with the building construction activity with people driven initiatives, in urban and rural areas, without the association of professional technical personnel, be it architects or engineers. Therefore, there is an imminent need to bring into force simple, user friendly, non-engineered construction practices for use by the community and the construction artisans. There is also demand for creating grass root level technology transfer mechanisms for translating technical 'know-how' to hands on 'show-how' practices.

2. Imperatives to Promote Safer Building Construction

The extent of damages to buildings and infrastructure, in disaster affected areas is colossal. These are primarily due to the fact that the buildings for various uses like residential (housing - individual and group housing), educational (schools, colleges, places of learning), institutional (health centres, hospitals), assembly (community centres, cinemas, auditoria, terminals), business (offices), mercantile (shopping, trade, commerce), storage (warehouses, godowns, sheds), industrial (factories, production units) are all damaged partially or fully due to unsafe design and construction from natural disaster related forces and effects. While these buildings could well be safe from dead and live loads and forces, these are not planned / designed / built to take care of the lateral / other forces due to earthquakes (from below the ground), wind load (forces above the ground), landslides, storm surges / flooding etc. Equally bad are the structures for infrastructure for water supply (water tanks, distribution network), electric supply (electric towers, transmission/distribution system), sewerage (treatment plants), electrical installation, communication / transportation (telecommunication network, roads, bridges, railway lines/systems, airports, ports, bus terminal) etc.

The unsafe structures from the point of earthquake forces and effects, cyclonic wind loading and forces etc. contribute fully to the damages due to structural deficiency in design and unsafe construction features. These result in structural collapse resulting in massive loss to life and property, leave alone the continuing economic loss due to the havoc caused by disasters. The nature of damages in traditional construction with large masses and heavy traditional / vernacular stone/brick masonry construction and heavy roofing systems further affect the lives of people carrying out various vocational activities.

The cyclonic/typhoon damages in the coastal towns and villages of Bangladesh, Philippines, Vietnam, Island countries in Pacific, Kutch Region in western parts of India, Andhra Pradesh, Orissa in eastern parts of India, flood havoc in China, Vietnam and India and raising to ground piles of rubble and concrete in earthquake affected areas in Japan, India, Nepal cause incalculable loss to property and life. Hundreds and thousands of houses get destroyed making the people homeless. They are to be immediately rehabilitated in make shift temporary relief shelters for quite some days, months and even years till regular alternative permanent safe housing units are constructed / reconstructed or repaired either in the same location / alternate locations.

The construction of health and educational facilities has an immediate impact for the young and the old, the sick and injured. After the massive earthquake in Gujarat (India) with over hundred thousand people wounded, injured with minor and major health setbacks needed immediate medical care and treatment. Some of the structures which collapsed first were the hospitals, health centres, whereas these should have had a stronger and longer structural life than other buildings. Even the school buildings, community centres which would have otherwise served the need for temporary healthcare units were destroyed. The powerful message was that the community asset public buildings under no circumstances should be built, without the structural safeguards to deal with all situations in normal / peaceful times but also during / after disasters. This effectively resulted in the lack of facilities to give the much needed medical treatment and healthcare. Therefore, make shift tented health facilities including operation 'theatres' had to be created on an emergency footing. The total collapse of industrial structures and production centres with its attendant damages to plants / machinery / production system result in bringing the industrial / economic activity to a grinding halt. The port towns in many countries have witnessed total damage to

the jetties, berthing areas, hoists, cranes, warehouses, godowns affecting the commerce / trading activities.

The damages to all the utility infrastructure (water supply, sewerage and sanitation systems, power supply, gas supply, telecommunications, roads, bridges, railways) bring in a larger compounded effect in not only physical damage to basic utility services but also enormous challenges to the authorities to make alternate arrangements. In many cases this leads to environmental hygienic and pollution related after effects including outbreak of epidemics. The large scale damages to roads, telecommunication system made it impossible to access many marooned villages after the super cyclone in Orissa.

In all the above case, the loss is not only in monetary terms, but also in terms of the time taken to rehabilitate / reconstruct the buildings(s) / physical infrastructure and also rebuilding socio-economic activity and to bring in normalcy.

It is clearly seen that if 100% additional costs are to be incurred in the post disaster reconstruction and rehabilitation efforts to set right the earlier unsafe buildings and structures, easily 90 to 95% expenditure could have been saved if only in the pre-disaster situation, additional features for safe buildings/structural strengthening were attended to or provided for to cater to the disaster risk needs. Scientific analysis have established that the additional costs for the basic safety features for A,B,C,D,E (anchorage, bracing, connection, ductility and detailing and environment protection) and strengthening for structural stability / sufficiency amount to only around 5 to 10% over the original conventional costs of construction (without taking into account safe and disaster resistant construction features).

The imperatives for promoting safe building construction in the context of disaster related structural and non-structural risks are:

a) saving of precious lives of human beings and animals;
b) saving of limited, costly and scarce resources of building materials and money (finances) for the loss of buildings, properties and infrastructure;
c) reduction in economic loss to the community / nation(s) due to its negative impact on economic/industrial activity and social and welfare areas like health, education and community well being;
d) reduction in huge loss of time element in planning, design, reconstruction phase lasting from 1 to 5 years or more;
e) reduction of trauma, physical and mental ill being of the affected community due to shock/fear psychosis of rebuilding life amidst the mound of ashes and rubble; and finally
f) providing confidence level among the community about the safe, strong, durable conditions of the houses, schools, health centres, community centres, offices, commercial establishments, industrial production units in normal times and disaster times (during and after).

3. The Elements of Promoting Safer Building

An in-depth analysis of the various elements that can help promote safer building construction identifies the following three critical areas of action:

(a) Awareness:

Most of the communities are not fully **aware** of the vulnerability of any city, town, village to disaster proneness (wind zone, seismic zone based on vulnerability atlas etc.) and the attended risks, the effect and impact of loads, forces due to disasters on the different elements and types of buildings made of different materials. The location specific damage that could be expected and the risk mitigation actions that should be taken for a safer habitat are beyond the general knowledge level of community. While at the Governmental and Professional level, there could be a larger awareness of the situation, even here specific action areas have not been forthcoming.

Take the case of Gujarat (India) disasters in the last three years. Heavy cyclone damages three year back (1999), was followed with massive earth quake damages one year back (2001). The scientific /

professional community are aware of the high wind zone in the Western Gujarat / Kutch Region. (IS:875* and NBC*). It was also very clearly known that Kutch Region is in Seismic Zone V, Rajkot and Saurashtra Region in Seismic Zone IV, Ahmedabad in Seismic Zone III (IS:1893*, NBC). The Anjar (in Kutch District) earthquake in 1953 was a recent event for at least one generation to be aware of. Yet the extensive damages to the life and property during the cyclone, floods (in Morvi), earthquake indicates that there is a clear lack of general awareness among the stake holders to take appropriate action for planning, designing and constructing the townships, neighborhoods and buildings of various uses with all safety features and risk mitigation measures. Equally lacking has been the awareness and action areas on behalf of the building regulatory authorities / local bodies to take care of the disaster related responses.

(b) Appreciation:

There is a lack of **appreciation** among the general public and building delivery system on the perceptible difference between safe and unsafe buildings in the context of the disaster related additional forces, loads and effects.

For example, people in Latur, (Maharashtra - India) have always believed that their houses, with massive 2 to 2 ½ ft. (0.6 to 0.75 m) thick stone masonry walls, were very strong. But the earthquake in 1993 had taught them that what is needed for earthquake resistant construction is not 'thick' but 'thin' walls of lesser mass, not 'rigid' structure, but 'flexible' structures to deal with the ground motion response. The fear psychosis, among the people that it was the stone walls that killed their families, needed substantial user friendly and credible education and guidance to appreciate that it was not the stone walls that brought damage, but the way the stone masonry / walls was constructed that was at fault. The simulating shaking table effect demonstrated at the Latur site clearly dispelled the fear on the same, by demonstrating the damaging response of the earlier structures built with original construction features with 0.6 to 0.75 m. thick walls without the linking key stones and the new 0.2 m walls of stone provided with earthquake resistant construction features of plinth band, lintel band, corner / intersection strengthening able to withstand earthquake simulated forces well. The 'appreciation' needed at the community level, professional level (building delivery group / construction artisans) is a major motivating factor to propel safer building construction practices.

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* IS:875 - Indian Standard Code on Wind Forces
NBC - National Building Code of India
IS:1893 - Indian Standard Code for Earthquake Resistant Design of Buildings

On the same count, there are some excellent responses from the people themselves, in designing and constructing the buildings, watching / observing nature and intuitively evolving solutions to take care of the disaster related forces / effects. The provision of timber / bamboo stilts for flood prone areas in Vietnam as safeguard, providing circular plan homes with wattle and daub construction for walls and sloping roofs of grass, weeds and thatches in coastal areas with high winds / cyclone effect provide an excellent aero-dynamic response. In the North – East States of India (located in highest Seismic Zone V) with frequent tremors have evolved excellent response with the traditional bamboo and timber column, horizontal braces at intervals and cladding with bamboo mats and daub (Ekra Walls), clearly providing for a structural skeletal system which is flexible and responsive to ground motion, walls with less mass, all of which contributing to a near perfect earthquake resistant construction system, rooted with traditional practices, local materials and resources. With advent of steel, cement, sheets, this has undergone modern adaptation with columns, running bands at plinth, lintel and roof level, ferrocement walls etc. The peoples' response to nature's forces in the North East India is one of the good and telling example. However this could be attributed to the frequent tremors / earthquakes of mild/ medium intensity at intervals reminding the people to evolve safe construction practices, though using traditional forms and resources.

As an important precursor to promote safe building construction in disaster prone / vulnerable areas is the strong intervention needed to create not only 'awareness' but 'appreciation' levels among the community and professional delivery modes.

(c) Application:

Safer building construction in disaster prone areas to deal with the disaster resistant features can only be ensured when there is an enabling environment for **application** of the appropriate norms for ensuring structural safety, fire safety and health safety to deal with disaster related response. The enabling environment can come through appropriate regulatory mechanism where the existing building regulatory media viz. the building bye-laws, regulations, planning standards, development control rules or building codes operating in the city or town do have adequate technical provisions to deal with the same. Equally important is the enforcement system as part of the building regulatory mechanism at the time of building permit before starting for the construction ensuring appropriate quality control during construction and at the time of furnishing completion certificates, and issue of occupancy certificate by the local bodies (municipality, city municipal corporation or other regulating agency having jurisdiction).

Techno-Legal Regime:

Unfortunately, most of the city municipalities / municipal corporations / local bodies do not have adequate provisions in the building regulatory media to deal with disaster resistant design and construction. Secondly, even where at the country level, there could be national standards and codes brought out by either the authorities dealing with standards or code formulation these remain only at the **recommendatory** level and do not have the **mandatory** force for application at the local body (city) level. India is a good example where it has one of the best and most comprehensive National Building Code brought out in 1970 revised in 1983 and the latest millennium version likely to be brought out in 2003.

The National Building Code and the related Indian Standard Codes dealing with earthquake resistant design and construction, cyclone resistant design and construction etc are extremely comprehensive. However, these are not reflected in the city level building byelaws. This is one reason why in spite of availability of national codes dealing with disaster resistant design and construction, many of the cities are suffering because of lack of appropriate building regulatory provisions and implementing mechanism to ensure that these safety features are incorporated in all new construction or insisted upon in earlier construction through appropriate strengthening or retrofitting measures. Therefore, what is needed is to have a **techno-legal regime** for providing the following:

(i) To introduce / formulate the most comprehensive provisions of disaster resistant construction depending upon the vulnerability of that city for any one or many of the natural disasters in the operative building regulatory documents. As indicated, there are 190 districts out of 590 districts in India, which are vulnerable to two or more natural disasters (earthquake and cyclone, cyclone and flooding, earthquake, cyclone and flooding, earthquake, flooding and landslides etc.). Such cities should have adequate provision to deal with the nature of disasters the cities are vulnerable for.

(ii) Introduce compliance to the above requirement as part of the building regulatory mechanism at the various stages of building permit, construction supervision, completion certificate by the owner / professional and issue of occupancy certificate by the local body and associating the right level of professionals like architects, engineers and structural engineers for ensuring the compliance depending on the nature of building (use, size, height and area complexities).

Of course, this will ensure fixing responsibility and accountability to the owner of the property, the builders, the professionals viz. architects, engineers etc for ensuring the safety criteria in the building proposals. After the Gujarat earthquake, some of the state level bodies have brought in legislative changes for ensuring the building safety for various disasters to be ensured as part of the building byelaws.

The risk based mitigation planning approach covering evaluation of vulnerability and identification of elements of risk has been done in the Sri Lanka urban multi-hazard disaster mitigation project taken up by Urban Development Authority, National Building Research Organization and Centre for Housing, Planning and Building with patronage of ADPC as part of Asian Urban Disaster Mitigation Programme.

This has led to the identification of series of risk control options for flooding, bank failure, landslide hazard for existing and future development. What is significant is the integration of zoning ordinance and spatial planning issues with the vulnerability of areas. Further the experience has helped in establishing flood prone areas as recreational and open spaces, avoiding building of new transportation routes in flood prone area, not locating new critical facilities needed for life sustenance within flood prone areas, landslide hazard zones, introducing slope stabilization techniques, creating and clearing by hydraulic paths, creation of public awareness, evolving shelter development training programmes to deal with safe construction practices for the above hazards and risk perceptions. The landslide hazard zonation mapping developed with the assistance of UNCHS / UNDP is yet another important initiative which is now proposed to be expanded to new city centers, municipality areas and divisional secretariat areas. Specific guidelines for site location and selection and the mitigation of landslide risk is another expected output.

The study of school building project damaged due to typhoons and floods in Thailand by a multidisciplinary task force has identified comprehensive design criteria for general guidance for the design of prototype school buildings. The step by step procedure to evolve the design criteria to deal with the flooding and wind pressure has led to the formulation of comprehensive structural design procedure for school buildings.

However, while the above requirements could be strictly enforced and made applicable to all building constructions (existing and new), it is not always possible to have uniform application in every city, small town and villages. There are enormous amount of construction being done by people themselves without going through the formal building permit and without the association of the architects or engineers and being executed with local artisans (masons, carpenters, small or petty contractors). These could be smaller structures of either single or double storied nature, mainly residential in character. Further, these constructions do belong predominantly to the weaker section, low income group, disadvantaged and marginalized groups. It is this group that require to be specifically targeted for providing them with the right level of 'guidelines' or still better 'guidance' for ensuring disaster resistant construction. Detailed structural design need not be carried out. However, based on the principles, the appropriate strengthening and construction features can be incorporated for compliance. India has the comprehensive design codes for earthquake (IS:1893) and in respect of 'non-engineered' construction based on the principles in IS:1893, a detailed construction code is available through IS:4326. This only stipulates nature of construction features from the foundation, walling, roofing and the inter connecting areas. The earthquake resistant features which can be applied for single storied, two storied construction made of mud, stone, bricks, timber etc. are identified. Such user friendly provisions can be disseminated through various demonstration units in public asset buildings and model houses so that the needs of over 60% construction done by people themselves without associating the professionals can be met in the actual construction practices.

Do(s) and Don't(s):

Equally important are the very useful pictorial brochures (folders), which identifies the **wrong** construction features, which are not to be utilised and which had contributed to damage and destruction and at the same time indicate the **right** construction features, which are disaster resistant. These have been evolved for earthquake resistant construction, cyclone resistant construction, flood protected construction and are extremely useful in pictorial and graphical forms, which can also be utilised by semi-literates. The details are available for all elements of construction. These are normally provided in local vernacular languages with very limited printed textual form but with more graphical (pictorial) form. These are printed and circulated very widely and freely. Further, wall posters of the same are also displayed in many public offices, office buildings and public asset buildings where common people have access.

Representative brochures are given in Annexure I, related to earthquake resistant, cyclone resistant and flood protected construction programmes.

Techno-Financing Regime:

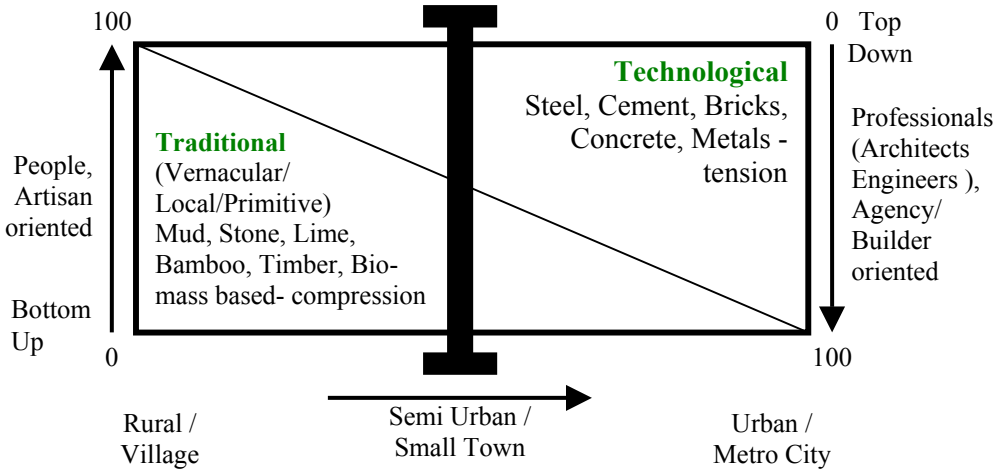
Another important instrument that can be utilised successfully for ensuring and promoting safer building construction is through the **techno-financing regime**. All building construction done by the public sector, private sector, corporate sector, co-operative sector, joint sector, community sector and individual sector do depend upon funds to be raised from either government, financial institutions, micro credit organisations, housing finance companies, mortgage backed loaning institutions etc. The financial institutions are equally keen when funds are advanced to ensure that the safer building construction is promoted so that not only a good product of a safe building is constructed but will also ensure the safer life of the building for a long period of atleast 15-30 years depending upon repayment cycle for housing or building loan. With this in view, many financial institutions are now insisting that the depending upon the location of construction and its vulnerability of the location to any or many of the disasters, the financial institution could insist as a condition to ensure incorporation of disaster resistant features in the actual construction before the loan is sanctioned/disbursed. This has proved to be extremely useful in the case of Housing and Urban Development Corporation Ltd. (HUDCO) of India where the techno-financing regime is strictly insisted upon for proposals for building construction from vulnerable disaster prone cities or towns. This is now being increasingly adopted by international financial institutions like World Bank, Asian Development Bank, JBIC, KfW etc.

Equally important is to use the instrument of **building insurance**. Many insurance companies and financing institutions have good tie ups for ensuring risk mitigation against all natural disasters through the payment of appropriate premia as a percentage of the cost of the house either as a one time payment or annually for ensuring appropriate risk mitigation in case of damages due to natural calamities. Obviously, as a result, many of the insurance companies who have tie up with the financial institutions (who already have a good techno-financing regime) are able to see the positive aspect of safer building construction features incorporated in the buildings and the premia for such buildings are substantially lower and the insurance companies are also increasingly coming forward to cover disaster related risks during the repayment period of 15-20 years. In many mass housing programmes for the poor and the low income categories, the insurance against natural calamities is incorporated right in the beginning with a very small premia to be paid for covering risks. The very fact the insurance companies also have come forward to cover damages due to calamity risks or disaster risk also brings in additional layer of checks and balances.

Cost Effective, Appropriate and Disaster Resistant Technologies:

There are an array of building technologies and techniques of construction depending upon the basic material form for foundation, superstructure for walling and roofing. For each of the material form (be it mud, stone, bricks, timber, cement, steel, concrete etc.) there are many alternate technology options available using conventional construction as well as cost effective (as against low cost) construction. The cost effective construction while it brings down the cost vis-à-vis functional options at the same time offers extremely strong, durable, functional and aesthetically acceptable solutions. In fact the alternate options are 'affordable and acceptable'. Many of the technologies have been developed by research and development organisations and scientific laboratories which have gone through a grill of technology validation before they are propagated to be used. In India, some good work has been done by Central Building Research Institution(CBRI), Structural Engineering Research Centre (SERC), University of Roorkee, IIT-Kanpur and Chennai, Centre for Scientific Research, Auroville, Centre for Application of Science and Technology for Research Areas (ASTRA), Centre of Science and Technology for Rural Development (COSTFORD) etc. These solutions are routed through certain **traditional** (vernacular) forms using purely local resources like mud, stone, lime, bamboo etc. and also using latest **technological** applications using burnt bricks, cement, steel and other forms of derived construction as well as intermediate, cost effective and sustainable technology options which combine the merits of time tested principles of age old good practices which have stood the test of time and the scientific application of results of research and development using many new material forms and also modern scientific knowledge on the disaster and its effects and based on intense study, research and analysis. (see chart below) :

Intermediate / Appropriate / Cost-effective/ Sustainable Technology Options



List of Cost Effective Technologies which are Disaster Resistant and with the extent of cost savings vis-à-vis conventional technologies are given in Annexure-II

Retrofitting:

This is an emerging area of technology application related to strengthening of partly damaged or vulnerable building stock affected by natural disasters to appropriately strengthen or retrofit the structural and non-structural elements of construction instead of rebuilding or reconstructing the buildings. There are many emerging retrofitting guidelines brought out in the Asian region as well as from the developed countries. The Indian standards dealing with strengthening in retrofitting of buildings for earthquakes through IS:13928 is a very good reference base and this has been used in a very major section for retrofitting of earthquake affected region with partly damaged houses for strengthening and also for vulnerable housing and building stock likely to be affected in disaster prone locations. This is especially useful for the existing building stock not provided with the right level of disaster resistant construction features.

The Federal Emergency Management Agency (FEMA) of USA has brought out a detailed home owners guide for retrofitting and is a very good reference document which can be adopted or adapted with respect to the needs of the developing countries in the Asian region.

The major efforts for retrofitting has been initiated in the construction programme of Latur as a part of major rehabilitation programme for the partly damaged and vulnerable housing and building stock. Equal efforts are now being taken in cyclone/earthquake affected areas of Orissa and Gujarat. This has also substantial potential for its application for typhoon / cyclone / flood affected areas with partial damages to existing buildings which can be retrofitted.

'Know-How' to 'Show-How':

In all efforts for promoting safer building construction based on the actual efforts providing for policy / regulatory / financing mechanisms, one of the important application area is in the actual implementation phases. Technology **know-how** are always available through codes, manuals, standards, brochures, folders etc. But what is more important is the actual grass root level application. This is an area where one of the biggest gaps have been noticed to promote safer building construction for disaster prone areas. The construction artisans be it the mason, carpenter, bar bender, tile layer, concrete work force etc. are the most important instrumentality through which disaster resistant building construction technologies can be actually translated on to the ***terra-firma.*** In predominantly traditional and conventional systems of construction, where such features are not actually applied or utilized, it is very difficult to expect from the local construction artisans to be aware of the special construction features, which provides for safer building construction from disaster risk point of view. They are normally familiar with the prevailing

construction practices, which had not been utilizing some of this safer practices. Therefore, there is a necessity for massive efforts for technology transfer on disaster resistant construction features to the construction work force and the building delivery system through artisans and small contractors dealing with the construction work. Lot of interesting initiatives have come up in the Asian region towards this. The construction workers training centre in Sir Lanka, the training initiatives through the social welfare department in Philippines, the vocational training imparted in Vietnam, the artisans training programmes in Nepal, special training programmes for cyclone / flood rehabilitation programmes in Bangladesh are good examples where safer building construction practices for disaster prone areas are specially imparted through capacity building, skill upgradation and training to the local construction work force. One of the very significant efforts in this direction has come from India through the establishment of a large network of **Building Centres** (Nirmithi Kendras or Nirman Kendras) which are one of the most effective grass root level technology transfer centres for disseminating and propagating appropriate skills to the cutting edge level for transforming the technological **know-how** through hands-on **show-how** skill formation systems. The programme started in 1988 in continuation of the work done by Laurie Baker, one of the doyens and eminent master builder in the field of cost effective construction. The institutionalisation of the building centre programme with support from the Government of India / State Governments and with a broad based participation of all stake holder agencies has grown into a very powerful network with over 640 building centres all over the country in the last 14 years. These centres take care of the following features:

- Technology transfer centre from 'lab' to 'land'
- Skill Upgradation and training centre for the construction artisans on cost effective and disaster resistant technologies.
- Building materials and component production centre using these technologies.
- Construction centre using the trained work force and the building material products manufactured at the local level for various building construction like houses, schools, health centres, community centres etc.
- Housing guidance, information and counselling centre for the local population on all aspects of cost effective and disaster resistant technologies.

The national network of building centres in India has played a very major role in disaster rehabilitation programmes of Uttarkashi earthquake (1991), Latur (1993), Orissa and Andhra Pradesh floods and cyclone (1996 to 1998), Jabalpur earthquake (1998), Gujarat Cyclone (1999), Chamoli-Rudraprayog earthquake (2000), Orissa Super Cyclone (2000) and Gujarat earthquake (2001). The concepts behind the working of the building centre has been also very well utilized by many non governmental organisations and technology transfer agencies like ASAG, SPARC, CARE, SEWA and many new initiatives in Gujarat through the Association of NGOs for propagating disaster resistant construction technologies.

Equally significant in the Core Shelter Housing Project implemented in the Philippines by Department of Social Welfare Development (DSWD) with ADPC technical assistance in 1991-1992. The social preparedness and community action through Neighborhood Association for Shelter Assistance (NASA) has helped in larger participatory involvement of the community. The technical aspects covering sequential guide to the construction, modular upgradation of the basic core shelter, quality control and maintenance issues has been important inputs in the implementation of the safe building project. The training imparted to local artisans and community to deal with the above at two levels namely the institutional and technical aspects of shelter construction, quality control and maintenance has richly contributed to the successful implementation of the programme.

Construction Medium as a Message:

The best way to disseminate and propagate technology for use of safer technologies is to use the building itself as a medium. Many state governments and local governments have now taken a lead in constructing public asset buildings of high visibility nature viz. school buildings, health centres, community centres, village offices, multi purpose centres utilizing cost effective and disaster resistant technological features incorporated n the same. Such buildings which are located along the length and breadth of the country which are accessible to the common man clearly demonstrate the various

technological features incorporated in such buildings which can be seen by the visitors and the users of such public asset buildings. These bring not only the demonstration effect and at the same time bring in the credibility for use of appropriate technologies. Some of the States popular and community development programmes for spreading education, health, social welfare etc. are using these features in a significant manner in all their building construction. Two significant initiatives that have come up are the multi-purpose school-cum-cyclone shelters in Orissa and series of school buildings, health centres and community centres being put up in Gujarat to take care of both earthquake resistant and cyclone resistant construction features. The fact that these are being funded out of a special fund available with each of the Members of Parliament, further, brings a powerful interface with the people as such buildings generate enormous amount of local participation from the community benefiting out of such building construction.

This is also good example where new construction and facilities are coming up as a pre-disaster initiatives so that a combination of post-disaster reconstruction programme and pre-disaster new construction programmes can bring in very positive impact. The community level awareness being created largely through the good work done by many non-governmental organisations with special training access has helped in creating the awareness, appreciation and application modes among the communities.

Use of Media as a Message:

The audio-visual media, electronic media and print media play a very powerful role in disseminating and propagating all the information related to the need for safer building construction, the methodology to be adopted, areas where assistance can be availed etc. With a very large network of television channels in vernacular languages the electronic media has been successfully utilized in the case of the post rehabilitation programme in Jabalpur earthquake, Orissa cyclone and now in Gujarat earthquake. This has produced a very major impact especially in small towns and rural areas where the message on safe building construction can be put across in visual form in a simple user friendly manner. This also helps substantially in getting the communities prepared to deal with any possible natural disaster depending upon the nature of disaster applicable to that location. Recently, as a result of a massive media projection in newspapers, journals and televisions there has been substantial interest generated among the common man before they acquire property from any public sector or private sector delivery mode. The consumers acquiring new housing or property are now asking the questions to the builders and developers whether the buildings are safer and strong against earthquake or cyclone. Such questioning attitude was never discernable before and this is an area of concern in the minds of the common man. This has created a large awareness on safer building construction among the general public. This is a positive augury and can be very well developed as a major strategy for action for promoting safer building construction.

Targeting the Young Professionals:

Unfortunately, the young professionals coming out of engineering colleges, architectural schools with degrees or polytechnics giving diplomas in civil engineering or architecture have very limited exposure on disaster resistant construction. This has been kept as a specialisation subject at the post graduate level for masters degree in earthquake engineering, wind engineering etc. It is, therefore, desirable to incorporate the safe building construction features from disaster mitigation point of view right in the curriculum for the basic degrees in architecture, engineering as well as for diploma courses. The exposure could be limited on the actual features of safe building construction. The higher order design and analysis features for complicated structures, tall buildings, towers can be a specialisation at masters degree level.

This need not be limited to the professional courses alone. The possibility of community level education including at the schools could be considered based on the good initiative taken in China. Community workers could also be given actual exposure on the lines of bare foot architects / engineers and they can play a very major role in the implementation at the local levels.

Quality in Construction:

In addition to the efforts taken for incorporating features of safe building construction at the planning and design stage including the building regulatory stages what is equally or more important is to ensure that these are actually applied with all its detail during the construction phase. Since the strengthening measures are identified keeping in view the structural requirements of a building, during disasters, it is very necessary that the actual building construction using masonry, RCC, steel, timber or other forms are able to reflect the structural details through specific construction detailing. Large number of buildings in Ahmedabad belonging to the high income families with multi storied condominiums got damaged primarily because the detailing needed for ground level soft stories developed as stilts for parking, did not incorporate the ductility requirements in all its details (a detailed Indian Standard has been brought out in 1993 on this subject after the Kobe earthquake and the soft storey effect) including the dimensions of the columns (the length to width ratio). During the major reconstruction programme after the Uttarkashi/Chamoli earthquake, detailed quality control guidelines for monitoring the actual application of safe disaster resistant construction practices have been framed for utilization by the field supervisors. After major cyclone, storm surges and flooding including tidal wave intrusions, the quality of water available for even upto 20 kms from the coastal region do have saline intrusion. In many cases of cyclone resistant construction in coastal Andhra Pradesh done in early 70s started showing distress/corrosion effect after a decade primarily because the quality of water used had saline content. In fact, Latur reconstruction and the present Gujarat reconstruction programmes has substantial problems on the availability of water for construction of good quality and quantity and so also are the problems of getting the other basic building blocks of bricks, fine and coarse aggregates. Safer building construction can only be ensured when the actual construction is done not only incorporating the special design and construction features but also using the right level of quality control measures and workmanship. This is one area where substantial amount of importance has to be given to the field supervisors. Cyclone/typhoon resistant housing in Philippines and Vietnam has brought in substantial amount of manuals for the field supervisors with all the construction detailing for the anchorages, connections (roofing material to the roof skeletal system, roof to beams and columns, columns to the foundation, bracing etc.).

The methodology to be adopted while taking up massive reconstruction and rehabilitation programme, while are taken up on an emergency war footing with very tight time schedules for speedy completion should not suffer at a later stage due to the poor quality of construction either in the use of the materials or in the construction techniques. This is an emerging area for not only the disaster resistant construction features but also for the retrofitting practices which are comparatively new for the field engineers and supervisors. This calls for substantial training and orientation programmes to the field supervisors on the constructional details / techniques of construction for safe disaster resistant construction.

4. Case Studies and Lessons Learnt

4.1 While the various elements for promoting safer building construction have been identified under 3, it would be of interest to see some specific case studies from AUDMP partnering countries on some of the issues related to safer building construction initiatives. The important issues arising of such case studies, the lessons learnt and the possible line of actions to be taken for putting into place sustainable strategies are identified below :

a) Nepal - During the implementation of Kathmandu Valley Earthquake Risk Management Project, one of the distinct observed feature was that around 90% construction are done by people with 'non-engineered' approach and 10% by 'engineered' approach and all the resource inputs on technologies, transfer efforts have predominantly concentrated on the few buildings done by organised agencies / government departments with 'engineered' approach, leaving out the majority of house building efforts of people. Another distinct feature was related to the twin thrust needed to deal with new construction needs to stop increasing risk and larger needs for retrofitting and strengthening of existing buildings for decreasing unacceptable risks. The latter is more manifest in many deficiencies noted in traditional construction using mud (adobe), stone, brick in mud/cement, frame construction. As a part of the holistic initiative, while the top down approach has concentrated its efforts

for passing 'Building Act' by Parliament, striving to implement the new Building Code brought out by National Bureau of Standards and Metrology and publication of Building Construction and Design Manual, the bottom up approach has concentrated its efforts for awareness creation and capacity building. These cover efforts for making it a participatory community movement, vernacular (Hindi) version of manuals and rules of thumb guidelines being disseminated, major training for masons, consultation and advisory guidance for house owners. At the horizontal networking level, creation of National Forum for Earthquake Safety with its efforts for Building Code implementation at Municipal level with focussed attention for pilot project in Lalitpur Sub-Metropolitan City has produced fair impact. This is further strengthened by working with Universities with internship programme at Bachelor and Masters level, including introduction of elective course on Disaster Management. The structural and non-structural assessment of hospitals from the point of providing desired building safety by working with WHO and Ministry of Health has produced productive results.

As a result, the thrust is proposed to be given for creating awareness that leads to increase in demand for safer buildings backed by imparting accompanying skills for artisans. The two pronged strategy is to assist earthquake resistant features for new residential construction and also strengthening and retrofitting measures for existing buildings in general and community asset public buildings in particular. Equal emphasis is proposed to be given to back up efforts for enforcement of building code and laws by actual application efforts at community level with thrust on transfer of technology on all strengthening features for foundations, walls, roofs. A major education programme is advocated to cover school earth quake safety programme, teaching teachers, children on response actions during / after calamity, raising awareness of households and community on safer earthquake resistant building construction.

b) Sri Lanka - Under the Sri Lanka Urban Disaster Management Project (SLUMDMP), a holistic approach had been initiated for ensuring safer building construction practices in Sri Lanka to cope with disaster effects. Special guidelines for construction in disaster prone areas with the main aim of reducing damage caused by improper construction practices and guidelines for stabilisation of areas prone to landslide disasters in local languages has helped the local communities to have a realistic understanding on the way to deal with development and construction. Sri Lanka has given a major thrust on training and awareness creation to all stake holders in the housing delivery process covering engineers, technical officers, supervisors, contractors, craftsmen and individual home builders. The training for artisans have been undertaken under "Livelihood options for Disaster Risk Reduction in South Asia" by Nawalapitiya UC, NBRO and ITDG South Asia. Other levels of technical personnel have been covered under various training initiatives. Further public awareness has been created through seminars, distribution of brochures, leaflets, TV/Radio Programmes, Newspaper Articles. With a view to create legal framework for safer building construction practices, necessary amendments in National Disaster Management Act, Urban Development Act, National Physical Planning Act, Town and Country Planning Act, Construction Industry Act are taken up. Action has been initiated in Sabaragamuva Province Provincial Council to make disaster mitigation mandatory through inclusion of a section in the Provincial Environment Act. Similar efforts to replicate this in other provinces has been taken up by the Sri Lankan Government with other provinces. One of the significant achievements under SLUMDMP has been the integration of Natural Disaster aspect into the land use policy developed by the Ministry of Lands, to reduce natural disasters through effective land use based on hazard mapping for landslide, floods, coastal erosion, cyclones, lightning. Further, this has been incorporated in the goals and objectives of National Physical Planning Policy and Western Province Regional Structure Plan. Under the replication phase in other cities / other provinces the Government has taken up formulation of comprehensive Building Code, preparation of detailed guidelines for disasters and operationalisation and strengthening the legal framework for enforcement of the guidelines with mandatory back up support during planning, designing and construction in disaster prone areas.

c) Vietnam - The massive damages to housing and public asset buildings due to frequent floods and typhoons have led to major structural and non-structural mitigation measures by the Government. The many ordinances for structural mitigation for dykes, embankments, coastal revetments have substantially helped in the massive protection measures against inundation, flooding. The Mekong Delta Redevelopment Ordinance has evolved the strategy for safer building site development and safer housing construction programmes. While many of the traditional / local practices using timber columns, trusses, beams, wall / roof covering using various permanent / semi permanent material options have been prevailing, the nature of strengthening needed to cope with floods / typhoons have been identified by the Ministry of Construction (VNCC). Further, as a result of many initiatives taken up after major floods / typhoons in the nineties, the need for construction of safer houses with all strengthening features has been identified in the house reconstruction programme of IFRC, VNRC, OXFAM (London), CECI (Canada), CRS, Development Workshop (France-Canada). However, these initiatives have been taken up to cover the needs of the poorest of the poor and some of the weaker sections and low income households. Most of the solutions had a stress for building up stronger construction using steel, concrete options. Around 12000 houses have been constructed using these options. While these efforts have helped in getting safe, strong core house structural frameworks in position, there is an increasing awareness and understanding that to provide sustainable solutions to the larger needs of Vietnam, it is necessary to provide a combination of technologies using local materials and construction process with the technology upgradation with some modern materials as well. The need for training and transfer of technology to local builders and communities is a strongly felt need. The building up of a techno-financing model for larger coverage of low income population with affordable housing design models is also identified as a thrust area.

While these are the national concerns, some good initiatives have taken place through some of the donor / Development Workshop work by reducing vulnerability / damage to houses by strengthening houses using improved techniques which exist locally and also ensure strong local participation in cash, kind and labour. The major action areas have been to strengthen the capacity of the community by getting the message across to the community by developing practical skills and debate on safe building and demonstrating accessible preventive strengthening. The project has successfully promoted ten key points of storm resistant construction through illustrative, graphical brochure/posters. Among the many innovative measures taken to get the message across to the community through animation, mobilisation and motivation, has been the efforts through concerts, theatres, lotteries, posters, fans with message, clothes, loud speaker announcement, TV and press. The theme of preventive strengthening and techniques have been demonstrated in schools, markets, safe haven port. As a result of working with schools, the theme of strengthening has been introduced into school curricula and training for teachers, drawing competitions, parades in the community about typhoons and damage prevention. As a part of civic capacity building, events have been organised to advice on preventive methods with the help of Community Damage Prevention Committee, Women's Union, Farmer's Union etc. All these have helped an enthusiastic commune engagement. This was backed up by developing practical skills to village builders and local communities as a participatory training process. It covered typical strengthening for attaching roof elements together, holding down roof coverings, providing shutters, doors, tyeing the structure together. The theme of "Vaccinate your home against the storm" has left a powerful message and impact with the needed skills to strengthen and protect the houses / buildings with safe building construction practices and more importantly helped families and local authorities to work together and contribute their time and technical and financial resources to apply to achieve the message of the project. It clearly defines the need for reinforcing the message in scale, frequency for large-scale application.

d) India - While some of the initiatives taken in India has been highlighted under 3 covering elements to promote safer building construction, some specific examples on efforts made in Maharastra, Gujarat, Uttar Pradesh through the efforts of governmental and non-governmental organisations have helped in promoting safer building construction. "Putting

Safety in Peoples' Hands" seem to sum up the powerful message behind the work of Swayam Shikshan Prayog (SSP) a developmental NGO, which has worked actively in the earthquake reconstruction programmes in Latur, Maharastra and Gujarat. SSP's strong conviction is that safety and security of people can be ensured only when the affected communities or vulnerable groups determine their priorities and control the use of resources (material, finance and human). This is to ensure active participation of affected communities for creating safe settlements that are sustainable. The focus is to promote safety principles and construction workmanship among the community. This further encourages in instituting community self supervision mechanisms and evolve collective construction management arrangements and especially build capacities of local women's groups in onsite supervision and management. The major action areas lay in diffusion of earthquake resistant housing technologies through people's information campaign, reorganizing and empowering women's self help groups and strengthening community institution of local governance bodies for effective decision making. This is fully backed up with demonstration of earthquake resistant technology and on the capacity building of homeowners and masons through building community resource assets.

Similar efforts has been successfully demonstrated by another leading NGO - SEEDS in the Gujarat Earthquake Rehabilitation Project, as a joint involvement of government - NGO - community under the Patanka Navjivan Yojana (Patanka New Life Project) in District Patan, Gujarat. The focus is to empower the individual and community with knowledge on safe disaster resistant construction features with right level of information and training to masons. This has helped in creating capacities among communities in ensuring safe building construction. SEEDS is also working in Uttaranchal State on hill related disaster response needs.

At the macro level are the efforts of Gujarat State Disaster Mitigation Authority (GSDMA), at the state level to bring out a holistic package of strategies by bringing the enabling legal framework for safe building construction to deal with earthquake, cyclone, flood safeties as part of the building regulatory mechanism through ordinance in building byelaws, to bring out the technology packages for safer building construction with various technology options for new construction for fully damaged building (G5), strengthening and retrofitting of partially damaged vulnerable buildings (G1 to G4 classification), demonstration through publication / dissemination of over 1 million illustrative user friendly brochures and guidelines in local language - Gujarati, massive training programme to cover 6000 engineers and over 25000 artisans on disaster resistant construction / strengthening features, with the help of technical institutions, network of building centres. The strategy also covered forging partnership with NGOs, CBOs, Private Sector Organisations in the massive programme for reconstruction, strengthening. As a result, nearly 1 million households could take up the reconstruction, strengthening of their fully/ partially damaged houses within the short one and a half year time period.

4.2 All of the above case studies (a) to d)) clearly demonstrate an emerging shift in focus with pre-disaster mitigation efforts with prediction, prevention, preparedness, planning, protection and publicity efforts in addition to earlier post disaster initiatives for rescue, relief, rehabilitation, reconstruction, repair, renewal and retrofitting for promoting safer building construction.

5. Issues to Consider

With a view to promote safer building construction for disaster affected / disaster prone areas, it is desirable to evolve appropriate strategies and approaches for achieving the same. The issues to be considered and the way forward in promoting the same are the following:

1. Creating awareness on vulnerability for hazards: Does the country, the state (province) or the city, the town or the village have appropriate awareness on the nature of vulnerability against any or many of the disasters? If not, the action plan for creating such awareness has to be evolved.

2. Establishing Techno-Legal Regime:The methodology to be adopted for creating a techno-legal regime by evolving disaster resistant safe building construction features in the building regulatory media is to be established. In this context the effective enforcement mechanism is to be put in place at the stages of building permit to be given by the local body, construction supervision and completion certificate stages by the professionals and builders and also issue of occupancy certificate by local body.

3. Associating the right professionals: The compulsory association of the right level of professionals will help in fixing responsibility and accountability on the owners, builders, practicing professionals be it the architect, engineer, structural engineer in the planning, design, construction and supervision stages.

4. Adopting the techno-financing Regime:The methodologies to be adopted for a techno-financing regime for promoting safer building construction systems in disaster prone areas by using financing / insurance mechanism as instruments as a leverage for ensuring the same has to be clearly established.

5. Evolving appropriate technology transfer system at the cutting edge level: Evolving methodologies for technology transfer at the grass root level for safer building construction systems for the construction work force including quality control measures should be given priority attention for suitable action.

6. Instilling appreciation and concern among general public for application: Instilling awareness and concern among the general public and the community on the theme of safer building construction is a pre-requisite for ensuring larger public participation and application. Effectively this will lead to "putting safety in people's hands"

7. Bringing out user friendly models for promotion of 'non-engineered' construction systems:
Bringing out user friendly and appropriate models for application of safer building construction and the methodology for use of 'non-engineered' housing and building applications for the low income and disadvantaged groups through simple and user friendly medium should receive priority attention and action.

8. Using the media for mass dissemination: Use of media (electronic, audio-visual and print) including demonstration units for wider dissemination of actual construction features for the use of general public be given importance.

9. Creating new breed of enlightened professionals / builders: Creating the new breed of young professionals and builders with thrust on safer building construction features for disaster prone areas by giving exposure in the curriculum of architects and engineers and construction management professionals and builders for the graduates at degree and diploma level should be a priority area for technical education agencies and universities and also the building delivery professional groups.

10. Mobilising participation of civil society: Mobilising mass participation by forging "public-private-people's partnership (P-P-P-P)" including association of NGOs, CBOs, private sector, beneficiary families along with governmental institutions for promoting the initiatives of safer building construction from the `tokensim' stages to `total-coverage' across the nation(s) should be considered as an important thrust and action area for promoting safer building construction. In effect, promotion of safe building construction for disaster related situation should emerge as a "people's movement"

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Annexure-I

Representative brochure / folder with do(s) and don't(s) for earthquake resistant, cyclone resistant and flood protected housing.

Annexure-II
Cost effective and disaster resistant technologies in comparison to conventional options and extent of cost saving.

	Cost-Effective Technologies	In place of Conventional options	% of Saving
I.	**FOUNDATIONS**		
1.	Pile foundation (under reamed)	Traditional stone/bricks	15
2.	Brick Arch foundations	Footings	25
II.	**WALLING (SUPER STRUCTURE)**		
1.	230 mm Thick wall in lower floors	330 mm brick walls	5
2.	180 mm Thick wall in bricks	230 mm brick walls	13
3.	115 mm thick recessed walls	230 mm brick walls	20
4.	150/200 mm Stone block masonry	Random rubble masonry Ashlar masonry	30 20
5.	Stabilised mud blocks	Burnt brick walls	20
6.	FaL-G Block masonry	Clay brick walls	20
7.	Fly ash brick walls	Clay brick walls	25
8.	Rat trap bond walls	English/Flemish bond	25
9.	Hollow blocks walls	Solid masonry	20
III.	**ROOFING**		
1.	85 mm thick sloping RCC	110 mm RCC	30
2.	Tiles over RCC rafters	Tiles over timber rafters	25
3.	Brick panel with joists	RCC	20-25
4.	Cuddapah slabs over RCC rafters	CS over timber rafters	20
5.	L-panel sloping roofing	RCC	10
6	.RCC planks over RCC joists	RCC	10
7.	Ferrocement shell roofing	RCC	40
8.	Filler slab roofing	RCC	22
9.	Waffle roofing	RCC	15
10.	RCC channel units	RCC	12
11.	Jack arch brick roofing	RCC	15
12.	Funicular shell roofing	RCC	18
13.	Brick funicular shell roofing	RCC	30
14.	Precast blocks over inverted T-beams	RCC	25
15.	Micro-concrete roofing tiles	Clay tile roofing AC sheet roofing	20 15
IV.	**MISCELLANEOUS ITEMS**		
1.	RCC door frames	Timber Frames	30
2.	Frameless doors (only inserts)	Frames and shutters	50
3.	Ferrocement door shutters	Timber shutters (2nd class timber)	30
4.	RCC window frames	Timber frames	30
5.	RCC jallies	Timber windows/ventilators	50
6.	Precast thin lintels	RCC lintels	25
7.	Precast sunshades	Cast sunshades	30
8.	Ferrocement sun shades-cum-lintel	RCC lintel-cum-sunshades	50
9.	Brick on edge lintels	RCC lintels	50
10.	Corbelling for lintels	RCC lintels	40
	Cost-Effective Technologies	**In place of Conventional options**	**% of Saving**
11.	Brick arch for lintels	RCC lintels	30
12.	Precast RCC shelves units	Timber/concrete	20-35
13.	Precast Ferrocement shelves	Timber/concrete	35-45
14.	Ferrocement manhole covers	Casion/concrete	50-40
15.	Ferrocement water tank	Rigid PVC	60

PROMOTING SAFER BUILDING CONSTRUCTION: EXPERIENCES OF KVERMP

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Background

To date, most residential buildings (even in urban areas of Nepal) do not receive any rational design for strength. Even though most municipalities (58 altogether) do have a system of building permits, there is no provision in the process to check strength criteria. The building permit process takes into account only the compliance related to planning (ground coverage, FAR) and building by-laws (height, provision of toilet, sewer and solid waste disposal). Kathmandu and Lalitpur municipalities now require some structural drawings (not design) for buildings with more than three storeys or a 1000 sq. ft. plinth area. Thus, there is poor institutional and technical capacity within the local authorities for implementing strength-related provisions if they were to be introduced in to the building permit process.

On the professional front, too, there is no system of controlling the professional standards of engineers/designers through reference to professional qualifications/ membership, peer review process or by legal means. Owner-builders who follow the advice of local craftsmen build more than 98 % of the buildings in Nepal. Neither the owner builder nor the crafts persons are not aware of the possible disastrous consequences from an imminent earthquake. Neither do they have adequate access to information related to safer building practices and incorporation of simple earthquake-resisting features at nominal extra cost. Even the building construction projects funded by national and multilateral agencies do not spell out any requirements related to seismic safety when they hand over the terms of reference to their consultants.

"As many as 60 percentages of all buildings in Kathmandu Valley are likely to damaged heavily, many beyond repair" is the result of loss estimation during earthquake scenario preparation under Kathmandu Valley Earthquake Risk Management Project, which was implemented by the National Society for Earthquake Technology – Nepal and GeoHazards International, as a part of Asian Urban Disaster Mitigation Program of the Asian Disaster Preparedness Center with core funding from the Office of Foreign Disaster Assistance of USAID. The Project had four objectives: 1) evaluate Kathmandu Valley's earthquake risk and prescribe an action plan for managing that risk; 2) reduce the public schools' earthquake vulnerability; 3) 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) build local institutions that can sustain the work launched in this project.

The Earthquake Risk Management Action Plan, created by KVERMP included among the top 10 priority actions the followings:

NSET will request the Ministry of Housing and Physical Planning to constitute the Building Council and direct it to draft the rules and procedures for implementing and enforcing the building code, and formally adopt requirements to implement and enforce the building code.

NSET will work with the Ministry of Housing and Physical Planning and others to prepare training materials and provide training for building inspectors, masons and engineers on applied aspects of design and construction of buildings to conform to the Building Code.

NSET will manage and co-ordinate the "School Earthquake Safety Project" which will (1) inform selected communities about the vulnerability of their schools and what can be done to reduce the risk; (2) prepare school-specific plans for improvements in seismic safety; and (3) mobilize support to improve the safety of the school buildings.

NSET will encourage engineering institutes to develop and offer short courses for practicing engineers on earthquake engineering principles and procedures.

Implementation

NSET's current effort is directed towards implementation of part of the Earthquake Risk Management Action Plan for Kathmandu Valley. Among others the promoting safer building construction is one of the focus areas.

Analysis of Existing Building Construction Mechanism

With the aim to better define the problem and its mitigation NSET's approach has been to look into the prevailing building construction mechanism.

Type of building construction mechanism

There are three distinct types of building construction mechanism in practice in Nepal.

A. Engineered Constructions:

These are the structures (e.g., buildings) that is designed and constructed as per standard engineered practices. In case of buildings, engineered construction are those that are supposed to have undergone the formal process of regular building permit by the municipal or other pertinent authority. The formal building permit process is supposed to require involvement of an architect/engineer in the design and construction for ensuring compliance to the existing building code and planning bylaws. In Nepal, formal building permit process is implemented only in urban areas. Building code exists but not implemented strictly! Consideration of seismicity on building design depends upon the individual initiative of the designers and the availability of fund.

B. Non-engineered Constructions:

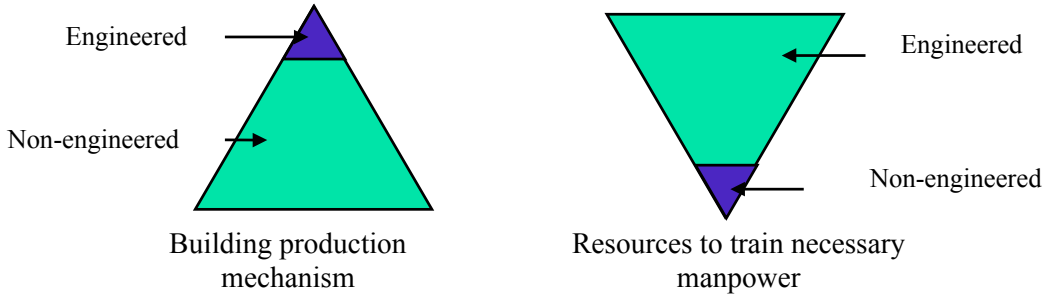
These are physical structures (e.g., buildings) the construction of which usually has not gone through the formal building permit process. It implies that the construction of non-engineered building has not been designed or supervised by an architect/engineer. Such buildings are obviously prevalent in the rural or non-urban (including urbanizing areas in the periphery of municipal areas). Although building by-laws exist and complied within municipal areas, they do not demand structural design considering earthquake effects during building permit process. Thus, a large percentage of the building stock even in Kathmandu Valley is non-engineered as the structural design is not considered in during design and there is no involvement of engineering professionals during construction phase in most of the cases. In the urban areas of Kathmandu, it is estimated that more than 90 percent of existing building stock are non-engineered (partly because there are many old historic buildings), and every year about 5000 more such non-engineered buildings are added.

C. Owner-built buildings:

These are buildings constructed by the owner at the guidance and with the involvement of a head-mason or a carpenter who lacks any modern knowledge on earthquake resistant construction. Traditional construction materials such as timber, stone rubble or brick (fired or un-burnt) and mud as mortar are used. There is usually no input from any engineer. These are usually rural constructions. However, such constructions are seen also in the poorer part of a city, or in the city suburban areas.

There is an increase in the prevalence of frame-structures now days. Unfortunately, many of them are non-engineering, which is a potentially high vulnerability situation.

Resources distribution in comparison to construction mechanism



The ratio of the number of buildings with different construction mechanism and efforts to prepare necessary manpower and documents can be compared with these two inverted triangles. The first triangle shows the ratio of buildings by different construction mechanism and second one the existing resources allocation. For real implementation of earthquake resistant measures the scenario should be changed.

Trends in building construction in Nepal

Building Typology and Classification

The buildings of Kathmandu Valley are of the following types, as indicated by the building inventory survey.

Table 1: Definition of building typologies in Kathmandu Valley

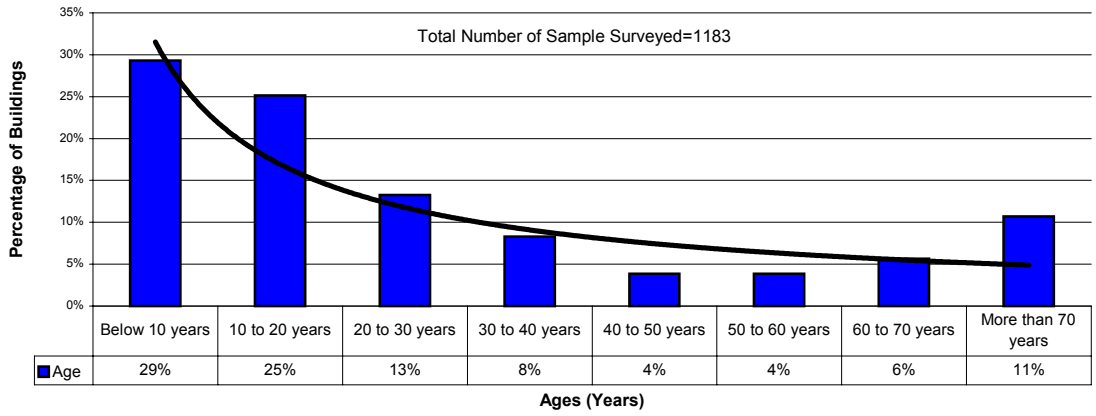
No.	Kathmandu Valley Building Types	Description	Percentage (%)
1	**Adobe**:	These are building constructed using sun-dried bricks (earthen) with mud mortar for the construction of the structural walls. The walls are usually more than 350 mm.	19
2	**Stone**:	These are stone-masonry buildings constructed using dressed or undressed stones. All the surveyed buildings of this typology have used mud as the mortar.	7
3	**Brick in Mud**:	These are the brick masonry buildings with fired bricks in mud mortar. In urban areas, the buildings with adobe inside and an outer layer of fired brick were taken as brick in mud.	18

4	**Brick in Cement**	These are the brick masonry buildings with fired bricks in cement or lime mortar. All the surveyed buildings of this typology have used cement as the mortar.	21
5	**Reinforced Concrete Frame**	These are the buildings with reinforced concrete frame with unreinforced brick masonry infill with cement sand mortar in general. In most of the cases The thickness of the wall is 230mm(9") and column size is predominantly 9"*9".	23
6	**Others**	Mixed buildings like Stone and Adobe, Stone and Brick in Mud, Brick in Mud and Brick in cement etc. are other building type in Kathmandu valley.	12

Age of buildings

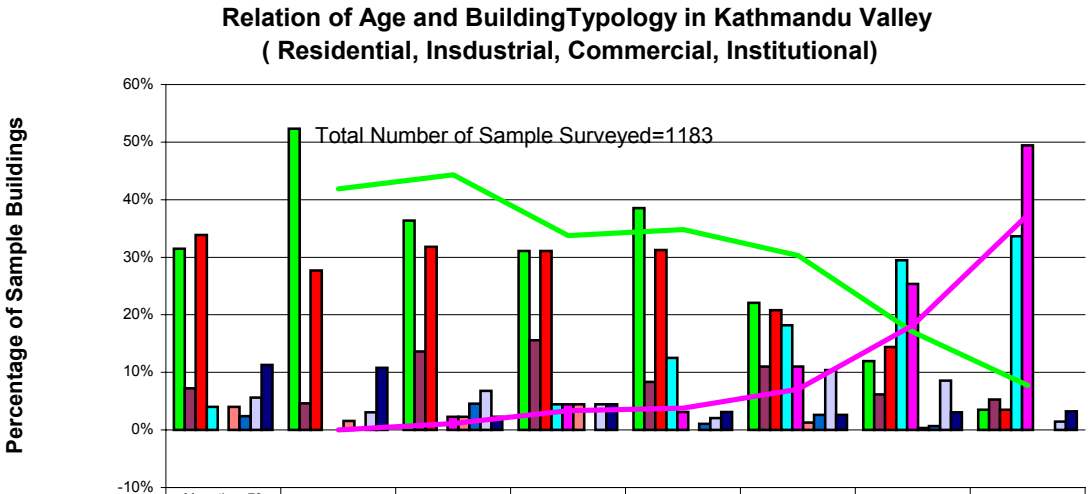
More than half of the existing buildings in Kathmandu Valley are less than 20 years old, while about a third of them are less than 10 years old. This fact shows the rapid urbanization process in the Valley. However, about 21% of the total buildings are more than 50 years old indicating to a high vulnerability, especially if one considers that the predominant type of older buildings, both in urban and rural areas, is either adobe or brick/stone masonry in mud mortar.

Age of the Kathmandu Valley Buildings
(Residential, Commercial, Industrial, Institutional)



Cement Based Construction

Mud based construction



	More than 70 years	60 to 70 years	50 to 60 years	40 to 50 years	30 to 40 years	20 to 30 years	10 to 20 years	Within 10 years
Adobe	31%	52%	36%	31%	39%	22%	12%	4%
Stone	7%	5%	14%	16%	8%	11%	6%	5%
BM	34%	28%	32%	31%	31%	21%	14%	4%
BC	4%	0%	0%	4%	13%	18%	29%	34%
RC	0%	0%	2%	4%	3%	11%	25%	49%
Stone and Adobe	4%	2%	2%	4%	0%	1%	0%	0%
Stone and BM	2%	0%	5%	0%	1%	3%	1%	0%
BM and BC	6%	3%	7%	4%	2%	10%	9%	1%
Others	11%	11%	2%	4%	3%	3%	3%	3%

Age

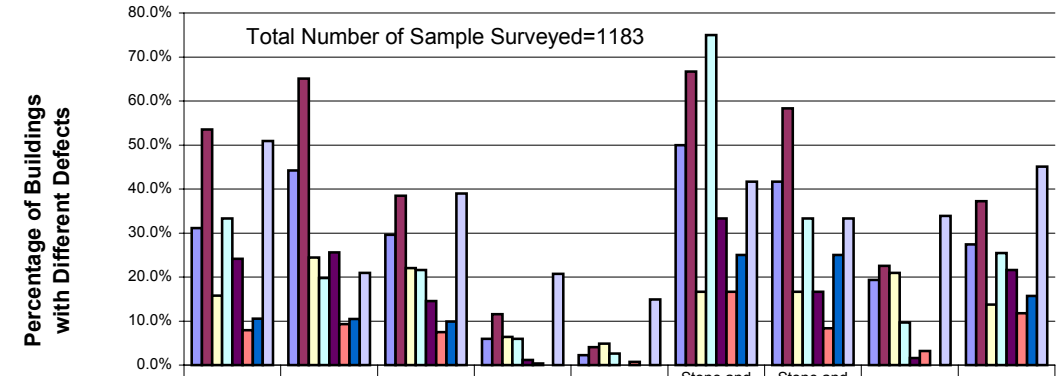
From the above chart it is seen that, a significant growth in brick-in-cement and RC frame constructions started only 20 and ten years ago respectively. During these years, the proportions of adobe and brick-in-mud buildings are on a significant decrease

Defects in Existing Buildings

Mud-based buildings (adobe, and brick or stone masonry in mud mortar) are the building types with the maximum of visible defects such as cracks, wall separation, bulging, and tilting of walls. On the contrary, cement-based constructions such as brick-in-cement and RC frames exhibit lesser visible defects. However, about 12% of the surveyed brick masonry buildings in cement mortar exhibit vertical cracks, 6% show diagonal and horizontal cracks, and about 6% show separation of walls. Major problem in the RC construction (in about 5% of the buildings) is the development of horizontal crack, mostly along the wall-beam contacts.

Dampness is a serious problem in all-building typologies.

Prevailing Defects in Kathmandu Valley Buildings



	Adobe	Stone	BM	BC	RC	Stone and Adobe	Stone and BM	BM and BC	Others
Diagonal Cracks	31.1%	44.2%	29.6%	6.0%	2.2%	50.0%	41.7%	19.4%	27.5%
Vertical Cracks	53.5%	65.1%	38.5%	11.6%	4.1%	66.7%	58.3%	22.6%	37.3%
Horizontal Cracks	15.8%	24.4%	22.1%	6.4%	4.9%	16.7%	16.7%	21.0%	13.7%
Separation of Walls	33.3%	19.8%	21.6%	6.0%	2.6%	75.0%	33.3%	9.7%	25.5%
Bulging of Walls	24.1%	25.6%	14.6%	1.2%	0.0%	33.3%	16.7%	1.6%	21.6%
Delamination of Walls	7.9%	9.3%	7.5%	0.4%	0.7%	16.7%	8.3%	3.2%	11.8%
Tilting of Walls	10.5%	10.5%	9.9%	0.0%	0.0%	25.0%	25.0%	0.0%	15.7%
Dampness in Walls	50.9%	20.9%	39.0%	20.7%	14.9%	41.7%	33.3%	33.9%	45.1%

Building Typology

Identification of these trends is based largely on the building inventory and vulnerability assessment carried out in 2001 by NSET under the JICA sponsored project "The Study on Earthquake Disaster Mitigation in the Kathmandu Valley, Kingdom of Nepal". It is assumed that the results of this work largely reflect the building construction trend in urban areas of Nepal.

Implementation Strategy for achieving seismic safety in Buildings

Towards promoting safer building construction NSET has been playing instrumental role in advocating the issues related to general and specific seismic safety requirements including in owner built buildings. Through a partnering approach with various organizations and stakeholders NSET is supporting the launching of public awareness programs, in conducting training programs at community levels, in integrating seismic resistance into the process of new construction, in increasing the safety of school children and school buildings, in improving the seismic performance of existing buildings and in increasing the experts knowledge of the earthquake phenomenon, vulnerability, consequences and mitigation techniques etc.

Considering rapid erection of new buildings in Kathmandu Valley and by taking account the large number of existing unsafe building stocks; two-pronged strategy is taken to achieve earthquake resilience of buildings in Nepal, as given below.

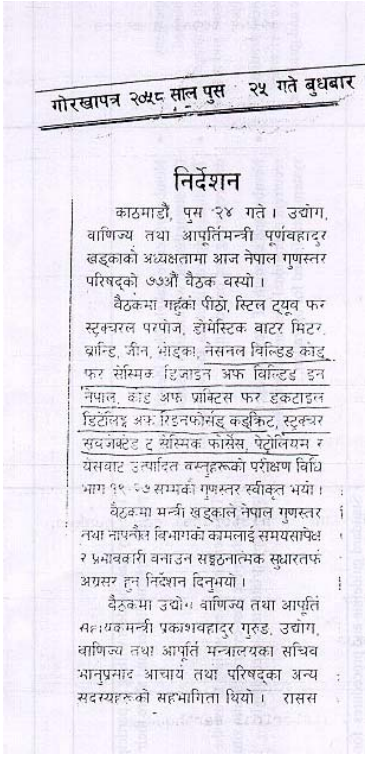
New Construction: Stop Increasing Risk**,** all new construction should be earthquake resistant so that there is not increase in risk.

Existing Buildings: Decrease Unacceptable Risk, existing structures should be either retrofitted or reconstructed to withstand reasonable shaking.

Three Approaches of Implementation

As there is existence of different construction mechanisms, the different approaches are necessary to meet the purpose. Either formally or informally, three major approaches have been taken for promoting safer building construction practice in Nepal. The three major approaches are: A) Top-Down approach B) Bottom – Up approach and C) Horizontal Networking.

A. Top – Down Approach



गोरखापत्र २०५८ साल पुस २५ गते बुधबार

निर्देशन

काठमाडौं, पुस २४ गते । उद्योग, वाणिज्य तथा आपूर्तिमन्त्री पूर्णबहादुर खड्काको अध्यक्षतामा आज नेपाल गुणस्तर परिषद्को ७७औं बैठक बस्यो ।

बैठकमा गहुँको पीठो, स्टिल ट्यूब फर स्ट्रक्चरल परपोज, डोमेस्टिक वाटर मिटर, ब्रान्डि, जीन, भोडका, नेसनल बिल्डिङ कोड, फर सेस्मिक डिजाइन अफ बिल्डिङ इन नेपाल, कोड अफ प्राक्टस फर हकटाइल डिटेलिङ अफ रिइनफोर्सड कङ्क्रिट, स्ट्रक्चर सुपरजेक्टेड टु सेस्मिक फोर्सेस, पेट्रोलियम र यसबाट उत्पादित वस्तुहरूको परीक्षण विधि भाग १९ र २० सम्मको गुणस्तर स्वीकृत भयो ।

बैठकमा मन्त्री खड्काले नेपाल गुणस्तर तथा नापतौल विभागको कामलाई समयसापेक्ष र प्रभावकारी बनाउन सङ्गठनात्मक सुधारतर्फ अग्रसर हुन निर्देशन दिनुभयो ।

बैठकमा उद्योग, वाणिज्य तथा आपूर्ति सहायकमन्त्री प्रकाशबहादुर गुरुङ, उद्योग, वाणिज्य तथा आपूर्ति मन्त्रालयका सचिव भानुप्रसाद आचार्य तथा परिषद्का अन्य सदस्यहरूको सहभागिता थियो । रासस

The easy way to improve the earthquake resiliency of engineered construction is formulation and implementation of good seismic code of practice. Now the "Building Act" has been passed by the parliament and laws are being formulated for actions. As a second way of implementing building code, it is now passed by Nepal Bureau of Standards and Metrology as Nepal Standard, in the initiation of NSET.

Bottom – Up Approach

As most part of the buildings fall under non-engineered construction mechanism, more effort has been paid to intervene this type of construction mechanism by various ways.

Calendar: A step of building code implementation is publication of calendar with simple earthquake resistant construction technique, and is the most effective and successful event. Many municipalities, inside and outside the valley, are now using our calendar during their building permit process. The number of involvement of different municipalities per year is increasing.

Mason Training under SESP: Different means are employed to transfer the technology to community grass- root. 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 illustrating them the details and complete procedures. It is observed that the conventional teaching and instructions to them can not yield the desired quality work. But, the perception of masons seemed much higher, given the instructors (Engineers) themselves do the work at first, telling them reasons behind it. This method avoids the improper reasoning and judgments made by masons in the ground of their previous knowledge and level of thinking. However indigenous knowledge and effective techniques gained from their long experiences are duly considered and employed to the best possible. It makes them work as usual practice, in highest precise level. It is all in form of on-job- training. Besides it, separate training courses about construction are conducted in form of classes. The training is placed at respective Schools. The target group is craftsmen of village but it is opened to all those are interested. The technical knowledge of earthquake

resistant construction is given to them systematically. The presence and participation of villagers and craftsmen is higher as expected attributed to raise awareness level of community people about earthquake by means of other supplementary activities and craftsmen's feelings on need and importance of such earthquake technology. They have seen their future in this 'modern' Technology that they should be equipped with and took part in it with much enthusiasm.

Obviously, the common people, during the training session, show high concerns over the matters that how their own houses are built. Masons pay much effort 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. The training are basically in form of interaction including speeches, Photographs display, presentation of slides and drawings in overhead projectors, visit to place where methods are being employed in school and tests. Attention is paid to the level of trainees' knowledge and perception capability while presenting any items during training.

Once weak points of prevailing construction are described and consequences are presented through photographs of past earthquakes, it stroke trainees' mind and so they start to mull over it. Solutions are explored from their side and shaped to standard techniques. All the knowledge and skill are backed by practical real structures in school retrofitting and EQ resistant new construction. 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.

House Owner Consultation Program: A weekly program to give advice and orientation about earthquake resistant construction is run for house owners who are going to construct new house. Small improvement in design and construction of buildings can make large change to its overall earthquake resilience. NSET engineers describe with the help of photographs, slides show and small physical models about the prevailing and recommended construction techniques. The program is fruitful to the public who has not access to engineers.

Nepali Version of Mandatory Rules of Thumb and Design Guidelines: NSET Nepal has now translated five documents (Three mandatory rules of thumb and two design guidelines) into Nepali and they are under publication.

Horizontal Networking:

National Forum for Earthquake safety: National Forum for Earthquake Safety (NFES) which consist of several professional organizations, municipalities and government offices and of which NSET is a member is now formulated and also working towards implementation of National Building Code of Nepal. Lalitpur Sub-Metropolitan City (LSMC) is now taken as pilot project area and work is started. LSMC has now made following decisions:

NBC shall be applied from May 15, 2002 within LSMC

All applications for building permit for new buildings will be subjected to additional procedures for application of NBC and warranty of Earthquake Safety Requirements.

Working with Institute of Engineering: NSET-Nepal is taking some M. Sc. Students of structure as intern and accepting some groups of (1-2 groups consisting of 5-6 students in each group) as project researcher which allow to students to understand the earthquake risk of Nepal and necessity of earthquake risk mitigation and preparedness in general and earthquake engineering principles and procedures in particular. As the graduates of academic institutions, vocational training centers, trade schools etc. are the ones who will be shouldering responsibilities at different levels in the professional field, NSET Nepal has recommended incorporating seismic resistant design and detailing as well as guidelines/manuals in the regular academic curricula of bachelor's level of engineering but it is still to implement.

Working with WHO and Ministry of health: NSET-Nepal conducted the project "Structural Assessment of Hospitals and Health Institutions of Kathmandu Valley" jointly with, World Health Organization and Ministry of the Health, HMGN. The purpose of this study was to develop/apply appropriate methodology for the evaluation of earthquake vulnerability of the medical facilities in general, and to understand the actual situation of the reliability of the medical facilities in Kathmandu Valley, in particular.

Another project "Non-Structural Vulnerability Assessment of Hospitals and Health Institutions in Nepal" will be started in August 2002 and major work will finish in October 2002.

Lesson Learned

Institutionalization is long-term process

To achieve better seismic performance of buildings the approach and processes should address the needs at more than one level and take into account the grass-root realities. It must create an awareness that leads to an increase in demand for safer buildings and accompanying skills. It must strengthen capabilities at all levels. It should allow some flexibility in how the various levels of safety norms/standards are adopted.

These should be applied incrementally in keeping with the varying and increasing need of the target groups and target buildings. Such an approach will create a climate of easier acceptance and will be simpler to implement.

Two-pronged strategy should be taken

Analyzing socio-economic level and availability of human resources, it is very difficult to retrofit all residential buildings. The cost involved in retrofitting is also more in comparison to the cost involved in incorporating earthquake resistant features in new construction. Thus, in case of residential buildings, the easy way to intervene is for new construction. But, in case of important public buildings for example schools, health centers or police centers should be retrofitted as these buildings play vital role.

In Urban Areas: Retrofit Masonry Buildings, Construct Earthquake Resistance RC Buildings

Trend shows that adobe and mud based construction in urban area is significantly reduced and a remarkable growth in brick-in-cement and RC frame constructions started in these years. So, to stop increasing risk RC construction should be intervened to make earthquake resilience. For decreasing existing risk, existing masonry (Brick in Mud, and Brick in Cement) structures should be retrofitted. But in Rural areas, intention should be paid to incorporate earthquake resistant elements in brick in mud or stone in mud buildings.

Retrofitting is a better and feasible option

For decreasing existing risk of structure to earthquake there are two options. Either pull down the structure and reconstruct it, or retrofit it. From cost comparison, it is seen that retrofitting is quite a promising option unless the building has lost its structural value and cannot be saved or the modern day's functional requirements of the building have changed.

The following table is based upon the experience of SESP/NSET, and suggests to undertake retrofitting upon condition of technical feasibility.

Table: Comparison of Options

Criteria	Demolition & Reconstruction	Retrofitting
Involved Costs	High	Low
Time for Construction	> 1 year	3-4 months
Disturbance to School Function	High	Low
Disposal of Scrapped Materials	Big Problem	No Problem
Technology (adaptability)	Usual, so no excitement	New, so high excitement, need Training.
Potential Impact (Replicability)	Low/Medium	High

Only one approach may not work

Seismic safety of buildings has to be improved by better use of material and improved technology and skill in one front and by legal enforcement and awareness rising in the other. The approach of creating building act and laws can provide legal environment where as awareness at community level or training to masons transfer the ownership and the process will be sustainable.

Approach should be taken as gradual increasing safety

Although, inherently weak materials and its improper use and poor technology/skill make the owner built buildings unsafe and earthquakes in Nepal are recurrent leading to high casualty, destruction and economic loss result from unsafe buildings; it is almost impossible to change the construction scenario at once where locally available materials will continue to be basic building materials for the majority of buildings.

In technological aspects, the local craftsmen play pivotal role. Technicians and engineers have little control over the construction of owner built buildings. Proper training of craftsman can built his confidence, in using the technology and skill to construct safer buildings.

Thus, the appropriate technology should be developed or transferred. For example, instead of changing very high strength construction material or applying higher technology in construction, stitching the walls, providing bands, tying roofs and floors and vertical rods at corners etc. in case of masonry buildings and improving ductile detailing, and workmanship in case of RC buildings are important than adopting new construction material.

Programs like school earthquake safety programs should be continued

In all the villages 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.

ENSURING SAFER BUILDING CONSTRUCTION PRACTICES IN SRI LANKA

Geethi Karunaratne, Center for Housing Planning and Building

1.0 Background

Sri Lanka Urban Multi-Hazard Disaster Mitigation Project (SLUMDMP) is the Sri Lanka country project under the Asian Urban Disaster Mitigation Program (AUDMP) implemented by the Asian Disaster Preparedness Center (ADPC), Bangkok with assistance from the USAID/OFDA. This project is being implemented by the Centre for Housing Planning and Building (CHPB), with technical inputs from National Building Research Organization (NBRO) and Urban Development Authority (UDA).

2.0 SLUMDMP Activities related to Safer Building Construction Practices

During the main project period several activities were undertaken for ensuring safer building practices. Some of these a re listed below:

- Development and publication of Guidelines for Construction in Disaster Prone Areas with the main aim of reducing disasters caused by improper construction practices
- Development and publication Guidelines for Stabilization of Areas Prone to Landslide Disaster in local language
- Training and awareness activities for relevant personnel at national and local levels

As an activity of the Replication Phase of the project, it was proposed to develop building codes based on the aforesaid guidelines. Training and awareness activities for relevant personnel too were undertaken during this phase.

For monitoring and providing guidance during implementation of these activities proposed in the Replication Phase of the project, a Ministerial Committee was appointed comprising appropriate professionals for advice and guidance under the chairmanship of the Additional Secretary (Technical) of the Ministry of Urban Development, Housing and Construction at the time.

The TOR of the committee were:

- To advise and guide on the preparation of the guidelines for each disaster separately in a more consistent manner than in the already available guidelines
- To initiate action for legal framework for disaster mitigation

This ministerial committee after lengthy discussion decided that it would be more appropriate to publish guidelines in a consistent manner after revising the present guidelines rather than developing building codes. Based on such improved guidelines it would be possible to make the adoption of the same mandatory by incorporating the same within the scope of relevant Acts and Regulations at national and provincial levels. Such legal framework would recommend using these guidelines during planning, design and construction in disaster prone areas for different selected natural hazards.

2.1 Training and public awareness activities

2.1.1 Training and awareness

Training and awareness were carried out for technical personnel including engineers, planners, consultants, clients, contractors etc. at national and local levels on how to use the guidelines. The target group included the following categories:

- Engineers
- Technical officers
- Supervisors
- Contractors

Awareness programs were carried out for the following:

- Craftsmen
- Contractors
- Supervisors
- Technical officers
- Individual home builders

Apart from the direct project activities, training and awareness programs were conducted under other programs by other agencies related to the project partners. Some examples are:

- As subjects in the construction management training courses of CHPB
- Training under the ADB funded Urban Development Low Income Housing Project (UDLIHP) for engineers and technical officers
- In the project replicating town – Nawalapitiya Urban Council with their funding
- Training for engineers and craftsmen under the project viz., "Livelihood Options for Disaster Risk Reduction in South Asia", which is a joint collaboration of Nawalapitiya UC, NBRO and ITDG South Asia
- Training for technical officers (project implementation officers), land surveyors and managers etc. of the Plantation sector in collaboration with Plantation Housing and Social Welfare Trust
- Land use planning officers attached to the Land Use Policy Planning Division of the Ministry of Lands

2.1.2 Public Awareness

Public Awareness by following mechanisms were carried out:

- Awareness seminars and other programs
- Dissemination through distribution of simple awareness brochures/leaflets
- TV/Radio programs, Newspaper articles etc.

2.2 Legal Framework for Safer Building Construction Practices

The aim during the project replication period was to establish legal framework through the following activities:

- To make necessary amendments in the following enactments as appropriate for making the adoption of relevant planning and construction guidelines mandatory:
    - Acts of national level authorities (E.g., National Disaster Management Act, Urban Development Act, National Physical Planning Act, Town and Country Planning Act, Construction Industry Act)
    - Statutes of Provincial Councils
    - Ordinances or Acts of Local Authorities
- Institutionalization of the adoption of the guidelines in different agencies as required by the above, once amendments done

During the main project period action had been initiated in the Sabaragamuwa Province Provincial Council to make Disaster Mitigation mandatory within the Council through inclusion of a section in the Provincial Environment Act, which will make it mandatory to adopt the Guidelines in disaster prone areas and implement other disaster management activities once the Statute is resolved, which is presently being considered by the Attorney General's department. In consequence, it was decided to request the other Provincial Councils too to initiate similar action. Letters of request were sent to Chief Secretaries of the respective provinces with a Draft Proposal for consideration, which is given in Annexure I.

In the process of its activities, SLUMDMP was able to achieve the following activities related to establishing legal framework that would promote safer building practices:

- Integration of natural disaster aspect in to the Land Use Policy developed by the ministry of lands. One of the objectives of this policy is to reduce natural disasters in Sri Lanka through effective land use. The policy includes aspects of mitigation of natural disasters such as, landslides, floods, coastal erosion, cyclones and lightning.
- Incorporation in the goals and objectives of the National Physical Planning Policy of National Physical Planning Department (NPPD)
- Incorporation in the goals and objectives of the Western Province Regional Structure Plan of NPPD
- This aspect has also been incorporated in the framework for the proposed Environmental Guidelines for the housing Sector

2.3 Hazard zonation mapping for safer building construction practices

In the demonstration Phase one main activity was the hazard zonation mapping for the demonstration city and replicating cities. This was undertaken by the NBRO (Landslide hazard zonation) and UDA (Flood zonation and infrastructure maps) and map workbooks. Such maps provided the councils with information for developing the revised land use zonation maps taking the natural disaster consideration, and finally it would help in controlling haphazard development in prone areas ensuring safer building practices. Flood mapping in the Colombo Municipal Council area will serve similar purpose.

The partner agency NBRO has undertaken an assignment on Landslide Zonation Mapping from the Central Province Provincial Council, which includes training as well. The mapping work is in progress at present and training will commence in time to come. Identification of critical, moderate and safe areas and creating awareness on the building practices to be adopted in different areas will promote building practices in the central hilly province. So far in this province, hazard zonation mapping has been done under SLUMDMP only in Nawalapitiya UC and Kandy MC, where the development plans have been prepared incorporating natural hazard consideration.

3.0 Strengths, Obstacles and Lessons Learnt

Strengths

- The high level of co-operation from the Mayor and officials of the Ratnapura Municipality and replicating cities was a strength for the implementation throughout the activities of hazard identification, mapping, training etc.

- The high level of co-operation from the Chairman of the Nawalapitiya Urban Council for the implementation of additional training activities in addition to those under the project was a great strength

Opportunities

- Technical training under the ADB funded Urban Development Low Income Housing Project (UDLIHP) entrusted to the CHPB was opportune as it made it possible to incorporate the training on Guidelines for Construction in Disaster Prone Areas as one subject I training for the technical personnel in the selected local authorities.

- The possibility to include this aspect as a subject in the construction management training courses of CHPB

- Training for engineers and craftsmen under the project viz., “Livelihood Options for Disaster Risk Reduction in South Asia”, which is a joint collaboration of Nawalapitiya UC, NBRO and ITDG South Asia was an opportunity

- Training for technical officers (project implementation officers), land surveyors and managers etc. of the Plantation sector in collaboration with Plantation Housing and Social Welfare Trust

- Opportunity to train the land use planning officers attached to the Land Use Policy Planning Division of the Ministry of Lands

- The assignment on Landslide Zonation Mapping to NBRO from the Central Province Provincial Council is an opportunity. This also includes training on Guidelines for Construction in Disaster Prone Areas.

Obstacles

- Due to the delay in identifying Kandy MC as a replicating city, its officials did not get the opportunity of participating in most of the training activities. This was a drawback.

Lessons Learnt

- Political patronage is essential for successful implementation of such activities.
- Successful execution of project activities has a rippling effect that it creates opportunities for initiating new endeavours by other interested parties including funding.

References:

1) SLUMDMP, Guidelines for Construction in Disaster Prone Areas, September 1999
2) SLUMDMP, Guidelines for Stabilization of Areas Prone to Landslide Disaster in local language, January 2000
3) SLUMDMP Process Documentation Report, 1999
4) SLUMDMP Project Completion Report, May 2000

Annexure I

DRAFT PROPOSAL

(RESOLUTION/STATUTE) TO PROVIDE FOR MEASURES TO MITIGATE THE IMPACT OF NATURAL DISASTERS WITHIN THE PROVINCIAL COUNCIL *(or these could be included in a Statute to Establish a Provincial Environmental Authority if already envisaged)*

The (resolution/statute) is to make the following mandatory:

a) To have a Provincial Natural Disaster Management Policy in compliance with the National Disaster Management Policy in order to
   i. Integrate natural disaster mitigation aspect in development planning by complying with Guidelines for Planning in Natural Disaster Prone Areas and Guidelines for Construction in Natural Disaster Prone Areas
   ii. Develop and implement Disaster Mitigation Action Plan
   iii. Develop and enforce Emergency Management and Response Plan within the Province.
   iv. Provide continuous training and awareness as necessary for PC politicians, administrators and other staff; professionals and other public and private sector officials active in the province; and the community.

b) To establish a Provincial Natural Disaster Management Advisory Committee with representatives from
   i. Central Environmental Authority or Provincial Environmental Authority (if established separately)
   ii. Urban Development Authority
   iii. Local Authorities
   iv. Organizations providing services within the province
   v. Any other government organizations having similar objectives (such as, Coast Conservation Department, Upper Watershed Management Division of Mahaweli Authority etc.)
   vi. Non-Governmental Organizations active in the province having similar objectives
   vii. Public and private sector enterprises/agencies carrying out business in the province (Eg., Gem and Jewellery Authority, Geological Survey and Mines Bureau etc.)

c) For local authorities (LA) within the province, to establish a Disaster Management Steering Committee complying with the Provincial Disaster Management Policy for
   i. Initiating and monitoring natural disaster mitigation activities in the LA
   ii. Providing measures for the rehabilitation and reconstruction after a disaster
   iii. Developing a Natural Disaster Mitigation Action Plan and implementing activities therein
   iv. Developing an enforcing Emergency Management and Response Plan for the LA and regularly updating and monitoring same.
   v. Promoting training and public awareness within the LA

d) To make it mandatory for the local authorities (LA) within the province, to comply with Guidelines for Planning and Construction in Natural Disaster Prone Areas in the following activities of the local authority:
   i. Identification and Zonation of natural disaster prone areas within the administrative area of the LA.
   ii. Development or revision of the land use zonation plan considering the natural disasters prevalent in different areas within the Local Authority
   iii. Preparation of the Development Plan for the LA based on the landuse zonation plan for gazzetting.
   iv. Revision if necessary of the Development Control Procedure of the LA by revising the application form incorporating this aspect applicable for natural disaster prone areas and stringent monitoring of the development activities.

MORE TO LOSE: ESTABLISHING COMMUNITY CAPACITY TO REDUCE VULNERABILITY TO ECONOMIC LOSS CAUSED BY STORM DAMAGE TO HOUSES IN CENTRAL VIET NAM

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ABSTRACT

Vulnerability in domestic shelter in central Vietnam is a critical and under-addressed issue.

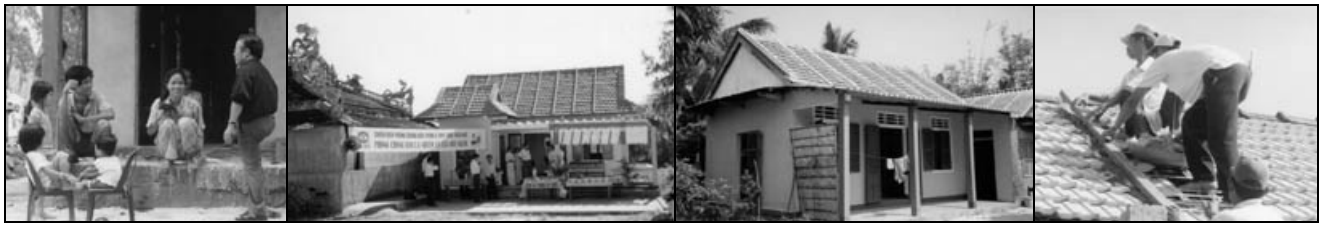
Families are extremely poor, but despite this over the past decade they have been investing their scarce resources in building better housing. Unfortunately this investment is insecure, because storm resistant techniques are not applied. Too often unnecessary damage is caused by the annual round of storms that hit the coast. But this damage can be avoided if families make the extra effort to strengthen their homes by applying ten key but simple points of storm resistant construction. Preventive action to strengthen community and domestic buildings is an effective and cost efficient manner of reducing economic and material vulnerability.

This paper presents the results of a project designed and managed by Development Workshop France (DWF) in Thua Thien Hué province, central Viet Nam, since 1999 that promotes preventive strengthening.

The project objective is to reduce vulnerability and damage in houses through preventive strengthening of existing buildings. This in turn helps secure family investment in shelter and enables families to subsequently invest in improvements, not repairs to damage caused by storms.

DWF has developed an interactive programme in each village that works to stimulate short and long term awareness of the need to take preventive strengthening in building and rebuilding. The project works with women's groups, local communities and schools, and with a strong relationship with local government. It demonstrates how preventive action can realistically be applied on existing homes and village buildings, showing achievable, durable and affordable strengthening within the community that respect local habits and resources.

Through animation and demonstration, the project has been successful in changing grass roots and official attitudes.



More To Lose: Establishing Community Capacity To Reduce Vulnerability To Conomic Loss Caused By Storm Damage To Houses In Central Viet Nam

The risk of storm damage to homes in central Viet Nam

The social and economic context

In the past decade Viet Nam has been emerging from decades of poverty and strife, and opening up opportunities both nationally and domestically. Poverty[1] decreased from 60% to 37% between 1993 and 1998, and while levels of poverty in rural areas have remained higher there has nevertheless been a relatively steady improvement over recent years.

This encouraging growth and improvement in general conditions can in large part be attributed to the economic reforms launched by the Vietnamese government in 1986, *doi moi,* which moved Viet Nam towards a market economy and contributed to a growth in family revenues. More families have been able to make small investments to acquire commodities such as bicycles, and the last decade has seen the start of formalised opportunities to borrow for income generation activities.

Nevertheless, despite this encouraging picture a significant proportion of families still live *below* the poverty line. A large proportion of families also live precariously just above it. Many of the latter families are 'temporarily poor[2]', resorting to a variety of activities in order to survive with irregular incomes. In this context, *reducing vulnerability[3] is a key to reducing poverty.*

It only takes a small mishap for a family to return to conditions of near starvation, ill health and debt. Making sure that the home and its contents are not at risk is therefore a fundamental need.

The importance of the home

For most families their home is one of the largest investments that they will ever make. A decent and storm resistant home provides security to the family, for family health and family possessions, including those needed for income generating activities.

Achieving a decent and structurally resistant home has invariably required enormous effort and saving. But families also describe how this incremental investment has often been destroyed by typhoons and floods. Such destruction occurs largely because neither materials nor structure have been used in a manner that assures the security of the building. Many families tell of the repeated destruction of their home by storms.

Vulnerability: the risk and impact of typhoon damage

The risk of destruction is ever–present. Viet Nam is one of the most disaster prone countries of the world. Major disasters occur at least every decade. There are indications that the severity of storms is increasing[4]: the floods in 1999 that hit central Viet Nam were the worst in living memory; families still talk of the huge losses that occurred in the 1997 massive typhoon Linda when 300 000 houses were destroyed and many more damaged.

Although less destructive, the coast is hit annually by tropical storms at a rate of 4 or 5 a year or more[5]. What are in effect "regular" disasters cause extensive and often repeated damage to housing and infrastructure as well as losses to agriculture and fisheries.

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[1] Where a family cannot satisfy the bare necessities of life. Viet Nam Living standards survey 1997 – 1998, Hanoi 1999, Viet Nam General Statistical Office.
[2] Families whose income levels fluctuate above and below an acceptable minimum level during periods of natural disaster and economic crisis (Vu Tuan Anh, GSO Viet Nam 1999).
[3] World Bank report: "Viet Nam: attacking poverty", November 1999.
[4] Viet Nam country report, Climate Alert Volume 7, No 4 July-August 1994.
[5] Tran Nhon, Vice-Minister , Ministry of Water Resources, Hanoi 1998.

In parallel with economic growth, *the levels of economic loss have climbed steadily* since 1985, reaching over 600 million USD by 1996[6]. This reflects the increase in private and public investment that has taken place.

Dealing with annual disasters

Whilst it is more difficult to provide protection against massive typhoons such as those that hit central Viet Nam in 1985 and again in 1997, *damage in the more frequent annual cyclones can and should be largely avoided*.

Avoiding damage can be achieved at a far lower economic and social cost compared to that of reconstruction by taking *preventive* action to increase the resistance of buildings and the resistance of their components to the effect of typhoons, high winds and floods.

DWF experience of working with hundreds of families in Thua Thien Hué Province since 1999[7] has shown that for an average house construction cost of 980 USD for 40m², an extra 15 - 30% needs to be spent on making the building typhoon resistant. The same applies to communal facilities such as schools and markets.

Housing in evolution: the renewal of housing stock has increased vulnerability to loss

It is a paradox that the very real improvements that have been made in building have contributed to increased vulnerability to loss, when this loss is considered in terms of the cost to the family of recovery and rebuilding a damaged or destroyed home after a disaster. Because more time and money has been invested in the home, this cost has become considerable. Vulnerability has in effect increased.

Fifteen years ago, the typical situation for villages in the centre of Viet Nam was a cluster of houses with thatched roofs, a pole or bamboo frame, and bamboo mat walls. Most if not all of the materials came from the locality, and many of these materials could be gathered. Capital investment in the home was very low and few inputs were monetary, even though families have always set social importance on getting, if they could, a good timber roof frame. Although many houses were frail and easily destroyed by typhoons, recovery could be achieved at relatively low cost and depended significantly on family and neighbour support. Once the immediate effects of a typhoon had subsided, village reconstruction took place quickly.

By the mid 1980's change was taking place. Families had begun improving their homes. New and purchased materials, such as cement, fired bricks and roof sheets, came into more widespread use. But along with these changes in building practice many of the storm resistant features of traditional housing, that, for example, had tied the roof down and held the structure together, have been neglected.
There would appear to be four related reasons for this:

- Ignorance: families interviewed[8] often say that they do not know how to make their new house stronger.
- Poverty: shortage of resources encourage people to make economies.
- Belief in new techniques: people mistakenly place greater faith in new materials thinking they are inherently more storm resistant.
- Unfinished homes: the incremental process of building means that many homes have not been finished, leaving parts of the structure weak and exposed.

The result is that along with investments in improvement and new building, there is also more - materials, investment and effort - at great risk of being lost and destroyed.

What does this mean for a typical family with a monthly income of between 20 and 30 USD?

[6] Disaster Management Unit, UNDP, Web site data.
[7] DW VN – database on house, improvement and strengthening costs.
[8] "Case studies of beneficiaries families" Lam Ngoc Mai, July 2001, and "External evaluation" Tran Minh Chau, June 2001.

Their home[9] with a floor area of 40m² and a terrace, represents an investment of between 650 and 1000 US$. The family may well have made their own cement tiles and blocks. But they will have bought most of the other materials including cement and steel, clay roof tiles or roof sheeting if these are used, and doors and windows. Help from the family and neighbours is very important, but as well many families borrow money to cover the building costs, and often at extortionate rates from informal sources.

The effect is that, today, damage to your house costs much more to repair than it did before, and such loss has a major economic and physical impact on the family and its health. Loss of roof tiles - a frequent and avoidable occurrence in a typhoon - costs some 100 US$ to replace; loss of the whole house requires many hundreds of dollars.

To get an idea of the scale of this problem along the coastline of central Viet Nam, visual estimates by DWF suggest that some 70% of provincial and rural housing in Central Viet Nam has been replaced or renewed over the past 15 years. But sadly, of these, commune surveys in Thua Thien Hué indicate that despite this investment in new building about 70% of housing stock can only be classified as '*semi-solid'* or weaker, and thus very vulnerable to damage.

As such, families are very vulnerable to loss.

Failure to take preventive action to ensure that such damage does not occur has a major effect of diverting money away from economic growth, and family security and health.

What can be done?

In the face of repeated typhoons and disasters, the government and the international community has been active in both responding to emergency situations and the provision of relief and support for rehabilitation. The government assists where it can in the aftermath of each disaster, for example by handing out roofing sheets to those who have lost their homes. When a disaster occurs, the donor community also contributes to the process of rebuilding, and organisations such as the International Federation of the Red Cross have been prominent in helping people acquire safe "core" houses. But given the scale and the repetitive nature of the damage, donor support for reconstruction or building core houses is inevitably limited in its impact and cannot reach out to a sufficiently large proportion of the population. Until recently, government policy and prevention programmes have also focussed on strengthening and developing infrastructure, securing land and sea based productive capacity and protecting dykes and riverbanks[10].

Meanwhile, faced repeatedly with major losses, families and local communities have themselves to take on most the burden of rebuilding, with only exceptional support. The cost of rebuilding is considerable, and many families (a) have to borrow in order to recover, and (b) often find themselves living in houses that are at best no stronger than before, and at worst, considerably weaker.

What support there is does not necessarily make the best use of scarce resources. For example, in the aftermath of typhoons and floods in 1999 that destroyed 10 000 houses and damaged 470 000 in central Viet Nam, the prime minister decreed exceptionally[11] that 1 million VN Dongs (+/- 70 USD) be given to each person whose house has been destroyed to help reconstruction: had this same money been used *in prevention* would have had a lasting impact on reducing vulnerability and loss. Again in 2001 after Typhoon Ling Ling, the province of Binh Dinh provided VN Dongs 3 millions to each family that had lost its house – a sum that would have gone a long way to preventing this loss[12].

[9] Not including the kitchen, veranda and any annexes.
[10] See, for example, the Central Provinces Initiative for Natural Disaster Mitigation in Central Viet Nam, Second National Strategy and Action Plan for Disaster Mitigation and Management in Viet Nam, March 2002.
[11] Central Committee on Flood and Typhoon Control "Official report on the damage and response to flood and typhoons in the south-central and central highland provinces of Viet Nam." Hanoi , November 1999.
[12] Viet Nam News Agency, Nov 12 2001.

It is in this environment that DWF has applied its strategy: to encourage people to take preventive action to safeguard the investment that they have already made in their homes and small local public facilities, by incorporating typhoon resistant details into both existing buildings and new construction.

Ten key points of typhoon resistant construction.

The ten points can be applied to almost any type of building in the communes, regardless of the type of structure or the type of materials that have been used. Each point describes a principle that when applied will reduce the risk of damage to the building or loss of materials. The practical training that DW provides makes sure that people know how to apply the ten key points to different types of buildings and materials, and the demonstration work on existing buildings shows people in practice what the preventive strengthening consists of. The project particularly encourages people families to strengthen existing buildings, but the same principles apply to new building as well.

A programme to promote preventive strengthening to protect the home and family investment

The DWF programme in central Viet Nam demonstrates a strategy that channels resources, including each family's own resources, into prevention rather than reconstruction. A long term aim is too see this strategy widely adopted.

Building on earlier experience in Viet Nam between 1989 – 93, since 1999 DWF[13] has been working in the central Viet Nam province of Thua Thien Hué with the population in all the coastal districts.

The strategy is to reduce vulnerability and damage in houses and community facilities.

The *focus is on encouraging and assisting families to reduce their vulnerability in a sustainable manner.*

The idea at centre of the project is to encourage families to apply the ten key points of storm resistant construction (see box)

But the project itself creates the environment that makes people aware of what should be done to reduce vulnerability, aware of how to do it, and how to put this into practice. The project creates the institutional, technical and financial environment in which this takes place. And in collaboration with families and the communes, it demonstrates how strengthening of buildings is done.

DWF's actions work at two levels:

1. The commune: convincing through doing – local partners who doubted that much could be done with a small budget are now convinced by the project strategy of support and mobilisation for preventive strengthening.
2. Decision makers: DWF collaborates with community and provincial leaders to encourage the adoption of the strategy of support for preventive strengthening of buildings in high risk districts and communes. Local leaders are now taking the initiative ti help expand the programme.

In the communes, the DWF project comprises three groups of action in each partner commune[14] :

[13] DWF is supported by Canadian International Development Aid (CIDA), Alternatives (Canada), and the Viet Nam Canada Aid Foundation (FAVC)
[14] Rural commune : from 3 to 10 000 inhabitants

1. **Animation:** getting the message to the population that preventive strengthening is easy and important

2. Developing **the social and institutional environment** that supports preventive strengthening.
   - Encouraging the **formation of family groups** for preventive strengthening in hamlets.
   - **Building civic capacity** with the People's Committees to organise events, provide support to families and advice on prevention.

3. **Practical action and support** : training, demonstration and finance
   - **Developing practical skills** in the community and developing knowledge about safe building.
   - **Demonstrating** how preventive strengthening of existing buildings can be done.
   - Developing **access to small loans** to cover some of the costs of strengthening one's home.

1/ Animation - getting the message across

A major issue is that families do not know that preventive strengthening is possible. They need to be aware that prevention is essentially easy and affordable, and they need to know that it is much cheaper than rebuilding after a disaster.

To address this in each commune DWF organises a wide variety of animation and awareness raising events and distributes products with a prevention message. Each activity – a play, a concert - deals in its own way with the risk of storms, the damage they cause and the action that one can take to reduce vulnerability, and these events are accompanied by information handouts and house-to-house visits with practical information. The animation activities has been undertaken in diversified forms which encourage the participation of different groups of people (children, youth and families) in each commune.

Working with schools

DW works with primary and secondary schools and kindergartens ; introducing the theme of preventive strengthening into school curricula with teacher training ; developing activities such as painting competitions with school children, and strengthening school buildings.

Below: child's drawing of a strengthened house done in one of the project competitions

Many of the animation activities are designed to be "memorable", events that one will recall maybe months or even years later. They include the organisation of concerts with local musicians, singers and poets, many of who perform their own material written for the project. There are theatrical pays (some written and performed by project staff). The project provides songs and text used on commune loudspeaker systems, and it makes use of radio and TV. In 2001 during a special "damage prevention week" a decorated old Renault bus toured each commune to distribute information and it handed out fans and hats with the project prevention message. In 2002 DWF in some communes is sponsoring commune football matches as another publicity event.

The animation activities are an ongoing process with different events happening regularly in each commune.

2/ Developing the social and institutional environment that supports preventive strengthening - a partnership between family groups and the Commune Damage Prevention Committees

The process of raising awareness, of providing support and of taking action cannot be sustained without the engagement of both families in the community and the commune representatives. Each plays a key role in awareness raising and support. In the villages, families who have made their homes safer share the experience with neighbours, whilst the commune provides the framework to provide guidance, support and organise animation events.

This participation is the basis for the continuation of the project activities after external funding is ended, and DWF has worked to formalise this local capacity to carry on the actions introduced by the project.

To achieve this, at the level of hamlets DWF encourages the development of family groups, bringing together all the people who are beneficiaries in the project and making beneficiary selection a democratic process.

In parallel DWF has instigated the creation of Commune Damage Prevention Committees who provide the necessary support and animation to encourage and help village family groups to undertake vulnerability reduction activities.

Family groups for damage prevention

In each targeted hamlet, beneficiary families are invited into a group to constitute a base for mutual support. They are involved in decisions about which families should have priority for support and credit, they provide support in the management of credit for house strengthening, and they participate in assessing what work needs to be done. Through experience gained with the project, these families become a focal point for sharing information and their experience. A group leader represents the views of the family group at commune level.

The project works with families to show how existing buildings can be strengthened simply and efficiently in a manner that is sympathetic to local tastes and visual preferences and this is important in developing local acceptance of techniques that can be used. Families always contribute both in kind and financially to the cost of strengthening.

The family group is central to the implementation of a family based vulnerability reduction process.

The Commune Damage Prevention Committees

In each commune DWF has collaborated with the People's Committees to establish a Commune Damage Prevention Committee (CDPC) who progressively take on responsibility for managing most of the project activities in their commune.

The CDPC brings together members of the People's committee, village representatives and local unions. DWF develops the capacity of the CDPC with training and work sessions so that it can provide the necessary support, technical advice and follow up to family groups benefiting from subsidies and credit and in undertaking preventive strengthening. The CDPC is helped to organise animation and

communication activities in the commune, and it is provided with prepared materials, such as cassettes and handouts (documents, posters, etc.) for their use.

Once established, the CDPC becomes the commune level extension of the project team, and in time takes over it's activities. For example, the CDPC, in collaboration with the Farmers and Women's Unions, manage the house strengthening credit programme.

3/ Practical action and support : training, demonstration and finance

Three complementary actions take place in each commune:

Training:

DWF runs training sessions for community representative and construction workers so that they can learn and discuss about the need to strengthen houses and public facilities, and get praticle and technical training about the ways that this strengthening is done on different types of building.

The workshops discuss the issues of typhoon damage prevention, the practical theories and methods are suited to the locality; practical work on local buildings then demonstrates different techniques. Each participant receives a manual on cyclone resistant construction.

For many participants these workshops are the first time that they can discuss local building problems and issues with professionals. This is also important, in that each commune has its own styles and requirements, and few buildings are actually the same.

After the training course, evaluations have shown that the local builders are more confident about applying the new techniques. They are also ready to promote the principles of storm prevention in housing construction inside or outside the target communes.

Demonstration:

DWF collaborates with individual families to strengthen their existing home. Each beneficiary house is surveyed, the weaknesses discussed and a contract drawn up detailing the work to be done to make the building safe and defining the contribution that will be made by the family and by the project. The project makes a subsidised contribution in the order of about 150 US$ and since the beginning of 2002 the family has access to a credit fund to contribute to costs. The family covers all of the remaining costs, and, using trained skilled labour and their own help, manages the strengthening work.

DWF also collaborates with the commune to strengthen small public buildings, including primary schools, kindergartens and markets, as these buildings provide additional exposure for the same techniques that can be used on homes.

No two buildings have the same strengthening needs, but typical actions include ensuring that all parts of the structure are solidly tied together, that the roof covering is securely held done with reinforced ribs or bars, that the building has strong doors and shutters and that walls are made more water and wind resistant.

Credit:

Although commune representatives were originally sceptical that people would contribute to and participate in the strengthening of their homes, the project has proved that not only are people very ready to participate in the process of strengthening, but that they will in addition borrow money in order to cover their contribution.

Household surveys have also shown that because no formal credit facility existed to pay for strengthening the home, families have had to go to informal moneylenders, who charge high repayment rates. DWF concluded that this was causing hardship and that the project needed to demonstrate that a dedicated source of credit for house strengthening can work successfully: the result is that it does.

Credit programmes relate more commonly to income generation activities, but the indications are that strengthening the house is considered just as important an investment, and families have both been ready to borrow sums in the order of 100 to 150US$ and make regular repayments (during 18 months) at 0,3% monthly interest.

The credit system is managed by the Commune Damage Prevention Committee in collaboration with the participation of the Women's or Farmers' Union. The target is to achieve loan rates up to 85% with a low level of subsidy, but as yet in the communes it is generally considered that until the poorer and most vulnerable families have been helped, a subsidy is needed to enable these families to strengthen their homes.

A longer term goal for DWF is to see other organisations including credit banks take note that people do repay loans for house strengthening and that they will in turn provide similar credit opportunities.

Who benefits?

The projects actions target poor and vulnerable families. But it has also been encouraging to see that women in particular have participated in the project's activities, and that 40% of the beneficiary families involved in house strengthening have been headed by women. Not only do women participate directly and efficiently in the animation and communication activities, but they have also shown themselves to key actors in bringing about change in the attitude of families so that prevention becomes a priority in housing improvement and construction.

The families who are directly helped by the project are selected by the community in a village. Some groups are more favoured, as those who have lost family members during the years of resistance, and single women heading families are also favoured. But beneficiaries also include families who are needy and likely to play a significant role in encouraging others to take preventive action to strengthen their house.

The case of Madam Phan Thi Yêm is quite typical.

Madame Phan Thi Yêm, village of Thanh Thuy Chanh, Thuy Thanh commune

Married at the age of 17, Madame Yêm assures us that this was not considered young at the time, but life was really hard – difficult to express how hard. To begin with, the young couple were farmers, and were able to feed and bring up their children. Then her husband went off in 1963 to fight in the Resistance. He was killed in May 1963 in a ghastly massacre. This was a terrible blow, leaving her with 5 young children, the eldest 13 and the youngest only 3 years old. With meagre savings from making straw hats, like others in the village, she was able to pay for her children to attend school. But once basic needs were met, she could only afford to live in a poorly maintained bamboo shelter. Using savings scraped together and with manual help from cousins and neighbours, in 1974 she managed to build a cement block house with a tin roof, but no reinforcement. Only to find herself homeless in 1985, when the typhoon ripped off all the roofing and she was forced to purchase fibro-cement sheets to replace it. "That's why when I hear a typhoon warning, I'm absolutely terrified," she adds.

Asked about strengthening houses against storm damage, she says she had heard about this and was most interested. Which is why when the village meeting to decide which families should benefit from the damage prevention project was held, Madame Yêm took an active part. In the event she met all the conditions for becoming a beneficiary. She assures us that if the project can make her a loan, she will do everything she can to help improve her house as required by the Project. Before strengthening, her house was built of cement blocks, with a tin roof and very rudimentary tin panel doors.

All her children are married and have work, but at some distance, except for her youngest daughter who still lives with her. So she hopes her house can be finished before the Têt [Vietnamese New Year] holiday so that she can celebrate with her neighbours. The total budget for the work is some 4 200 000 dôngs, of which Madame Yêm is contributing 200 000 dôngs, and the Project has agreed to loan her a further 1.5 million dôngs at an interest rate of 0.3% per month. She receives a State pension of 120 000 dôngs (as a Revolution widow) and this together with her income from raising animals will enable her to make the monthly repayments of 57 000 dôngs. Before, she used to borrow from the Women's Union for her farming activities, but until now no organisation used to provide loans for strengthening homes against storms. She is delighted with the new loan scheme and is determined to save and repay on time so that others can also benefit. At the time of writing, the walls of her house have been carefully rendered and eight iron reinforcements have been added to the roof, making it both attractive and strong!

The house of Madame Phan Thi Yem in Thuy Thanh Commune

Greatly moved, Madame Yêm tells us that although her children have grown up now, none of them are in a position to help her. Thanks to the help she has received from the Project as well as from her cousins and neighbours, her house is now comfortable and strong. She is grateful to the project and hopes that others like her will be able to benefit.

Conclusions

In 1999 when DWF first proposed a strategy that is based on working in the community with families to strengthen existing homes in central Viet Nam, and with relatively small sums of money, many people were sceptical that this could either work or even be of any value.

Four years later, opinions are very different.

DWF's team in Thua Thien Hué has been successful in developing a programme that is changing the attitudes and the practices of the different stakeholders in the community - families, technicians, and decision-makers - so that damage prevention in housing becomes a higher priority.

The diversity of the animation activities has encouraged the active involvement of both local authorities and the population; the beneficiary families are pleased and reassured by their strengthened homes; the community leaders fully understand the project's aims and are engaged in the process, and they recognise that by motivating people and mobilising relatively small sums of money a great deal can be achieved to strengthen houses and small public buildings.
They recognise too that with a safer home, families can turn their attention to meeting other priorities and needs with greater assurance.

The scale of the project remains, however, small, covering, as it has, only ten communes in one province. The challenge in the coming years is to expand the example, to bring more help, both practically and financially to vulnerable families along the coast, and to work towards a much wider adoption of the strategy of preventive strengthening.

PUTTING SAFETY IN PEOPLES' HANDS - PROMOTING SAFER BUILDING PRACTICES

Upmanyu Patil and Prema Gopalan, Swayam Shikshan Prayog

1. Summary

Putting safety into people's hands means that disaster-affected communities are themselves empowered with information and tools to develop safe building practices. It follows that i**nvestment in reconstruction of housing and infrastructure is viewed as an opportunity for rebuilding of homes and communities**. This paper shares insights and lessons from SSP – Swayam Shikshan Prayog's experiences of working with community groups after several earthquakes in India including the Latur (1993) and Gujarat (2001) earthquakes –here after referred to as quakes in India.

Disasters offer a range of opportunities for the affected to respond to the crisis. There are two ways of dealing with the crisis - to build houses and give it to people, or support collective efforts to reconstruct. Investment in public infrastructure and housing almost triples after such large-scale disasters.

The inflow of large resources in the form of aid demands that at every level mechanisms are created to inform people about their entitlements and rehabilitation packages. A "brick and mortar" approach that targets individual house owners is likely to result in structures that do not cater to household needs. The major barrier to promoting safe construction is the brief timeline of disaster "emergency projects". This represents a serious constraint to the possibilities of the developing building practices, which are centered on community ownership. The post disaster scenario is characterized by separation between relief, rehabilitation and development

- Lack of trust between communities and institutions
- Centralized systems for distribution of aid
- Top-down planning for reconstruction

In the above framework, safety issues need to be linked to creation of a secure environment especially for poor communities. This becomes even more important after a large-scale disaster. In a situation where institutional mechanisms and local governments mechanisms are in disarray, and outsiders dominate the decision making process. A culture of mistrust is created among survivors about the use of local technology and existing building practices. Among the beliefs promoted, is that existing practices (which are low cost, using mud and stone) need to be discarded in favour of new technologies, engineers should replace masons and engineered structures should replace non-engineered ones.

By creating a space for communities to address risk and vulnerability issues, the macro pay offs are tremendous. For the poor, safe construction is linked to broader issues around security of land and livelihoods. Housing and infrastructure investment after disasters if planned with a view of building local capacities; results in the empowerment of all actors and development of the local area and its peoples.

SSP's efforts to redesign reconstruction programs show that *rebuilding* can be an effective trigger for collective action. SSP use the various stages starting from relief to rehabilitation to educate people on earthquake safe construction whether it was building temporary shelters, construction of houses, restoring schools or establishing common infrastructure. Self-education tools such as study tours, exposure to demonstration projects and onsite workshops proved to be effective in mobilizing communities to undertake reconstruction. Scaling up of good practices by SSP in partnership with local governments is occurred through district wide trainings, structured dialogues, peoples information campaigns, exchanges and networking among various stakeholders.

2. Creating space for community participation

After both the Gujarat and Latur earthquakes, reconstruction of houses was the major component of the state led, rehabilitation project. This involved two-pronged approach - complete reconstruction of houses

in the epicenter or core villages and a self-help effort driven by house owners to undertake repair and strengthening of houses with cash, materials and technical support being provided by the government.

What has been the post disaster response? After the 1993 and 2001 earthquake, the government swung into action to make a technical assessment of damage to structures. Communities were not informed of the methods; instead people were locked out from the results of the damage assessment. More often than not, social and economic issues link to housing and settlements were not part of the official assessment. Lifestyles of rural poor communities, which included livestock, storage of rains was never considered while planning the houses.

Since the assessment completely excluded peoples' perceptions it negated existing building practices in the area. Several myths persist, if survivors are not involved in the understanding and analysis of what constitutes safe building practices in the area. After the Latur earthquake in 1993,the widespread perception was that stone construction killed people. After this, it took several years for people to regain their confidence in local building materials in particular, stone masonry as a government effort. For this to happen, community groups need to be aware of their rights and entitlements (in rehabilitation), technical support to build earthquake resistant structures and capacity to access resources and dialogue with administration. At a wider level, NGO networks need to create a space for participation of community groups in the reconstruction and rehabilitation project.

3. Recommendations

1. Risk and security have to be defined in the context of location specific vulnerabilities,
2. Safety and security of people can be ensured only when the affected communities determine their priorities and control the use of resources
3. Building innovations that are evolved by the poor to cope with the crisis can be sustained by mainstream institutional structures if they are supported with resources and capacities.
4. Standard safety norms and building codes are developed (in relation to local skills, materials and resources)
5. Alternative institutional arrangements to ensure resources allocated for the widespread awareness of safe building techniques.
6. Besides the State governments, private sector, international organisations, and civil society organisations are new actors. Social and technical auditing become urgent in order to ensure that creative ways involving communities need to replace centralized decision making.

4. Lessons from a people-led disaster-to-development strategy

1. Empowers the poor and among them women, to overcome established boundaries and limitations
2. Involves the poor/women as active citizens, clients and consumers, and not only as target groups of subsidies of state-led programs
3. Facilitates new relationships between grassroots groups, social organisations, and the private and public sectors
4. Promotes the institutionalization of innovations, implying the breaking of and making of new sets of social and political norms and rules
5. Promotes the establishment of a more responsive institutional environment, mainly by lobbying, empowerment and awareness-building

5. Strategy

A community led reconstruction to development strategy is based on the premise that communities can be mobilized around rebuilding efforts. Collective action around rebuilding – whether it is houses, schools or community centers involves people in sharing of skills, resources, materials, benefits and ideas, and therefore is a shift from disaster to sustainable development. The process of social reengineering that occurs, results in empowerment, collaboration, knowledge sharing and joint learning with other actors to introduce innovative changes.

5.1 Building confidence in people's decision-making capacities
To ensure that firstly people receive on time information on their entitlements, understand safety features and develop first hand knowledge about local and new materials. Develop capacities to access cash and materials resources, are aware of earthquake resistant technologies and are part of community self-monitoring mechanisms if and when they are established.

5.2 Diffusion of Earthquake-resistant housing technologies - peoples' information campaign
After the Gujarat 2001 earthquake, over 7,00,000 houses were to be built, reconstructed, repaired strengthened in the affected region as part the rehabilitation program. It is proposed to immediately undertake a major earthquake-resistant housing technologies' diffusion campaign in the affected regions. PSI and later SSP had initiated similar information campaigns after the Uttarkashi and Latur earthquakes. The house owners, the district administration, voluntary organisations and the media acclaimed these campaigns.

After the Uttarkashi and Latur earthquake, the reconstruction package funded by the government ended up promoting manufactured building materials, e.g. cement, steel, fired bricks and tin sheets as against the traditional, locally available natural materials like mud mortar, stone and wood. Poorer families end up with very small and inappropriate houses. It needs to be emphasized, that all building materials with appropriate engineering can provide resistance in an earthquake. On the other hand, even manufactured materials can fail, as it happened in after the Gujarat 2001 earthquake. The scientific principles of earthquake resistant construction are fairly simple. The thrust of campaign has been to show how these can be incorporated in traditional buildings practices at minimal cost.

5.3 Demonstration of earthquake resistant technology: Demonstration units in the form of pilot strengthening of houses, building public community centers act as a catalyst for people to learn techniques of reconstruction. Rebuilding efforts are part of overall confidence building strategy with communities. Community centres provide the much needed space for women and communities to meet and voice concerns.

5.4 Strengthening community institutions: There is a need to ensure that village committees are formed after disaster to play an intermediary role bwteen govt,and communities. The key role in ensuring information and assistance reaches at every stage - finalizing list of beneficiaries, compensation, damage assessment, housing assistance, etc.

5.5 Empowering women's self help groups: to play a key role in mobilizing communities, addressing women's issues, enhancing participation of women in rehabilitation. Specific to the reconstruction program, women's can play a key role in reaching out information, Promoting safe construction practice, monitoring relief and reconstruction, ensuring earthquake resistant standards and providing feedback to administration.

6. Capacity Building Activities of women in Reconstruction

6.1 A coordinated **information and awareness campaign** on the nature and extent of damage, earthquake resistant construction, building material options, etc. resulting in a network of local development organisations equipped to conduct and scale up information campaigns for widespread dissemination.

6.2 Promoting the **construction of earthquake-resistant housing** in region, by popularizing the relevant concepts through

- Training of local masons and artisans
- Pilot strengthening of houses
- Demonstration of temporary shelters through community involvement
- Construction of community centres on demonstration basis
- Strengthen women's groups with skills to supervise earthquake resistant technology/construction
- Create a resource pool of trained artisans for reconstruction

6.3 Capacity building of NGOs/CBOs and women's groups

- Strengthen community/women's groups with capacities and skills to supervise onsite construction of community centers
- Facilitate exchanges between experienced NGOs and women's groups on post earthquake/disaster strategies from relief to rehabilitation
- Establish a team of trained NGOs and CBOs for scaling up of the community led strategy

6.4 Advocacy for policy initiatives on reconstruction and rehabilitation.

At every stage, there is a need for assisting NGOs and local groups to:

- Understand and analyze the reconstruction package and its implications for community participation. Together with this, suggest alternatives and demonstrate the usefulness of community institutions in planning, implementation and monitoring the rehabilitation

6.5 Right to information on entitlements

Gram Panchayats and /or village development committees need to be involved in mass scale information dissemination to affected beneficiaries. People need to be informed through Gram Sabhas or village assemblies.

6.6 Demonstration of low-cost earthquake resistant construction through building community centers

In addition to educating people through information campaigns and training workshops, building demonstration units in the form of community centers is essential, as there is little previous experience of such construction in the area. Building local capacities and skills is at the heart of the approach. Local artisans, masons and community volunteers receive on site training in earthquake resistant technology and construction. For the first time in this area, women were trained as masons. The women's groups were trained to manage the construction process – hire labour, ensure earthquake safe construction and operationalise activities.

The centers have proved very effective in bringing the network of women's groups and communities together to provide an effective platform for community planning and dialogue with institutional actors. Scaling up of this effort was done by SSP in partnership with the government and other agencies.

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The multiple benefits of community resource centres:

- Demonstration and on-site training on earthquake-resistant construction
- Community asset that is built and managed by women's groups
- Single window for investment in sustainable development and capacity building at the cluster level

6.7 Building temporary shelters with community involvement:

Temporary shelters built by people have clearly remarked functional spaces. There is a space for storage, space for women, separate bathroom and toilet, thus taking care of needs of family members. These are in contrast to the standard plastic tents provided by the govt. Involvement of community groups especially women allow for planning of shelters and basic services. Community spaces need to be provided for pre-school, community centres, health centres, office of local government, etc. These priorities can be decided through a consensus building process within the village and marks the start of involving people in rebuilding activities.

6.8 Pilot Strengthening of houses

In addition to demonstration of earthquake resistant community centres, there is an urgent need for demonstration of strengthening and reconstruction of individual houses. Besides, contribution of recycled materials , the pilot strengthening act as a demonstration unit. (Over 7,000 villages across 20 districts have been affected by the earthquake. The women's groups be responsible for the selection, flow of funds, monitoring earthquake resistant construction, etc.

6.8 Participatory Resource assessment:

A rapid assessment of earthquake-affected villages includes community readiness, capacities and skills, available technology and material options, and document initiatives by house owners on temporary shelters and public facilities.

- Availability of building materials,
- Technical personnel, Artisans and labour
- Access to market, infrastructure and transport
- Water supply and sanitation
- Access to basic services, schools, health centers and PDS etc.

6.9 Production of Education and Training Materials

- Production and dissemination of educational and training materials on earthquake-resistant housing.
- Do-it-yourself construction manual for building earthquake resistant rural houses. The manual describes in a step-by-step manner the procedure for building such homes. It is well illustrated with minimal text so those neo literates can use it.
- Depicting how typical houses collapse in an earthquake and how earthquake resistant features can strengthen such houses, at minimal cost, and help save lives. 50 copies each of two video films made by SSP highlighting the community involvement and in particular women's groups

7. Empowering Grassroots Women's Groups in Reconstruction

Rebuilding of public infrastructure is an opportunity for visible participation of women's collectives. Designed by SSP, the community self-monitoring system in 200 villages in Gujarat is led by women's groups. This bottom up system has proved crucial in monitoring of "progress" to ensure transparency in resource allocation, maintain quality of construction and provide on-the-spot technical guidance to house owners. SSP's core principle behind organising women's groups is that reconstruction serves as the focal point for organising women to address practical and strategic concerns in development.

Latur Earthquake

With the initiation of the community facilitator programme, where members of women's groups interfaced between the government and the communities, the local women's groups played a key role in the Repair and Strengthening programme after the earthquake. Crucial to the community facilitator programme was the government decision to "empower" women's groups as dialogue assistants to monitor village-wise reconstruction of houses. The women defied the long-held gender stereotypes and there was a significant shift from their being restricted to house and fieldwork to entering construction and taking on public roles. At the village level, the local leaders supported the participation of women in reconstruction first and later in long-term development.

SSP's experience of working with a 'critical mass' of women's groups from 200,000 households revealed that listening to women pays. Consequently, strengthening the participation of women's groups and communities in reconstruction, rehabilitation and later in their development in the quake-affected areas in Kutch is at the core of SSP's and its partners' strategy.

8. Networking and Building Partnerships

Training of NGO teams, CBOs, women's groups and house owners engaged in the reconstruction of earthquake-resistant housing. This is an essential confidence-building exercise for persons who do not have any significant construction experience.

Holding NGO trainings and village-level camps for educating the homeowners on earthquake-resistant housing principles and construction features. In addition to using the variety of training and education materials described above, a novel feature be to use the damaged and undamaged structures in the village to explain the principles of quake-resistance. Besides this a range of connected areas be addressed. The focus is create aware and trained teams who can carry this process forward.

- Post disaster relief and rehabilitation
- Needs assessment and planning with women's groups
- Facilitating community led reconstruction
- Monitoring government policy and plans
- Organizing women's groups to address post disaster trauma, health, livelihoods and shelter

Exchanges among community level women's self help groups: As part of the confidence building strategy, exchanges among women's groups (from Latur and Garwhal) at first to share insights and foster solidarity be planned. Build confidence in women who are coping with the crisis.

- Introducing women/community led approach to construction
- Role of women's groups in outreach, mobilization, bridging gap between govt. and communities
- Demonstration of earthquake resistant construction through building community centres

After a crisis, people need to interact with others who have coped with similar disasters. People to people exchanges between survivors and affected communities have many benefits. Exposure to self-reconstruction allows local groups to experiment with local materials, building techniques, and strengthen self-initiatives for rehabilitation. Later, these initiatives form the basis of building efforts in the area.

Kutch Earthquake

After the earthquake struck Gujarat, SSP along with the local Women's Federations shared its insights and experience from Maharashtra with affected communities in Gujarat. SSP's resource pool for transferring lessons consists of community and technical teams and 300 leaders of federations who have worked actively for post-earthquake rehabilitation in Maharashtra. The organisation and the grassroots women leaders brought in a range of strategies that created conditions for women and poor communities to participate in post-disaster rehabilitation, leading to people-centred development.

Latur Earthquake

With the Repair and Strengthening programme in progress in 1,300 villages simultaneously, project managers and government officials could not communicate directly with each beneficiary. Due to the very nature of the owner-driven project, it was imperative to have people's participation and their ability to handle the reconstruction work with limited supervision. A need was felt to find a village-based agency that could liaise between the administration and the communities. SSP through its field surveys had discovered that every village had at least one women's group although these were inactive. It took on the challenge of activating groups and initiated the community facilitator programme. The members of the programme belonged to the women's groups, and they interfaced between the government and the communities. Community facilitators had the responsibility of supporting house owners in the more technical aspects of construction including optimally accessing and utilising their entitlements, understanding earthquake-resistant construction, and using appropriate technology and resources.

Latur Earthquake

After the Latur quake, SSP spearheaded a mass-scale outreach and capacity-building programme with affected communities in the Repair and Strengthening Programme across 1,300 villages in Latur-Osmanabad districts. As Community Participation Consultant to the Government of Maharashtra from

1994 to 1998, SSP in collaboration with the government redesigned a community self-managed effort that replaced the usual beneficiary-oriented programme.

By forging alliances between the government at the state and national level and the NGO in key sectors such as disaster management, basic services and community infrastructure, a space is created for women's groups and community institutions to participate actively in designing and undertaking projects.

In order to sustain and build partnerships with the government and other institutions, and ensure that these relationships extend to women from the communities, women should be encouraged to visit municipalities and representatives of the government regularly and establish their priorities and needs.

Collaborating with a range of institutions is important because it not only brings in resources and information, but also educates the institutions on the situation of women and children in the quake-affected areas. In addition, these partnerships establish women as important actors with needs and demands, and help agencies to channelise resources and skills to victims.

About Us ….

Swayam Shikshan Prayog advanced the leadership of 500 village women's organisations by taking advantage of a World Bank mandate requiring the government to support community driven strategy in the post earthquake rehabilitation program across 2,00,000 homes in 1,200 villages in rural India's Maharashtra state.

Following the Latur earthquake in September 1993, women's collectives in the two districts were supported by SSP to play leadership roles in educating communities on their entitlements and infusing energy through mobilisation of communities in what was essentially an individual beneficiary focused state-led World Bank supported programme. Women's collectives were trained to recognise earthquake-safety features and supervised construction of houses, ensuring long-term sustainability of their homes and communities.

At the core of SSP's self-education strategy is the concept of peer-to-peer learning. SSP believes that community-to-community transfers of innovations can transcend boundaries and regions. In the context of the earthquake that struck Turkey in August, 1993, SSP's was challenged to transfer experiences from India to women's collectives supported by the Foundation for Support of Women's Work in the earthquake hit regions.

The massive earthquake in Gujarat state in January 2001 has occasioned a recent, extension of the scope and scale of community self-education processes. Eager to help, the SSP team and leaders of the women's federations traveled to their neighboring state to share their knowledge and skills previous experience to forge a community led reconstruction strategy in Gujarat. Today, SSP partners with emerging women's collectives in 200 villages in three districts in Gujarat, SSP and the women's groups are developing community to community exchange visits and other training methodologies to transfer their insights and lessons in earthquake reconstruction, re-establishing livelihood strategies, and mitigating future disasters.