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Rebuilding Nepal for next earthquake

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ABSTRACT

The paper is prepared to draw attention of local and international community including the government and donors to gear up for policy reform and create an environment for investing in proactive earthquake safety initiatives before the next earthquake strikes. The paper focuses on the outcome of the author's continuous interaction with local community since 1985 on the need for extended earthquake safety initiatives through stakeholders' easy access to technical assistance and financial resources. The most neglected aspect in the earthquake initiatives of Nepal is the lack of state ownership and lack of dedicated responsible institutions resulting in a massive toll of life and property. It is time to use the opportunity created by the April 2015 earthquake.

Keywords: policy reform; proactive initiatives; conservation; strengthening.

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Reconstruyendo Nepal para el siguiente terremoto

RESUMEN

El documento está preparado para llamar la atención de la comunidad local e internacional, incluyendo el gobierno y los donantes, para prepararse para la reforma de políticas y crear un ambiente para invertir en iniciativas proactivas de seguridad ante terremotos antes del próximo terremoto. El documento se centra en los resultados de la interacción continua del autor con la comunidad local desde 1985 sobre la necesidad de ampliar las iniciativas de seguridad de terremotos a través del fácil acceso de los interesados a asistencia técnica y recursos financieros. El aspecto más desatendido en las iniciativas con respecto a terremotos en Nepal es la falta de propiedad estatal y de instituciones responsables, lo que da lugar a un gran número de pérdida de vidas y bienes. Ya es hora de utilizar la oportunidad creada por el terremoto de abril de 2015.

Palabras clave: reforma de políticas; iniciativas proactivas; conservación; fortalecimiento.

Reconstruindo o Nepal para o próximo terremoto

RESUMO

Este artigo é elaborado para chamar a atenção da comunidade local e internacional, incluindo o governo e os doadores para se preparar para a reforma política e criar um ambiente para investir em iniciativas pró-ativas de segurança de terremoto antes do próximo terremoto se iniciar. O artigo enfoca os resultados da interação contínua do autor com a comunidade local desde 1985 sobre a necessidade de iniciativas de segurança ampliada de terremoto através do fácil acesso das partes interessadas à assistência técnica e recursos financeiros. O aspecto mais negligenciado nas iniciativas para prevenção contra terremotos do Nepal é a falta de propriedade estatal e a falta de uma instituição responsável neste assunto, resultando numa perda maciça de vidas e prejuízos às propriedades. É tempo de aproveitar a oportunidade criada pelo terremoto de abril de 2015.

Palavras-chave: reforma política; iniciativas proativas; conservação; reforço.

1. INTRODUCTION

The Nepal earthquake of April 25, 2015 and two major aftershocks of April 26 (magnitude 6.1) and of May 12, 2015(magnitude 6.8) and 425 smaller aftershocks (magnitude over 4) has left Nepal devastated making it difficult to return to normal life. Perhaps, the meaning of devastation is fully revealed in the experience of this quake, which has disrupted urban and rural physical settings and besides destabilizing mindsets as shown by reports from all over the world in vivid color.

Many aid workers were frustrated due to inability to visualize aid delivery to needy communities in the hinterlands and supply to more accessible urban areas including the Airport. Many supplies below national or international standards were dumped openly in the Airport and could not get into the country, a real pathetic scenario. The first few days saw many people flee of the country in panic in selfish disregard for the local partners with whom they had shared so much. Many countries rescued their own people leaving others to despair. Scenes of some running away while others rushing in led one to ponder over the wisdom of the rationale of action itself.

The rescue of devastated people from under the rubble in the aftermath of the Earthquake was a spontaneous efforts of local people and authorities working without any proper instructions – the Red Cross and local volunteers were much appreciated for help in rescue of several lives from the rubble. It was not surprising that those at the top floors escaped the death traps. The prompt relief by the international and the local communities were what brought the quake ravaged populace to a safe mode of refuge in the temporary shelters like tents, tarpaulins and tunnels of corrugated sheets.

This helped society in turn to achieve some resilience to earthquake by ensuring that post-earthquake epidemics like cholera, typhoid, swine flu, dysentery and diarrheria do not occur. Spontaneous volunteerism and active SMS network across the country warned about the range of precautions needed to be taken in a state-of–the-art show of our performance.

Cities in Nepal after the April quake look normal and did not at all resemble quake stricken cities. Vital infrastructure like water supply, electricity, telecom, roads, bridges, and airports remained unaffected and services were not disrupted. That was instrumental in effective delivery of the international and domestic relief works across the affected 14 districts. However, Kathmandu-Kodari Road, a vital link with China across Mahabharat and Himalayan range, was severely damaged and remained unserviceable. The surprise that this was not reported by the government and media is a proof of miss governance.

The damages though accounted as significant did not match that forecasted by previous studies (UNDP, 1992). The estimated and actual casualties and damages are presented in Table 1 below.

Table 1. Damages and toll

Description	Expected toll	Actual toll	As % of national figure
Human toll	100,000	8,969	0.03%
Injuries	300,000	22,321	
Collapsed buildings in Nepal	546,000	893,539	8.33%
Fully /partially damaged private houses		887,074	4.46%
Fully /partially damaged health facility		963	3.33%
Government offices		6,465	
Schools		6,308	
Industries		133	
Collapsed/damaged cultural heritage		745	
Endangered cultural heritage		1500?	
Hydropower damaged		18	
Bridges	> 50%	1	0.07%
Roads	> 10%	Few places	Very small
Water supply	> 95%	Few days	Very small
Telephone	> 60%	None	None
Source: Kathmandu Valley Earthquake Risk Mapping Project, UNDP 1992;			
http://drrportal.gov.np			

Apart from damaged buildings making over 4.5 million people homeless, numerous landslides and rock falls were triggered in the mountain areas, temporarily blocking roads.

The 1934 Bihar-Nepal Earthquake produced strong shaking in the Kathmandu Valley, destroying 20 percent and damaging 40 percent of the Valley's building stock. In Kathmandu, itself, one quarter of all homes were destroyed along with several historic sites (USGS).

The current Kathmandu cityscape is hardly indicative of one stricken by an earthquake. This is the result of 30 years' hard work of many people preparing in advance against the hazards of earthquakes. Damages and casualties were minimal because of this hard work without precedence. The airport was running 24/7; all bridges were intact, emergency supplies undisturbed; high rise buildings still standing tall in spite of non-structural cracks all over, and thousands of houses, commercial and institutional buildings standing intact except those that compromised on quality; devastation all around but people still smiling.

2. PROBLEMS AND ISSUES

The huge toll of life and property in the April 25, 2015 and numerous aftershocks could have been reduced considerably if capacity building of the local community, government and non-government agencies had been undertaken in time and a dedicated agency given charge. It was well known to all that a large earthquake was overdue and the only way to face such earthquakes is to make adequate preparations. Glaringly visible tasks such as need for updating building codes and urban development bylaws, removing the weaknesses and mischief in them, putting sincere efforts in implementation of the bylaws and codes, checking the strengths of buildings and determining the design earthquake, the need for peer review of design, quality and construction, verification, certification and the like were knowingly or unknowingly neglected and not implemented.

In spite of several voices called for attention to need for declaring policy on building Earthquake Safer cities and protecting important premises like historic cultural monuments, schools, hospitals, industries, communication and tourism infrastructure, the country has no pronounced program to the effect needed. Priorities related to conservation of heritage and cultural values versus modern engineering technology needs to be established. The technology for safeguarding millions of existing structures needs to be identified. The encouragement and motivation factors for investment in earthquake safer cities are still missing.

The need for training of municipal and practicing engineers in the design and construction of small buildings was initially addressed through young engineers training for earthquake resistant design with the support of UNDP (UNDP/Earthquake Safety Initiatives, 2008) but lately discontinued due to lack of support and initiatives.

This deplorable situation cannot continue any more. There is a strong felt need to find ways to create earthquake resilient communities through credible institutions, coordinated programs, environment for effective delivery mechanism, checking and verification of the actual deeds, and assuring the plans and programs are effectively implemented.

3. THE OBJECTIVES

The objectives of the paper are:

- To draw attention of the local and international communities to make significant investment in capacity building of the country as a whole to face challenges of potentially large earthquakes in the future,
- To strengthen 5.5 million units, already weakened by the current earthquakes and aftershocks, and comprising mostly Brick/Stone construction in mud mortar,
- To draw attention to the need to set a target for the next earthquake: the human toll below 1,000!
- To draw attention of the community and the government on the need for recovery and conservation of lost cultural heritage and ancient heritage settlements as priority, recovery of vast urban and rural settlements, and help to conserve and regenerate local economy to sustain the post-earthquake recovery needs,
- To provide training to structural engineers, architects and urban planners for post-earthquake recovery, seismic resistant planning and construction, and artisans training for quality construction,
- To encourage documentation of all premises for assuring earthquake safety,
- To help develop recovery guidelines,
- To help update building bylaws and building codes based on the lessons learnt from the recent earthquakes and international experience, and

- To draw attention to the need to establish an apex agency for earthquake affairs to develop ownership and responsibility.

4. THE GRAND REHEARSAL OF FUTURE EARTHQUAKES

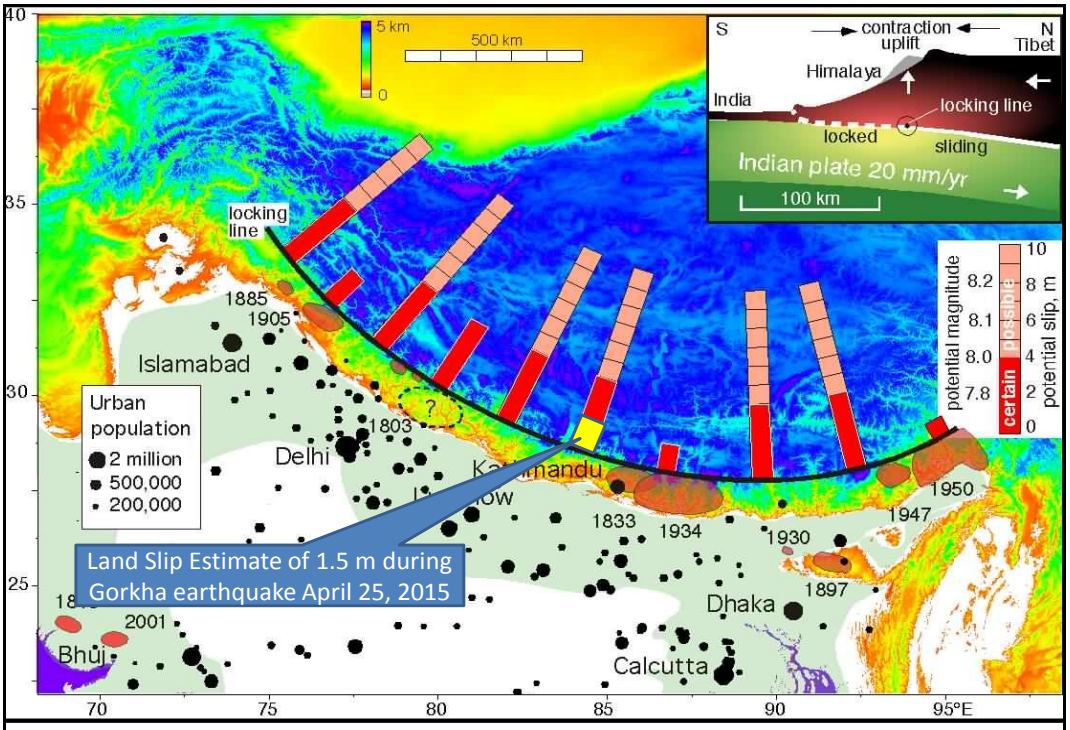
The potential for earthquakes in Nepal was already realized immediately after the 1988 Earthquake of Dharan and Rajbiraj which killed 722 people in Nepal and India, injured 12,000 and 450,000 left homeless. The best part of this quake was the triggering of awareness within the Government in Nepal and the donor communities leading to the establishment of the Kathmandu Valley Earthquake Risk Management Project, 1997.

The USGS quick report on the April 25, 2015 Gorkha Earthquake made reference to very large Nepal earthquakes, with a moment magnitude of 7.5 or more, observed in the historic periods in 1100, 1255, 1505, 1555, 1724, 1803, 1833, 1897, 1947, 1950, 1964, 1988. Three earthquakes comparable to the Gorkha Earthquake occurred in the Kathmandu Valley in the 19th Century: in 1810, 1833, and 1866. Seismic record of the region, extending back to 1100, suggests that earthquakes of this size occurred approximately every 75 years, indicating that a devastating earthquake is inevitable in the long term.

The strong motion network of Nepal is quite limited. Nevertheless, Kanti Path (Kathmandu) recorded the maximum ground acceleration of 0.164 g. The USGS preliminary estimation of the maximum ground acceleration (PGA) in the epicenter area was about 0.35g and 0.1 - 0.15 g for Kathmandu. In Western Nepal, PGA range was between 0.5 g and 0.6 g, whereas in Eastern Nepal that ranged between 0.3 g and 0.6 g. The PGA estimate was based on the empirical relations developed by Aydan (Aydan and Ohta, 2011; Aydan 2007, 2012).

Mr. Jean Ampuero, California Institute of Technology, in his paper "Salient Features of the 2015 Gorkha, Nepal Earthquake in Relation to Earthquake Cycle and Dynamic Rupture Models" indicates that the high-frequency (HF) ground motions produced in Kathmandu by the Gorkha Earthquake were weaker than expected for such a magnitude. The static slip reached close to Kathmandu but had a long rise time. An important observation (Katsuichiro Goda, Department of Civil Engineering, University of Bristol, Bristol, UK et al) is that the ground motion shaking in Kathmandu during the 2015 main shock was less than the PGA estimates (with 10% probability of exceedance in 50 years i.e., a return period of 475 years). This may indicate that ground motion intensity experienced in Kathmandu was not so intense, compared to those predicted from probabilistic seismic hazard studies for Nepal. Therefore, a caution is necessary in relation to future earthquakes in Nepal because the 2015 earthquake is not necessarily the worst-case scenario and more intense Earthquakes may be in the making.

The surface deformation measurements including Interferometric Synthetic Aperture Radar (InSAR) data acquired by the ALOS-2 mission of the Japanese Aerospace Exploration Agency (JAXA) and Global Positioning System (GPS) data were inverted for the fault geometry and seismic slip distribution of the 2015 Mw 7.8 Gorkha Earthquake in Nepal. The rupture of the 2015 Gorkha earthquake was dominated by thrust motion that was primarily concentrated in a 150-km long zone 50 to 100 km northward from the surface trace of the Main Frontal Thrust (MFT), with maximum slip of ~ 5.8 m at a depth of ~8 km, and 1.5 m at surface in Kathmandu Valley. In 1988, Roger Bilham estimated this slip would be of magnitude of at least 10 m (Figure 1). Thus, based on the observed values of maximum land slip and the maximum Probable Ground Acceleraation (PGA), the April Earthquake could be termed as a grand rehearsal for bigger future earthquakes in Nepal.



Source: Roger Bilhamand Peter Molnar of the University of Colorado and Vinod K Gaur of the Indian Institute of Astrophysics, 1997

Figure 1. Earthquake Gap in Himalayan Arc

5. VULNERABILITY ASSESSMENT AND CERTIFICATION NEEDS

Most of the existing buildings stock in rural and urban areas comprises of Non-engineered traditional construction of Brick/stone in mud mortar, with some recent buildings in cement and RCC structure. In the aftermath of the April Earthquake, it is assumed that over 80% of the damaged buildings fall in the first category of brick and mud construction, and remaining buildings in second category. But there is no post-earthquake detailed vulnerability assessment report of damaged and existing building stock available at this time. However, it is absolutely necessary to determine whether the existing building stock can withstand the next Most Considered Earthquake or Design Earthquake. This question demands a detailed vulnerability assessment of the building stock covering four issues: 1) lack of documentation of the building stock, 2) Updating of building code with consideration of recommended Design Earthquake Model. Many of these buildings are not designed to sustain that kind of load; 3) construction quality and change in occupancy, and 4) maintenance (Samir Chidiac, McMaster University, May 21, 2008).

No matter how good the design is, the building is not the one it should be if it is not built or used as specified. This is what we have seen happening quite often. The buildings designed and constructed have neither the quality monitoring certificates, nor operational monitoring like design load maintenance, occupancy and maintenance certification. Even a well-built building age, which means its properties change, and we have a problem if we do not address these issues. One of the most important actions carried out in Nepal immediately after the earthquake was the rapid visual vulnerability assessment of buildings. But the action faced controversy because of lack of adequate preparation and legal provisions. The tools used were informally borrowed from ATC 40 without proper legal backup and training. Most controversial action was the issue of Stickers (Green, Yellow and Red) categorizing the buildings into Safe, Caution, Unsafe (Figure 2). The actions created confusion in the community about its rationale and relevance. Surely, that was the result of lack of preparedness for such rapid action.

Strikers: Safe and Unsafe Category of Buildings
Figure 2. Rapid Vulnerability Assessment

The stickers were a good example of lack of adequate preparation. They were issued in very unprofessional manner and illegally since there were no such laws or guidelines that provide authority to do so. The Rapid Vulnerability Assessment forms were borrowed from elsewhere without authorization, proper guidelines and did not match with typology of the buildings in the country.

6. THE CHALLENGES

6.1 Recovery of damaged buildings.

Table 1 above indicates the extent of damages to the building stock that include various category of buildings such as 1) Low rise concrete buildings, 2) Residence in brick masonry in cement mortar, 3) Residence in brick in mud mortar, 4) Residences in traditional heritage Buildings in brick and mud mortar, and 5) Rural construction in stone in mud mortar, and 6) Rural construction in bamboo and thatch roof.

The distribution of the category of these buildings is not known. There are two major challenges: 1) Demolition of collapsed buildings and disposal or reuse of debris, and 2) Rehabilitation of partially damaged buildings and buildings with minor damages. The general psyche is that buildings with cracks (whatever may be the extent and cause) are no more useful for habitation and many started demolition without any thoughts to potential for restoration or rehabilitation. That has created strain on building stock deficiency creating huge price rise on rental. But the rational for recovery is on rise.

Quick recovery of damaged buildings immediately after the earthquake was a very important aspect that would reduce the strain on the building stock. But in the absence of recovery guidelines, access to resources like technology of recovery and financing, the people gradually forgot the earthquake shock and started recovery in their one way, mostly guided by the approach to quick repair and to demonstrate that the buildings were not affected by the earthquake. They could no more wait for proper process but made efforts for quick financial recovery through early use of the premises, neglecting safety issues. The buildings demolished during the relief works period was never recorded and analyzed to find the root cause of the damages and actual effect of the earthquake.

6.2 Conserve and earn.

Most challenge is faced by the traditional residential buildings and heritage monuments with vernacular aesthetics that represented the identity of the country and carried the value of history and culture of over 2,500 years. Recovery of these buildings in the original form and shape would be a strain on resources unless specific measures are taken to recover the lost heritage and generate economic return. The traditional residences without modern infrastructure and vehicular access

could be very redundant. There are several approaches being forwarded under the principles of "Integrated Settlement Development" which will be developed following massive dismantling of damaged buildings to produce an outlook (Pilachhen Integrated Reconstruction in Lalitpur and Khokana, 2016, Figure 3).

A: Pillachhen redevelopment (Source: Maya Foundation)

B: Khokana reconstruction (Source: Kantipur Daily)

Figure 3. Some cases of proposed recovery of traditional heritage settlements in Lalitpur.

This will be totally a new construction and will carry none of the cultural or historical values represented in the settlements. The modern trends towards quick recovery will change the landscape and will lead to the extinction of ancient values and a total loss of the whole heritage assets. The broad objectives of these reconstruction as stated are: 1) To provide safe living and healthy environment by repairing and reconstructing houses of the local residents, 2) To protect the traditional architecture, 3) To develop infrastructures and improve vehicular accessibility, 4) To promote local business, 5) To increase income of local residents by promoting the tourism - oriented business, and 6) To conduct programs in social buildings and open space for encouraging social interactions.

Though the reconstruction program has prevision for protection of traditional architecture in its objectives, it has ignored the conservation of heritage and historic values of 2,500 years. Possibly, we are wandering in the forest of post-earthquake slogans and terminologies like Building Back Better, rebuild, recovery, retrofit, renovation, rehabilitation, protection, conservation and reconstruction. Until we are clear about our needs, we are sure to be swept away by the flood of funds being poured in the reconstruction. Immediate resource mobilization and the money power it represents is much stronger than represented by professionals struggling with lack of resources and time. However, sharing information on best practices may be still relevant and useful if only to give some lessons and directions for future. Some of the examples of regeneration based on recovery of cultural heritage settlements promoted under the principle of "Conserve and Earn" have successfully carried the message for paying attention to heritage conservation. These schemes are very popular and are better known as "Home Stay" tourist accommodation. Some of the better examples are: Shrestha House and Swotha Café (Figure 4).

Figure 4. Shrestha house and Swotha Café converted to "Conserve and Earn" projects

The innovative concept of "Conserve and Earn" was recognized by UNESCO and given "World Heritage" recognition. These structures did not suffer during Gorkha Earthquake.
Some of the cultural heritage monuments restored with International assistance suffered severe damages and totally collapsed (See Figure 5). Apparently, earthquake resistance was not in their agenda.

Bhimsen Temple, Lalitpur; Nautalle Durbar, Basantapur; Digutaleju, Lalitpur.
Figure 5. Heritage monuments restored with international assistance damaged during Gorkha Earthquake

Similarly, there are a few instances where local authority intervention damaged structures of cultural heritage post Gorkha Earthquake (Figure 6). Temporary timber struts were erected without any purpose and without the authority's knowledge and without consultation with local community. The struts were removed again without any information nor evaluation of required strength or caution. This shows lack of ownership at the Government level and lack of consultation with the professional and local community. The world-famous Krishna temple of Lalitpur was damaged by the municipality's unthinking intervention with erection of timber struts immediately after the quake, causing considerable damage to the temple. Note the damage to ancient inscription on the stone.

Figure 6. Krishna Mandir at Patan, damaged with post-earthquake protection efforts

7. BUILDINGS CODES UPDATE AND PEER REVIEW

The lessons from the earthquake clearly indicate that the building damages are largely dependent on appropriate use of the building codes, quality of construction, proper operation and maintenance, monitoring occupancy change and location. The use of building code itself is a complex process requiring considerable time for design of building based on the code requirements and inelastic design based on computer modeling. The Building owners hardly understand the complexities of time consuming seismic resistant design. More complex is the situation in Nepal where the need for following other international codes is paramount since Nepal Building Code in itself is inadequate and incomplete (Box 1). There is a dare need to update the Nepal Building Code (UNDP/ERRRP: NEP/07/010, 2009) to make it independent of other codes or reduce it to a guideline to help choose better codes. More important is the lack of prevision of a mechanism for Inspection and Code Enforcement (ICE). The lack of prevision for peer review of design, construction and assurance of public safety is indeed very detrimental to serious professionalism.

Box 1: Nepal Building Code Deficiency

Nepal Building Code is divided into four sections: Part 1) State-of-the-Art Buildings, Part 2) Professionally Engineered Buildings, 3) Non-Engineered Buildings (Mandatory Rule of Thumb), and 4) Rural Construction. The code is divided into 22 parts and the seismic design method is specified in NBC 105.

In the preface, NBC 105 has included IS 4326 - 1993 Code of Practice for Earthquake Resistant Design and Construction of Buildings as related code. There is a marked difference between these two codes with various values of the seismic parameters and giving different results. This anomaly has confused most of the practicing engineers and NBC is practically not used. Other factor affecting the use of NBC is the non-accessibility of International software as SAP, ETAB and STAAD Pro which do not recognize NBC.

During Gorkha Earthquake, a lot of buildings designed under NBC 105 Part MRT (Non-engineered Buildings) were damaged. The part of the code is considered inadequate in terms of structural safety and need to be replaced with standard designs for ready use. This part of the code is most misused by the municipality registered designers through copy and paste without a care for details or applicability without giving design considerations and not verified for its acceptability.

The return period, as specified by NBC 105, for the onset of damage for a typical building of ordinary importance has been chosen as 50 years. The return period for the strength of buildings has been chosen as 300 years. NBC 105 specified return period may be an under scored value compared to Katsuichiro Goda recommendation (See Box2).

Box 2- Design earthquake model
The Gorkha Earthquake Damage Survey report (Katsuichiro Goda and et el) recommended that a basis for seismic design comprising the PGA estimates with 10% probability of exceedance in 50 years as the design earthquake model for Nepal. IS 1893 has included two categories of Design Earthquakes: 1) 2 percent probability of exceedance in 50 years (Maximum Considered Earthquake - MCE) and 2) 10 percent probability of exceedance in 50 years (Design Basis Earthquake - DBE) with category 1 structures designed for MCE, which is twice that of DBE, whereas structures in category 2, 3 and 4 are designed for DBE for the project site. ATC 40 has specified 3 levels of earthquake ground motions: 1) Serviceability Earthquake (SE) with 50 percent probability of exceedance in 50-year period, 2) Design Earthquake (DE) with 10 % probability of exceedance in 50-year period, and 3) Maximum Earthquake (ME) with 5% probability of exceedance in 50-year period. ATC 40 has related the level of earthquake with the performance level of buildings which is not the case with NBC 105.

Considering the above earthquake design parameters, the level of risks of structures will depend on the choice of building code selected. Hence, the considered level of risk in every project is different and level of earthquake hazard risk in Nepal also becomes heterogeneous depending on the source of funding. In this context, NBC 105 may need updating to reflect the demand of recent earthquake and future probable earthquakes and may need to develop consensus among the leading professionals and academia about the choice of appropriate earthquake design model.
Having said that, it is imperative that the consistency of design principles is not lost and compliance to the building code requirements or application of correct design criteria and analysis is assured. The need for a unified code acceptable at international level has become imperative.
Apart from this, the assurance of use of appropriate code provisions and correctness of its interpretation and compliance is very important to insure consistency and to eliminate any deficiency through peer review of seismic resistant design and Third Party Verification (TPV) of the quality of design and construction.

8. REBUILDING APPROACH

After the donors meet called by the Government in May 2015, the International Community and the country expected that rebuild initiatives would be launched very quickly and the recovery initiatives started. The Government's effort to establish an independent authority met political and legal hurdles and was practically paralyzed. The Government's post-quake instructions, related to 1) restriction on new construction, 2) reduction of interest on bank loans, 3) short term training of fresh engineers and 4) the creation of National Rebuilding Authority, became redundant due to inadequate homework and preparation and hence could not be formally established even after 6 months. Lack of expert consultation led to unilateral decisions and the general government attitude of "making decisions in haste and repent in leisure" was clear.
The well-wishers from all over the world are quite in panic about Nepal loosing precious time, being unable to gear up for post-quake recovery. With no practical guidelines people started repair and recovery without any engineering or government support and many of the buildings started returned to status quo ante.

Strong voices urge Nepal to learn from the experience of other countries (Japan and New Zealand et el) in earthquake recovery by sending fact finding mission for learning lessons in right approach and policy. The New Zealand's approach to post quake recovery through nomination of the Rebuild Team comprising of industry representatives i.e. the government, consultants, contractors, bankers, suppliers and manufacturers, insurance and community was a unique model that helped New Zealand to recover from the 2011 earthquake in a fast track manner with most effective use of cost and time, employment creation and funds recovered from insurance coverage.

Recently, the september 16, 2015 earthquake with magnitude 8.3 Mw in Chile caused only 13 fatalities. Why only 13 fatalities in this earthquake, considered the world's strongest earthquake to date in 2016 while far weaker earthquakes in Haiti and, more recently, in Nepal, killed tens of thousands? The Chileans very proudly report that the resilience of Chile has three dimensions: a) Strong evacuation plans in coordination with international community as the UN humanitarian affairs office and the International Search and Rescue Advisory Group [Insarag], b) Strict building code that demand all new buildings must be able to survive a 9.0-magnitude earthquake: buildings can crack, tilt and even be declared unfit for future use but must not collapse, and c) Strong and sensitive response to the disaster carried out by Ricardo Toro, a former army general, in-charge of Chile's disaster relief agency, ONEMI.

The 24th August 2016 earthquake (6.2-magnitude) in Amatrice, Accumoli and Pescara del Tronto in mountainous central Italy, killing 240 of people and ruining the whole city reminded Barpak, the epicentre of Gorkha earthquake and indicated the need for taking proactive initiatives before earthquake strikes.

Lack of an institutional model for rebuilding, generally dealing with Earthquake Affairs is the prime reason behind the current chaos in rebuilding regime.

9. ASSISTANCE FOR PROTECTING EXISTING BUILDING STOCK

Protecting existing building stock of Nepal with over 5.5 million is a big challenge in itself. There is not a single building, affected by the Gorkha Earthquake, specially the rural brick/stone buildings in mud mortar. The biggest threat to the rest is from a society that views demolition is the best way in three reasons: 1) The building does not belong to them or the owner is from the different community or neighborhood, 2) It is the easiest way to be safe from the risk it is associated irrespective of the actual physical condition, and 3) There are no funds or technical assistance available for detailed damage assessment and to determine the wisdom of demolition or protection through retrofit techniques. Surely, when wisdom fails and the fear-mongers prevail.

The Chandeswhori temple of Lalitpur, Bhaktapur municipality building and Bhisen stambha of Kathmandu.

Figure 9. Existing Building stock waiting for rebuilding

Demolition and reconstruction of 5.5 million houses is not a figure any economy can afford, and surely not Nepal. If the Bhimsen stambha (Dharahar Tower) reconstruction with a price NPR 3 billion were to contest with the recovery of more valuable heritage objects like Chandeswhori temple, among 15,000 heritage monuments country wide, besides the 745 prepared by the Department of Archeology, not counting the recovery of 5.5 million houses. Nepal Reconstruction Authority needs to look seriously at formulating a judicious policy, with a set of priorities that will ensure the recovery of most valuable national assets associated with the daily life of the people.

10.NEED OF AN EARTHQUAKE SAFETY COMMISSION

Earthquake issues and remedies discussed above leads one to a specific need for a permanent responsible institution in-charge of earthquake affairs, acting as an apex national body that will provide leadership, undertake policy reforms and guide all activities in the sector.

Obviously, there is no common approach to earthquake issues dealt at national or regional or state levels. In the context of Nepal, there is clearly no top-level agency responsible for earthquake issues. It is widely felt that an Earthquake Safety Commission may be required for dealing with the vast scope of rebuilding, preparing for next earthquakes, and mobilizing national and international resources. The Commission may be an independent and autonomous body charged with the mandate to deal with all aspects of earthquake including research and studies, development of technology and policy reforms, performance evaluation, development of strategy for the future, review and updating of building codes, bylaws, guidelines and manuals, conducting training and capacity building, and ensuring overall safety including support for total insurance of residence and infrastructure. Dissemination of this information and knowledge to professionals and community leaders helps to upgrade local community capacities for creating an Earthquake Resilient Society.

11.CONCLUSIONS

Nepal is a highly earthquake prone area with noted earthquakes of magnitudes 4-5 Mw two times a year, one in summer and one in winter. The Gorkha Earthquake of April 25, 2015 is considered as a grand rehearsal for future potential earthquakes based on the historical frequency. The large energy accumulated in the Himalayan Range, particularly around Kathmandu, could rock the area with a land slip of 10 m, which was not fully released during Gorkha earthquake.

The huge loss of life over 8,900 and loss of property about 600,000 collapsed buildings and 500,000 damaged buildings, though a very sad result, is considered significantly less compared to the previously estimated figures. This is a positive result of efforts made during last 3 decades towards creating Earthquake Safer Cities. At the same time, it is also commonly agreed that pre-earthquake preparation was grossly inadequate.

Nepal's march towards Earthquake resilience carries a lot of challenges. In the wake of the recent earthquake and those sure to come, Nepal needs to rebuild over 800,000 buildings and strengthen other existing 5.5 million buildings of adobe construction. Apparently, there is no effective technology to restore, rebuild and strengthen the existing adobe construction. At the same time, updating of the building code and its strict inspection and enforcement would help to ensure an Earthquake Resilient Society in terms of assessment, planning, implementation in a timely manner. The rebuilding initiatives already have been delayed by 16 months. It has disappointed the whole world and the devastated people. But the Government is still not in moving. This is a very pathetic situation, aggravated by the economic embargo at Nepal-India border of september 2015 further delaying the rebuilding and overall progress. The country is slowly going back to the same status of vulnerability as it was before the earthquake.

There are several models of recovery and rebuilding from earthquake disaster. Gujarat, Haiti, Chile and Christchurch are recent models. The Chile model has very strong search and rescue plan, strict building codes that demand for no collapse design, and sensitivity towards Earthquake Disasters. Christchurch model mobilized resources within the country with formulation of a strong and dedicated rebuild team based on non-profit job distribution. Probably, Nepal need to combine and blend together a suitable rebuild course based on world experience.

Creation of Earthquake Resilient Societies and traditional settlements require advanced preparation in the form of: a) Overall Plan for rebuilding and recovery of lost assets, b) strengthening of existing buildings and structures including vulnerability assessment, data base of buildings and infrastructure, technical assistance for damage assessment and design for strengthening, c) implementation of strong building codes and enforcement plan, and d) sensitization towards earthquake disaster. These tasks need meticulous planning, setting priorities, developing tools to enhance access to expertise, building capacity, mobilizing resources, and verifying compliance with standards, along with plans for new construction, strengthening and retrofitting of existing buildings.

The planning, design and effective implementation of earthquake resilience plans require an effective and responsive agency that can take leadership and guide the stakeholders to take delivery of services required for earthquake resilient societies. Two dedicated institutions are in high demand, if the country is to prepare for the next earthquake: 1) Earthquake Safety Commission, and 2) National Building Council to take charge of building code update. The process of institutional building in the post-earthquake rebuilding course of Nepal appears to be straining for release as the initiatives are yet to be recognized and put in place. The steps to be taken, consistent with agreed priorities could be summarized as follows:

- Mobilizing fact finding missions to various countries for learning lessons from previous devastating earthquakes including the Italian Earthquake of September 2016 and identifying effective rebuilding approach,
- Taking initiatives for updating of building codes and defining inspection and code enforcement (ICE) procedures including third party peer review or verification (TPV) including remodeling of the unacceptable design of non-engineered buildings,
- Developing support mechanism for appropriate technology to address local demand for recovery and rebuild of lost buildings and strengthen existing buildings in adobe construction,
- Developing consultation mechanism for addressing professional and community concerns,
- Establishing historical ownership and local community rights on heritage settlements and monuments,
- Providing priority to conservation of cultural heritage monuments and settlements, and economic value return for recovery and rebuild products for sustainability,
- Establishing incentives and motivation packages including reduced interest rates for bank loans, eliminate Government and municipal taxes on rebuild activities and seismic strengthening of properties, and
- Taking policy reforms in updating building bylaws, building act, evacuation and rescue plan, and earthquake hazard insurance.

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