From Code to Practice

Challenges for Building Code Implementation
And the Further Direction of Housing Earthquake Safety

Records and outcomes of
International Symposium 2008 on Earthquake Safe Housing
28-29 November 2008, Tokyo, JAPAN

UNCRD
United Nations Centre for Regional Development
Disaster Management Planning Hyogo Office

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Notes: International Symposium 2008 on Earthquake Safe Housing (28-29 Nov. 2008) in Tokyo, Japan has hosted by three organisations; Building Research Institute (BRI - Tsukuba, Japan), National Graduate Institute for Policy Studies (GRIPS - Tokyo, Japan) and United Nations Centre for Regional Development (UNCRD) Disaster Management Planning Hyogo Office, Kobe, Japan. This publication is a record of the Part II of the symposium, whereas proceedings of the Part I (coordinated by GRIPS) and the Part III (coordinated by BRI) are issued separately by respective institutions.

Preface

by Shoichi Ando
Coordinator
UNCRD, Disaster Management Planning Hyogo Office

For those whom live in earthquake prone area in the world, reduction of damages in earthquake disaster is one of the urgent issues. Every single earthquake may occur massive damage in human lives and properties- as recently for instance, around 70,000 people were killed with the Wenchuan Earthquake occurred in Sichuan Province of China on 12 May 2008. Many of them claimed their lives by being pressed with collapsed buildings particularly their own houses. Remembering the similar damages in Kobe in 1995, and other disasters, I believe that the victims have taught us the importance of building and housing safety against the earthquake as mostly killed by their own houses.

The impact of earthquake on livelihood of people can be reduced by measures such as adherence to earthquake resistant building design and construction standards, proper planning, education and trainings. However, the risk is ever increasing as urbanisation in developing countries is adding extra pressure on building construction. Although those countries have established a building controlling system, it can seldom function effectively due to lack of awareness on disaster prevention in communities as well as lack of regulatory mechanism for effective implementation, monitoring and reviewing.

Obtaining the support from the Ministry of Land, Infrastructure, and Transport (MLIT), Government of Japan, in 2007, United Nations Centre for Regional Development (UNCRD) launched the Housing Earthquake Safety Initiative (HESI) with goal to improve structural safety of houses and currently is working on activities for policy recommendation and capacity development. As the initial step for the works of HESI, UNCRD has launched a project on Anti-seismic Building Code Dissemination (ABCD) in Algeria, Indonesia, Nepal and Peru. One of the major endeavours within those activities is creation of platform for networking, information exchange, sharing knowledge and sharing good practices in mitigating earthquake risk throughout the world. For maximising the effectiveness of the platform, UNCRD has organised “International Symposium 2008 on Earthquake Safe Housing: Discuss together on the keen and common issue” in Tokyo, Nov. 2008 with Building Research Institute (BRI), Tsukuba, JAPAN, and National Graduate Institute for Policy Studies (GRIPS), Tokyo, JAPAN, which are both also working on the matter of housing safety in terms of preparedness of earthquakes. UNCRD was in charge of the second part of the symposium- “From Code to Practice: Challenges in Building Code Implementation”. Also, utilising the occasion of international symposium, UNCRD also conducted the international expert meeting on HESI in order to identify the further way to promote the work on Earthquake Safe Housing.

A record of the above mentioned events was prepared and published to illustrate the work for HESI. At this symposium the HESI received valuable inputs from the greatest authorities in this field. Having been successfully clarified the latest issues around housing earthquake safety the papers included here go beyond the mere records of the reports, rather precious literatures and resources which indicate the latest issues of the Earthquake Safe Housings. UNCRD believes, therefore, even though published as a part of series of proceedings under HESI events, the booklet would be instrumental as one of the crucial reference for the future activities on Housing Safety, which would be the significant outcome of the platforms amongst stakeholders which was intended under the HESI project. I sincerely thank to the participants, particularly presenters at the symposium, co-organisers of the symposium: BRI and GRIPS as well as the MLIT, which also supported the symposium and the project.

Shoichi Ando
Coordinator,
Disaster Management Planning Hyogo Office,
United Nations Centre for Regional Development (UNCRD)

Foreword

by Salvano Briceño
Director
UNISDR Secretariat

The loss of life and property from disasters is detrimental to the effort of sustainable development and to achieve the Millennium Development Goals. Notwithstanding the progress of the *Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters*, the damages witnessed in the recent earthquakes in China, Indonesia and Pakistan are cruel reminder of the challenging task to meet the goal of sustainable development. Majority of the losses in earthquakes are caused by damages to buildings and structures. There is tremendous progress in science and technology of earthquake safer structures and the knowledge has been documented as codes and guidelines. Unfortunately, many structures unsafe against earthquakes are still being raised. Effective implementation of those codes and guidelines is essential for reducing losses from earthquakes.

The United Nations International Strategy for Disaster Reduction (UNISDR) has supported initiatives for housing earthquake safety, conducted by various organizations. Those initiatives should be further implemented and shared regionally amongst earthquake affected areas. The UNISDR, thus, appreciates the Anti-seismic Building Code Dissemination (ABCD) project conducted under the Housing Earthquake Safety Initiative (HESI) by UNCRD, which connects regionally various efforts and experience in various sectors, international and local experts, national and local governments and policy makers, expert NGOs, academic institutions and construction practitioners.

The HESI of UNCRD is a very important step to translate the existing knowledge into practical measures to mitigate the risks from earthquakes. This publication, which is a summary of the experiences of UNCRD in the dissemination of building codes to different countries and of experience of noted experts who have devoted many years in propagating the message of earthquake safer society, will contribute further in understanding the achievements so far and challenges ahead for safer housing.

I hope that readers will find it useful and will use it as reference material in their work for mitigating earthquake disaster risk and building resilience of nations, regions and communities to disasters. Also, I cordially expect for further challenges of HESI of UNCRD and collaboration with us in order to build disaster resilient households, which are essential requirements for building resilience in communities, regions, and the world to natural hazards.

Salvano Briceño
Director
UNISDR Secretariat

Opening Remarks

by Kazunobu Onogawa
Director
UNCRD

Good afternoon, ladies and gentlemen,

Thank you very much for your participation in this International Symposium 2008 on Earthquake Safe Housing, jointly organized by Building Research Institute of Japan, National Graduate Institute for Policy Studies, and UNCRD.

I also appreciate the participation of the people coming from abroad including resource persons for this session "From Code to Practice: Challenges in Building Code Implementation", such as Professor Arya from India, Mr. Boen from Indonesia, Mr. Sangachhe, from Nepal. I am also happy to be able to see the face of our long term friend Mr. Amod Dixit, from NSET, Nepal. .

Ladies and gentlemen,

Earthquakes in different parts of the world are claiming thousands of lives and million of dollars' worth property every year.

Despite the tremendous progress made in the science and technology of earthquake resistant building construction, many buildings including public facilities such as schools, are still being constructed with a manner not safe enough against earthquakes. The earthquake in Pakistan in 2005 damaged 10,000 schools, and by this earthquake, 17,000 students were killed, trapped in collapsed school buildings. More than 7,000 students died during the Wenchuan China earthquake in May 2008.

A survey conducted by UNCRD and Geo Hazard International in 2001 highlighted the fact that, regretfully, many cities await similar fate.

The UN MDG envisages that, by the year 2015, children all over the world will be able to complete a full course of primary schooling. As we are insisting on every child to go to school, it becomes an essential task to keep all the schools safe. Schools have important roles to play in a community and they can play central role in all stages of disaster risk reduction cycle: starting from preparedness, response, and to recovery.

UNCRD conceptualized and initiated School Earthquake Safety Initiative (SESI) in 1999, and from 2001, Hyogo – Nepal collaboration on earthquake school safety was started. After that, "school safety programs" have been at the core of UNCRD's disaster risk reduction activities. The current project on Reducing Vulnerability of School Children to Earthquakes is being implemented as model projects in four countries, Fiji, India, Indonesia and Uzbekistan.

It is also important to extend such efforts to other buildings. UNCRD's approach, in collaboration with Building Research Institute of Japan, for the development of building code with due attention to the non-engineered buildings, and its dissemination among the developing countries is another activity of us. I am happy that Dr. Narafu, BRI, would introduce such a collaborative approach to you at this session.

What is important is the materialization of the ideas, theories and concepts in the real world. For this purpose, I understand the importance of the involvement of all the stakeholders in our society, starting from the responsible government offices, association of engineers, masons and further, our own communities. In addition to the fundamental roles and responsibilities of the leading organizations for construction and urban planning, it is essential that we ourselves are being prepared for possible disasters including the earthquake.

There is no doubt that we need an established building code for our own buildings. Having an alerting system in our society for such disaster, including forecasting system, information dissemination system using public media, etc, are also essential. But, at the same time, we have experienced many cases that these systems and established rules and requirements did not function well as were expected because of the lack of communication network among ordinary citizens. We should not forget the fact that the final actors are individuals, citizens, ourselves.

This is why UNCRD has worked on the community based approach to be prepared for the disasters, in particular earthquakes, since the establishment of Disaster Management Planning Office at Kobe in 1999, seeking the effective involvement of local citizens in this activity expecting effective improvement of the situations we have faced.

Ladies and gentlemen,

All of our activities on earthquake safe housing which we are discussing today can be effective tools to reach to the communities for building a culture of safety. All the key components of our activities can become good opportunities to create awareness in the community and to build their capacity for disaster preparedness, response and recovery.

At this opportunity I would like to express my gratitude to the counterpart organizations and experts that have been involved in this collaborative initiative. UNCRD will continue to seek possibilities to share the outcomes of our work, and to promote our activities in the future, for the sake of the people who are facing disaster related problems in the world.

Thank you.

Housing Earthquake Safety

Lessons and Challenges

Earthquake and Non-Engineered Buildings
Role of Governments, Experts and Guidelines

by Anand Swarup Arya,
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National Seismic Advisor – Government of India / UNDP
INDIA

Abstract

This paper illustrates the importance of institutional arrangements in terms of (earthquake) disaster preparedness alongside with guidelines for construction of non-engineered buildings, which is widely used in seismic countries particularly in India. Outlining the comprehensive action to be taken for safer non-engineered buildings, the paper explains the role of experts and governments to complete the duties. In the list of works, the author focuses more on long term action, by employing legal and educational strategies; as it is essential for minimising the loss which could be happened with the earthquakes in the future to see consolidated efforts of experts as well as governments.

Introduction

Earthquake falls in the category of hazards which have low frequency probability of occurrence in a given area but highly disastrous consequences. The occurrence of an earthquake cannot be prevented nor predicted with any precision at present. The catalogue of earthquakes in India prepared by India Metrological Department (IMD) lists more than 1200 earthquakes of magnitude ≥5 on the Richter scale which have occurred in India from the year 1505 to 2006, (about 90 of these belong to the period before 1897). Earthquake zoning map of India classifies 59% of land area prone to earthquakes of MSK VII and higher Intensities (See Figure. 1). Thousands of masonry buildings have been damaged or totally destroyed in some of the moderate to major earthquakes with Magnitudes 6.0 to 8.7 on Richter scale. A few of the better known damaging earthquakes are shown in TABLE 1 with the numbers of lives lost. The experience in the recent earthquakes in Kachchh district in Gujarat State in 2001 and in Jammu & Kashmir in 2005 has created high concern about earthquake damages in the Government circles in the country.

Figure.1:- Seismic Zoning Map of India

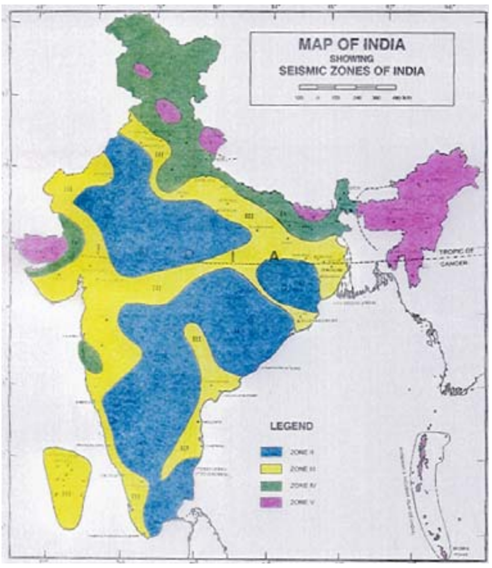
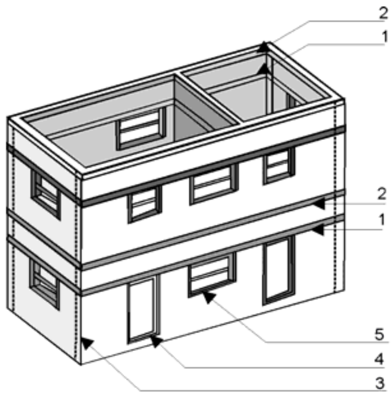


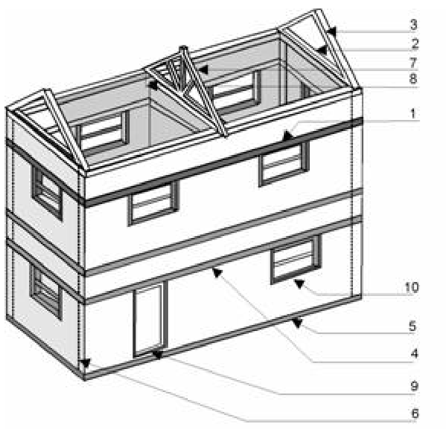
TABLE 1. SOME BETTER KNOWN DAMAGING EARTHQUAKES IN INDIA

Year	Area	Date	(I.S.T) Time hr:m:s	Latitude degrees North	Longitude degrees East	Magnitude M	Max. MM Int.	Deaths
1819	Gujarat (Kutch)	Jan.16	Mid Night	-	-	8.0	XI	Thousands
1833	Bihar-Nepal	Aug.26	-	27.5	86.5	7.7	XI	Hundreds
1897	Assam (Shillong)	Jun.12	16:36:-	25.9	91.0	8.7	XII	1600
1905	Himachal Pradesh (Kangra)	Apr 4	06:20:-	32.5	76.5	8.0	XI	20000
1934	Bihar -Nepal	Jan 15	14:13:26	26.6	86.8	8.3	XI	14000
1950	Assam (NE)	Aug 15	19:39:28	28.7	96.6	8.6	XII	1500
1956	Gujarat (Anjar)	Jul 21	21:02:36	23.3	70.0	7.0	VIII	Hundreds
1956	UP (Bullandshahar)	Oct 10	-	28.1	77.7	6.7	VIII	Many
1988	Bihar - Nepal	Aug 21	04:39:10	26.76	86.62	6.6	VIII	1003
1993	Maharashtra (Killari)	Sep 30	03:55:47	18.07	76.62	6.3	VIII	7928
2001	Gujarat (Kachchh)	Jan 26	08:46:00	23.6	69.8	Mw = 7.7	X	13805
2005	J&K (Kashmir)	Oct 08	09:20:00	34.5	73.6	Mw = 7.6	X	Ind-1400 POK-73276

Figure 2. Earthquake Safety Elements in Non-Engineered Building



1. Lintel band
2. Roof / floored band
3. Vertical bar at corner
4. Door
5. Window



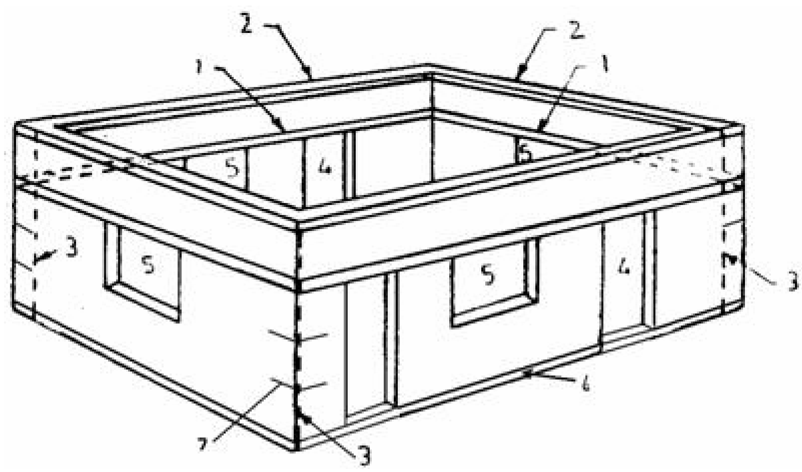
1. Lintel band
2. Eave level (Roof) band
3. Gable band
4. Floor band
5. Plinth band
6. Vertical bar
7. Rafter
8. Holding downbolt / Vertical bar
9. Door
10. Window

TABLE 2. EARTHQUAKE OCCURRENCE IN INDIA, M ≥5.0 (RICHTER SCALE), JUL. 1505 TO SEPT. 1996

Seismic Region	No. of Earthquake Having M =				Max MSK Intensity	Average Return Period Observed for M≥5.0
	5-5.9	6-6.9	7-7.9	8.0 or more		
Kashmir & western Himalayas (J&K, Himachal Pradesh, Sub-mountain parts of Punjab)	135	35	11	1	X	7 months
Central Himalayas (UP & Nepal Himalayas, North Bihar)	104	28	4	1	XI	9 months
North East India	339	157	20	4	XII	2 1/2 months
Indo-Gangetic basin & Rajasthan (Rajasthan, Punjab, Haryana, Delhi, Plains of UP, Bihar & Bengal)	82	26	5	-	VIII	1 year
Cambay and Rann of Kachchh	12	4	1	1	IX – X	6 years
Peninsular India	24	8	-	-	VIII	3 years
Andaman & Nikobar	136	54	2	1	> IX	6 1/2 months
Whole India including those before 1897	832 (32)	312 (40)	43 (18)	8 (1)	XII	1 month

Earthquake engineering studies in India formally started in India in 1960 at the University of Roorkee, where a full interdisciplinary Department for Earthquake Engineering was established in 1971. Most of the research and development work on the earthquake safety of Non-Engineered buildings has been carried out at the University of Roorkee. Some of the selected research papers by the author and his associates have been compiled in a book published in November 2006. As a result of these studies an Indian Standard Code of Practice IS:4326, was brought out in 1967 in which small amount of reinforcing at critical points of the building (see Figure 2 and 3.) was specified based on research carried out till then. Many of the government Departments started adopting these details in construction of masonry buildings used for residences, schools as well as offices. Actual damaging earthquake occurrences since then have proved the efficacy of these provisions in not only preventing the total destruction but also minimizing cracking damage, which saved the lives of occupants and contents of those buildings. This paper outlines the role played by the Experts on Guidelines prepared on the subject and the action taken by the government on various aspects regarding earthquake protection.

Figure 3. Overall Seismic Arrangement



1 Lintel Band, 2 Ceiling/ floor band, 3 Vertical member, 4 Door, 5 Window, 6 Plinth band
7 Dowels at wall corners

Holistic Approach for Safer Non-Engineered Buildings

In any country undertaking the objective of achieving earthquake safe non-engineered building construction, it must develop a holistic approach consisting of the following action points:-

1. Assessment of the earthquake hazard in the country which could be expressed in either a probabilistic hazard map or an earthquake intensity-wise map defining the various seismic zones in the country.

2. Collection of data on building types existing in the country as well as the kind of non-engineered building construction is prevalent in various geographical areas of the country.

3. Assessment of the vulnerability of the identified building types in relation to the various earthquake Intensities. It should lead to categorization of the damageability under the future earthquakes.

4. Assessment of risk of damage under the postulated earthquake Intensity occurrences which should also include the awareness of the various communities about the dangers and their preparedness if any.

5. Awareness to various stakeholders, for example, schools, hospitals, industries, resident welfare associations, etc. The awareness issue of safer construction technology will be the most important issue since most losses under earthquakes occur due to the collapse of buildings.

6. Sensitisation of the policy makers and top administrators towards priority actions required and funding to be provided for taking such actions. They need to be made aware of the following actions on priority:-
    - Creation of necessary legislative instruments for proper town planning as well as rural area habitation development.
    - Land-use Zoning for developing Master Plans taking care of hazard proneness of the areas such as landslide and liquefaction potential affected by the earthquake activity.
    - Development Control Regulations and appropriate Building Bylaws in the Municipal bodies called Urban Local Bodies as well as Rural-Local Bodies called Panchayats in India.
    - Training of professionals including architects, engineers, construction supervisors, masons, bar benders and carpenters. In this regard it is to be understood that most non-engineered buildings are constructed in the informal sector without any involvement of architects or engineers, wherein the construction planning is carried out by Master Mason so as to meet the requirements of the owner.

In all these issues the experts as well as the government have to play extremely important role.

TABLE 3. BUILDING CATEGORIES (FOR USE WITH INDIAN STANDARDS: IS 4326 AND IS 13928)

Building Use	Building Category in Seismic Zone			
	II	III	IV	V
Ordinary	B	C	D	E
Important (I = 1.5)	C	D	E	E

Important Buildings	- Hospitals - Schools - Monumental Structures - Emergency Buildings (i.e. telephone exchange, television, radio stations, railway stations, fire stations) - Large Community Hall (i.e. cinemas and assembly halls) - Subway Stations - Power Stations - Important Industrial Establishments - VIP Residences - Residences of Important Emergency Persons

TABLE 4. MEASURES FOR ACHIEVING SEISMIC SAFETY ACCORDING TO THE BUILDING CATEGORIES

All types buildings in Seismic Zones (IS-4326 for masonry walls)	- Control on length, height and the thickness of walls in a room - Control on size and location of openings - Control on material strength and quality of construction
Additional Measures for all building categories D to E+	- Seismic band at plinth level (may be omitted if founded on rock or hard soil) - Seismic band at door-winder lintel level in all cases
Where flat roof is adopted	- Seismic band at ceiling level of floors or roofs consisting of joisted roofs or jointed prefab elements - Stiffening of prefab elements in roofs/floor where used (using peripheral seismic band and RC screed integrated together)
Where sloping/ pitched roof is used	- Seismic band at eave level of sloping roofs - Seismic band at top of gable wall and ridge wall top (where such walls used) - Bracing in roof structure of trussed as well as raftered roofs - Vertical Steel bar at each corner and T junction of walls
Additional measures for all buildings of Category E or E+	- Seismic band or dowels at corners and T junctions at window sill level - Vertical Steel reinforcing bars at jambs of doors and large windows

Note: The Vertical Reinforcement at jambs of small windows at ventilators (say 600 mm x 600 mm or less) may be omitted

TABLE 5. PREDOMINANT MATERIALS USED IN HOUSES* IN INDIA (CENSUS 1971)

Wall Material	Percent of Rural Houses	Percent of Urban Houses	Percent of all Houses	Roofing Material	Percent of Rural Houses	Percent of Urban Houses	Percent of all Houses
Clay Mud	48.67	15.10	41.99	Tile, Slate, Shingle	37.12	33.11	36.32
Unburnt Bricks	8.35	3.26	7.34	Corrugated Iron, Other Metal Sheets	4.68	12.02	6.30
Burnt Bricks	15.55	59.08	24.21	A.C. Sheets	0.40	2.47	0.81
Stone	14.17	12.00	13.74	Brick & Lime Concrete	1.52	4.09	2.03
Cement Concrete	0.14	1.11	0.33	Stone Slabs	2.65	6.13	3.34
Wood	1.32	2.28	1.51	Cement Concrete or R.B. Slabs	2.93	23.10	6.92
Metal Sheets	0.14	1.76	0.46	Grass Leaves, Reeds, Thatch, Wood, Mud, Bamboo	50.42	18.92	44.15
Grass Leaves, Reeds, Bamboo	11.57	5.26	10.31				
Others	0.09	0.14	0.10	Others	0.08	0.26	0.11

* The term houses here includes: Residences 72.98%; Shop-cum Residences 9.86%; Residence-cum-household Industry 1.41%; Hotel, Sarai, Dharamashlas, Inspection and Tourist Homes 0.14%; Shops including Places and Offices 2.93%; Factories, Worksbeds 1.3%; Places of Gathering and Worship 1.23%; Others and Vacant 10.15%

Role of Experts

In achieving safety of various types of buildings in general and non-engineered buildings in particular the most important expertise is required in the field of civil engineering. The experts will have to contribute in the following ways:

- Identification of building types and assessment of their damageability under various earthquake Intensities.

- Carry out research and development studies to determine the available strength of the various building types prevalent in the country, to identify their deficiencies and weaknesses from seismic behaviour point of view, and to workout how such deficiencies and weaknesses can be eliminated or minimized by feasible and economical actions in the field. The objective of such intervention will be to reduce the risk of total collapse and prevent the loss of life as well as loss of contents in the future earthquake occurrences.

- The experts should produce such Guidelines which could be easily understood by the construction workers, masons, carpenters and bar benders for adoption in the new constructions.

- The expert's role in developing workable building bylaws can not be over emphasized. The building bylaws will have to be made in such a way that they are fully transparent, as well as, will make the involved persons accountable for the safety of the buildings.

- The professionals should make the results of R & D and the know-how so created, available to the community at large without any copy rights or reservations to keep it to them.

In India we have tried to work for achieving these objectives and all R & D results have been brought out in the formal Bureau of India Standard Building Codes for various types of Non-Engineered buildings (Brick, Concrete Block, Stone, Wood and earthen constructions) as well as in large number of informal Guidelines for free distribution. A list of such Codes and Guidelines is attached in Annexure – 1. Effort is being made to disseminate these guidelines in many different ways, the best example of which was in the reconstruction programme after the Kachchh earthquake of January, 2001.

Role of Governments

The role of government can best be exemplified by citing the initiatives undertaken by Government of India since after the super cyclone in Orissa and the major earthquake in Gujarat.

A National Disaster Management Act was adopted by the Indian Parliament in 2005 which have provided the establishment of National Disaster Management Authority at the Centre, the State Disaster Management Authorities in the States, as well as, the District Disaster Management Authorities in all Districts numbering more than 600. These authorities have to plan and execute all actions for advance preparedness as well as mitigation activities so that the future hazard occurrences may not impact the society as badly as before. The safety of non-engineered buildings will be one of the important issues to be taken up by the authorities. Already training of architects and engineers as well as training of masons and bar benders has been initiated on sufficiently large scale which are proposed to be expanded to larger numbers and larger areas in the near future. Besides the earthquake safe elements to be provided in all new constructions actions are being taken towards retrofitting of all lifeline buildings such as schools, health centres, large community buildings and residences of government officials who will be taking care of post disaster management. Model Amendment to existing Acts and Building Byelaws in various levels of Local Bodies has been worked out at the Centre and being disseminated to States for implementation.

TABLE 6. GOVERNMENT INITIATIVES

- Techno-legal Regime
- Techno-financial Regime
- Training of Engineers
- Training of Industrial Workers
- Training of Masons, Bar Benders
- Awareness
e.g. Videos of Earthquake Resistant Construction
e.g. Shake Table Tests, to Prepare Videos for Showing on TV Channels

Concluding Remarks

In most areas, frequency of damaging earthquake occurrence in India is very low except in the North East region, hence people have very little concern and perception about earthquake safety. Traditional constructions are coming down for ages and in high earthquake prone areas some indigenous safer construction developed such as like Ikra construction in the North-east India and Dhajji Diwari in Western Himalayas. In such circumstances, we have found that no revolutionary changes would be practical. Only marginal low cost improvements will be found feasible and acceptable. Such philosophy and intentions are successfully incorporated into the guideline which the Government of

India had developed so far based upon practical inputs proved by the scientific experiment and academic analysis conducted by experts.

To achieve safety of Non-Engineered masonry buildings which account for 85% of all 249 million building units as per Census 2001, and which are increasing at the rate of about 6 million housing units every year, is a gigantic task in India. However, in the seismic zone based on MSK VII the extra expenditure for earthquake seismic safety measures remains only 2 percent of the construction of the building. In seismic zone 4 or the intensity VIII, it is just 4 to 5 percent. Even in the most serious hazardous area, it could be just 6 percent of the whole expenditure of the construction. The inclusion of anti-seismic technology which requires only marginal improvements in the traditional construction procedures, therefore, can be feasible and adaptable for the public in general.

For any other country also depending on their own resources, the task of providing safety to all house holds will indeed be huge. But a concerted initiative has to be taken in which the experts as well as the government have to play their roles over a long period to minimize the losses which could be caused by the future earthquakes.

Annexure 1.

Guidelines Uploaded on Website of Ministry of Home Affairs National Disaster Management Division, Govt. of India, www.ndmindia.nic.in

1. Rapid Visual Screening of Buildings
   i) Rapid visual screening of masonry buildings
   ii) Rapid visual screening of RCC buildings
2. Amendment of Draft IS 13935 - Repair, Restoration & Retrofitting of Masonry Buildings – Guideline
3. Design Criteria for Buildings in Tsunami Affected Areas of States/UTs.
4. Preparation of Strategy Document for Protection and Mitigation from the Risk of Tsunami Disasters.
5. Design Guidelines for Construction of Cyclone Shelters
6. Preparation of Sample Design for unit houses supported by *Indira Awaas Yojana*
7. Earthquake Safe Construction Of Masonry Buildings [*Simplified Guideline for All New Buildings in the Seismic Zone III,IV & V of India*]
8. Guideline for Earthquake Resistant Reconstruction and New Construction of Masonry Buildings in Jammu & Kashmir State
9. Guideline for Repair, Restoration and Retrofitting of masonry Buildings in Earthquake Affected areas of Jammu & Kashmir
10. Seismic safety of non-structural elements and contents of Hospital Building.
11. Model School Designs for Construction in Various Seismic Zones of India.
12. Cyclone Resistant Building Architecture
13. Self Assessment Guide for Buildings Situated in Seismic Zone IV of India
14. Condition Assessment of building for repair and retrofitting.
15. Self Assessment of Earthquake Damageability of residential brick Building in NCT of Delhi
16. Simple Retrofitting Details for Improving Earthquake resistance of Brick Masonry Building in NCT of Delhi and the NCR

Lessons from the Reconstruction of Houses in Aceh After the Dec. 26, 2004 Tsunami

by Teddy Boen,
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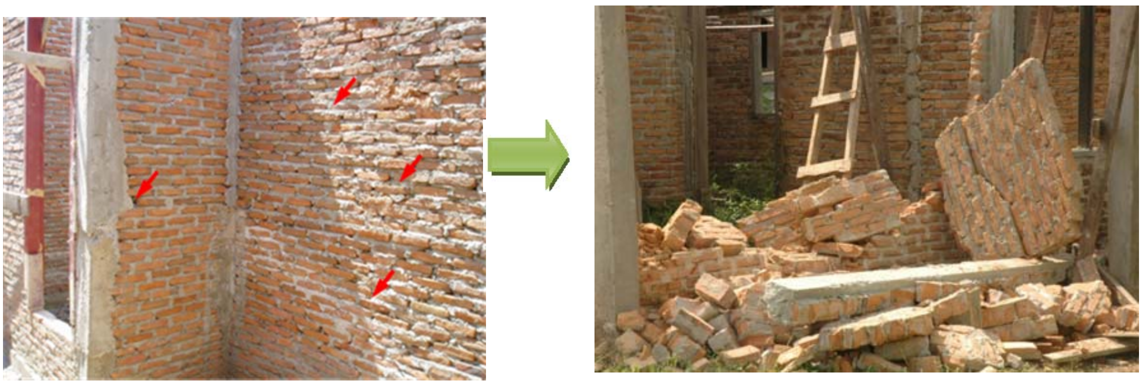
Abstract

This paper is a summary of four papers by the author regarding the reconstruction of houses in Aceh post December 26, 2004 tsunami (ref. [1/], [2/], [3/], [4/]). The issues of reconstruction are elaborated and four years after the tsunami it can be said that the statements in all those papers are still valid. Some significant shortcomings are identified and serves as lessons learned.

Quality of Houses Built

One year after the December 26, 2004 tsunami, the author and others wrote that in general, the quality of materials and workmanship for the reconstructed houses in Aceh are below average and in many cases poor (ref. [3/], [5/]). However, it seemed that the government ignored the findings and no improvement was introduced. The main reasons are among others, lack of knowledge in earthquake resistant buildings; the main target is "numbers" and imposing a policy to maintain cordial relationship with donors. All those resulted in compromising the safety of the beneficiaries. From recent site visits it is clear that no improvement has been introduced in spite of the Simeulue earthquake of February 2008 where newly built houses were severely damaged or collapsed. In 2007, almost three years after, most NGOs and world organizations recognized the poor quality of houses built and some of them assigned the design of seismic retrofitting for a small number of poorly built houses to some structural engineers/engineering firms (ref. [6/], [7/]). Unfortunately, there were few experts that are capable to do retrofitting, particularly for Indonesian non-engineered buildings. Many of them lack professional conduct and made recommendations or follow whatever pleases the client (ref. [1/]).

Figure 1. Poorly built new houses caused by poor quality materials and poor workmanship (left); Simeulue earthquake, February 20, 2008 revealed houses built are not earthquake resistant (right).



Reconstruction of houses | **Simeulue eq, February 20, 2008**

Figure 1. (Cont.)

Reconstruction of houses | Simeulue eq, February 20, 2008

Reconstruction of houses | Simeulue eq, February 20, 2008

Reconstruction of houses | Simeulue eq, February 20, 2008

Figure 1. (Cont.)

Reconstruction of houses **Simeulue eq, February 20, 2008**

In 2009, BRR will end its assignment and since the end of 2007, almost all NGOs already left Aceh, leaving behind poorly built houses that are not earthquake resistant. All the evidence indicates that the reconstruction of Aceh missed the golden opportunity to introduce earthquake mitigation measures. Once again, the Simeulue earthquake, February 20, 2008 demonstrated the above statement.

Prevailing House Type

The majority of the buildings, particularly houses that were destroyed by the tsunami in Banda Aceh city, and villages in Lhok Nga, Krueng Raya, Meulaboh city and villages along the West coast of Aceh, are non-engineered buildings consisting of two types (ref. [4/]).

The first type is one or two stories confined masonry buildings which has become the "new culture" all over Indonesia and from observations for the past 40 years, are earthquake resistant if built with good quality materials and good workmanship. And the second type is timber construction which is in line with the facts obtained during past earthquakes surveys in various areas all over Indonesia (ref. [8/]). However, as the economic condition is prospering, people tend to upgrade their timber houses into masonry because a measure of status is associated with the owners of such masonry houses. Therefore, for the permanent housing, it is advisable to construct masonry houses because they are in accord with the local culture and will therefore be sustainable (ref. [3/]). In most cases, the quality and strength of masonry buildings must be improved, however, it would be wrong if instead of enhancing the trade, try to re-invent the wheel by introducing "alien" types of houses (ref. [4/])- particularly using "progress" as a justification.

Lessons Learned

Almost four years after the Dec. 26, 2008 tsunami in Aceh, it can be said that the quality of constructed houses so far is poor and are among others caused by the following shortcomings, namely:

1. Needs Assessment and Site Specific Information

Needs assessment is a statement of what needs to be done. It is a prerequisite for the success of any reconstruction. They must have appropriate and timely information about what has happened, what needs to be done, and what resources are available. It provides a preliminary estimate of the total cost of damages; identifies the needs for reconstruction and outlines some strategic considerations and guiding principles for implementing a reconstruction program and strengthening disaster risk management as part of a medium term development process. The assessment reflects in the first instance damage (direct impact) estimates. These refer to the effects on assets / stock / property, valued at agreed replacement unit values (as different from actual or possible reconstruction costs). The assessment considers the level of damage, i.e., whether an asset can be rehabilitated / repaired, or was completely destroyed. The total damage and loss assessment also gives close attention to losses (indirect impact) which refer to income flows that will be affected, such as reduced or lost income, increased expenditures, etc. until the assets are recovered. These are quantified at the present value of such flows.

One of the important component in the needs assessment for a reconstruction is the in depth study of the site specific information, local wisdom and expertise. The reconstruction strategy should be localized and site-specific as far as possible. Economic, environmental, social and cultural factors must all be taken into account when developing disaster risk mitigation strategies and solutions must be anchored in the prevailing circumstances of local situations.

A detailed and accurate disaster assessment is a very important factor for a successful planning and execution of the rehabilitation and reconstruction. Such assessment is expected to produce reliable data of beneficiaries of houses such as to which target group they belong; numbers of Internally Displaced Peoples (IDPs) eligible for the program at the transition stage as well as the long term; number of persons who do not possess land and are permanent evacuees; the suitability and availability of site for relocation; the availability of the resources (human, material and fund) necessary to carry out such a huge undertaking, namely building thousands of houses within a very short time span. All those data is vital prior to commencing the actual reconstruction. In Aceh, within six months after the tsunami, many foreign "experts" introduced all sorts of house types which are not the prevailing practice and many are culturally unacceptable.

As mentioned in various reports, until one year after, the number of IDPs and housing needs is constantly changing depending on the various sources. This is a clear indication that an in depth disaster and needs assessment was not available. The poor quality of houses was also a result of lack of assessment concerning the real need of materials, construction workers and technical supervisors.

After announcing the completion of the 100,000 houses, the Agency of the Rehabilitation and Reconstruction for the Region and Community of Aceh and Nias (BRR) claimed also that the majority of need have been made. At the same time, approximately 6,000 families remain in temporary shelters and barracks as their houses are still under construction, and four years after, thousands of completed houses are still not occupied. This is an indication that the needs assessment is still far from accurate and number of constructed houses is still the main target (ref. [1/]).

Figure 2. Lack of need assessment caused many houses that were ready were not yet occupied (Aceh)

2. Directives from the Authority

Any successful reconstruction needs a capable authority with strong leadership that can provide clear directives and requirements concerning the type of buildings and the standards to be followed from the onset. The approval / permit system must be strictly enforced and all parties (NGOs, Government and other organizations) involved in the reconstruction of houses should provide continuous qualified technical assistance and inspect their respective works on a consistent basis.

In Aceh, most NGOs felt that the government did not provide clear cut guidance, particularly with regard to quality of the construction. Therefore, NGOs developed their own guidance. Unfortunately, the guidance in some cases provides incorrect or conflicting information which can cause confusion. BRR considers that it is the responsibility of the local authority to enforce good practice, however, at the same time recognizes they do not have the capacity to do that (ref. [5/]).

In developing countries, if earthquake resistant design codes exist, they have been adopted by some larger cities only and very few if not any have been adopted and enforced for smaller cities and rural areas. Also most codes are incomplete; almost no standards have been developed for non-engineered buildings. The current Indonesian seismic code does not regulate non-engineered buildings, but for Aceh and Nias, a Building Code was issued by the Ministry of Public Works in July 2005. The code is an expression of desired results than a set of instructions on how to attain that. However, it is not accompanied with the necessary sketches of seismic detailing (ref. [1/], [5/], [9/]).

Past experiences showed that in developing countries, unfortunately, most earthquake disasters occurred in rural areas, thus affecting non-engineered buildings. Codes are also designed to regulate new developments and not the repair, retrofitting, and strengthening of existing and/or damaged buildings. In other words, the minimum standards contained in the codes are meant to build new buildings or rebuilding totally damaged ones and do not address the issue of repair and strengthening, the most common situation with most buildings after an earthquake disaster. This is one of the main reasons why no provisions to prevent future losses are taken into account after an earthquake disaster since people has no understanding and is not aware about repair, retrofitting, and strengthening methods.

For new construction, relevant guidance for good practice of non-engineered buildings exists or has been developed for Indonesia, long before the reconstruction in Aceh and Nias (ref. [10/], [11/], [12/]). Yet all those relevant materials were ignored and instead, many foreign consultants made their own layout and adopted the confined masonry construction method, but leaving out the detailing for seismic resilience (ref. [1/], [8/]).

From surveys in Aceh and Nias, the author found out that almost all designers involved in the reconstruction of Aceh did not follow the existing guidelines and at the same time did not perform the necessary appropriate analysis and design for earthquake resistance (ref. [1/], [5/]).

3. Differentiation between Emergency Shelters, Transition and Permanent Houses

Reconstruction of houses after a disaster must be planned within the overall context of phases from emergency shelter to durable solutions. Immediately after the disaster, displaced people moved to emergency shelters provided by the government and NGOs. They will soon be shifted to transition houses until permanent housing can be built. Differentiation between emergency shelters, transition houses and permanent houses shall be made.

In Aceh, in the early stage of reconstruction, several NGOs do not differentiate type of houses between immediate shelter needs (which were already built by the government); medium term / transition houses and permanent houses (which are appropriate to restore their livelihood). Therefore, in the early stage, many of the houses already built were of the transition type but built on permanent former lands belonging to recipients. Many of those “temporary / transition” houses become permanent and the final reconstruction stage fails to materialize (ref. [4/], [9/]). The need for “permanent” housing in part reflected the large amount of funding available and was articulated in terms of reconstruction rather than the recovery. This lead to a focus on physical construction rather than how the process of rebuilding can lead to economic activity and the role than shelter plays in meeting needs and allowing families to return home and carry out their livelihoods.

Also no phase construction which will allow phasing of occupancy is observed. Usually phase construction is adopted to construct transition houses on the site and allow early occupation while the permanent houses are being constructed. Programs to provide semi-permanent shelter sought to provide this assistance, quickly and economically but were superseded by the demand created for “permanent” housing, and affected by poor quality timber.

Figure 3. No differentiation between emergency shelters, transition and permanent houses (Aceh)

Figure 4. “Temporary / transition” houses become permanent. Pictures were taken at the end of November 2008 (Aceh)

4. Influx of Local and Foreign “Experts”

In major disasters, developing countries are often offered and accept large amount of technical assistance as foreign aid and most of the time such assistance may not be linked with the actual needs of the disaster victims.

In Aceh, the lack of immediately available site-specific information is coupled with the influx of many so-called “experts” (local and foreign) offering an endless number of earthquake resistant building type “solutions” causing unsatisfactory results. Most of those “experts” lack technical capacity and a clear understanding of the local building culture and the social order of the community as well as the ability to adapt disaster resistant techniques to local styles and situations. Many NGOs ended in trying to “re-invent the wheel” by introducing house types defying the local culture. Only few NGOs constructed houses based on the prevailing culture in Aceh (ref. [4/], [9/]). It is not advisable for experts to try to "teach" local people, but instead they must try to absorb and understand the local wisdom regarding why it was done the way it is. Having understood the local way of thinking, experts must try to facilitate locals in among others making their houses earthquake resistant but without introducing abrupt changes or use new “alien” materials. The “experts” need to draw upon the past knowledge and practice of that area and try to incorporate their expertise and latest developments to develop an appropriate, do-able solution to ensure that their reports and works are meaningful and also useful.

Even though Indonesia is highly vulnerable to earthquakes, seismic engineering does not form a core topic in undergraduate engineering degree programs leading to Bachelor or Engineering (Civil). Concrete design is one of many modules and seismic design is only included for those taking structural options in the final years. The knowledge of local engineering consultants can not be assumed to include seismic design. This appears to be largely due to the lack of expertise in construction and knowledge of how to specify and verify materials. However, it was compounded by the fact that neither the government, nor NGOs, carried out a strategic assessment of local capacity at the outset of the reconstruction process. This would have identified the limitations in local supply and the need to strategically build capacity to manufacture or import materials. (ref. [9/])

Based on the Aceh reconstruction experience, the author suggests that in any reconstruction everywhere in the world, criteria of “experts” shall be clearly defined and the number shall be limited.

5. Alien Type of Construction, Culturally Inappropriate and NOT Sustainable

From the beginning of the reconstruction, the author suggested to build confined masonry houses because confined masonry houses are permanent and not transition houses and since masonry houses is the new culture in Indonesia (ref. [4/]). Many donors started to adopt the confined masonry houses for their reconstruction project one year after the reconstruction. However, BRR directed NGOs to construct confined masonry houses in Aceh and Nias in 2007, two years after the reconstruction, and after many houses were built without considering the local culture.

In spite of repeated elaboration by the author regarding type of houses to be built and preferred by Indonesian people, in 2007, many NGOs introduced alien construction methodologies that will not be sustainable apart from being seismic resilience (ref. [1/], [3/]). The re-emergence of alien construction methodologies in 2007 only confirms that the main target of the reconstruction of houses is only numbers and not seismic safe houses. Sustainability and cultural appropriateness shall be the main justification not to introduce such alien construction methodologies.

Apart from that, the author has not seen any analysis for all the “alien” construction methodologies. Also, it is evident that there is no more overall context and clear direction for the reconstruction of houses in Aceh and Nias.

The trouble with most of the “imported solutions” is that the buildings last as long as the fund is still available. The village people learn how to fit up the alien buildings, but as soon as the free materials stop arriving, the village people are as badly off as ever – except, of course, for the buildings they already have. The point is that they can not employ the skills they have learned because they can not afford the materials. “Alien methods”, in fact, merely succeeds in giving the village people an illusory feeling of progress and superiority while tempting them into the most frustrating blind alleys, a sophisticated trade that will inevitably be shut to them a short time later. In Indonesia, disaster victims rely more upon family, neighbourhood, friends, and other local coping mechanism and such mechanism must be encouraged and supported. Some of the alien methodologies observed by the author in the second and fourth quarter of 2007 are as follows (ref. [1/]):

5.1. Pre-cast Construction

Poorly designed connections and poor workmanship at connections between pre-cast components has lead to catastrophic behaviour of structures incorporating pre-cast concrete during past earthquakes.

Figure 5. Pre-cast construction using wet joints and reinforcement splices of approximately 10 cm as the connections (Aceh)




Figure 6. Walls using extra large size blocks with poor connections




Figure 7. Pre-cast construction using 2 bolts for connections between components

5.2. Interlocking Masonry

The criteria for interlocking which the blocks should be sized and shaped precisely are not met due to poor quality of blocks and poor precision. All the shortcomings resulted in poor quality houses.

Figure 8. Interlocking masonry walls, poor quality blocks and no precision (Aceh)

5.3. Light Steel Construction

From the beginning of reconstruction, the author did not advise to use this method because defy the local culture and will not be sustainable. However this method is still used by NGOs and BRR agreed it.

Figure 9. Light weight steel construction (Aceh)

6. Main Target is Numbers and NOT Quality

One year after tsunami, the author suggested to go beyond numbers for the reconstruction of houses and to concentrate on the technical aspect as well as quality of the houses (ref. [3/]). The author also wrote about the importance of the need assessment to be able to exactly know among others the correct number of houses needed. However, until today (almost four years after), the main target is still numbers and not quality (ref. [1/], [2/], [3/], [7/]).

BRR compared the reconstruction of houses in Aceh and Nias with reconstruction of houses in Bam (Iran), Gujarat (India), and Turkey and claimed that Aceh and Nias is the fastest in the world (ref. [1/]). BRR did not realize that the need assessments for Bam, Gujarat, and Turkey were made more accurate and therefore the number of houses built within a certain period was as planned. The reconstruction in those three places also followed the concept "do it right the first time" with the aim to prevent vulnerabilities in future earthquakes. On the contrary, in Aceh, most of the houses built so far are not earthquake resistant (ref. [2/], [3/], [4/], [5], [9/]) and this could be a disaster in the making until the Sumatra fault or the plate boundary breaks. As mentioned earlier, the damage of new houses before they were occupied due to the February 20, 2008 Simeulue earthquake confirmed that the quality of houses are below standard and are not earthquake resistant.

7. Site Development and Infrastructure

The other important aspect in the reconstruction process of houses is the planning of site engineering design and infrastructure such as the drainage, the arrangement of access roads and foot paths, provision for sanitary facilities, provision of water supply and utilities. It must run parallel to the planning of the site layout (ref. [3/]) and must be constructed during the site preparation stage. However, in Aceh, almost four years after, the engineering design was still left out (ref. [9/]).

Figure 10. Site engineering construction activity did not run parallel with the site layout planning. All pictures were taken at the end of November 2008 (Aceh)

8. Misinterpretation of Community Based Reconstruction

Local communities will need to be actively involved in planning, decision-making and implementation in most sectors if reconstruction is to be successful. Experience with disaster reconstruction all over the world has shown that community participation is a fundamental requirement that helps in reducing trauma, ensuring appropriate solutions, equity, community ownership, transparency and accountability. It will also be essential to set up a fair and accessible grievance redress system.

At the onset of the reconstruction of houses in Aceh and Nias, one of BRR's missions was community driven or community based reconstruction. Basically, community based construction is a bottom up model; beneficiaries are involved, jointly with the professionals, in planning and implementation (ref. [1/]). They are engaged in decisions about the project through discussions among themselves and professionals. Within the community there will be a range of experiences, skills and resources among the beneficiaries. The ideal is for each to participate according to his or her special abilities. In reality, however, not all will contribute, and, in most communities, the collaboration with professionals will be largely left in the hands of representatives or local leaders.

Basic safety regulations must be developed within the context of community based construction and this is a challenge for technicians: closing the gap between communities based and safe structural methods is a priority. Only thereafter one can expect to build a safe but affordable building. Participation stimulates self reliance, because, people who participate in their own house building, will be confident about problems and less dependent on outside agencies.

At the beginning of reconstruction of houses in Aceh, most of NGOs and other organizations provide the fund but leave the purchasing of materials and hiring of construction workers to the beneficiaries. They forgot that with community based mass housing; the quality control becomes a difficult issue. The facilitators and consultants hired were civil engineers, architects with no specific seismic experience and were unaware of the importance of ductile detailing. This resulted in the poor quality houses.

In the course of the reconstruction, due to many complications due to misinterpretation of community based construction, BRR, NGOs and other donors moved to project type of construction by assigning a local contractor to do the job and the beneficiaries are not involved in the construction of the houses.

9. Core Housing, Building Completion and Further Extension

Core houses are frequently introduced but seldom really understood. Many architects working for NGOs as well as World organizations were suggesting that the 36 m^2 house should be considered as a core house that can be extended by the beneficiaries at a later date. Such opinion becomes very common in Aceh and Nias, while in fact, in earthquake prone countries like Indonesia, it is not advisable to encourage beneficiaries to extend their houses unless the extension is pre-designed and all the connections for the extension are already in place.

Extensions are not advisable without engineering assistance. Unless already pre-designed, earthquake engineers will not recommend the idea of extending core houses for the following reasons: seismic resistance depends upon wholeness of building action in which building acts as *one integrated unit* and not as a loose assembly of pieces. Therefore, the continuity and rigidity of construction that is so required is difficult to ensure when the completion of core structures and their physical expansion over a larger plan area is undertaken without technical supervision.

Extension and original core house must be united structurally to act as one integral unit when shaken by earthquakes. The newly extended house must be re analyzed because the new extended house will behave differently than the original core house. Or the extension house shall be structurally completely separated from the core house.

Figure 11. Core housing, unplanned extensions. All pictures were taken at the end of November 2008

Figure 11. (Cont.)

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Development of Building Code Experience of Nepal

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NEPAL

Abstract

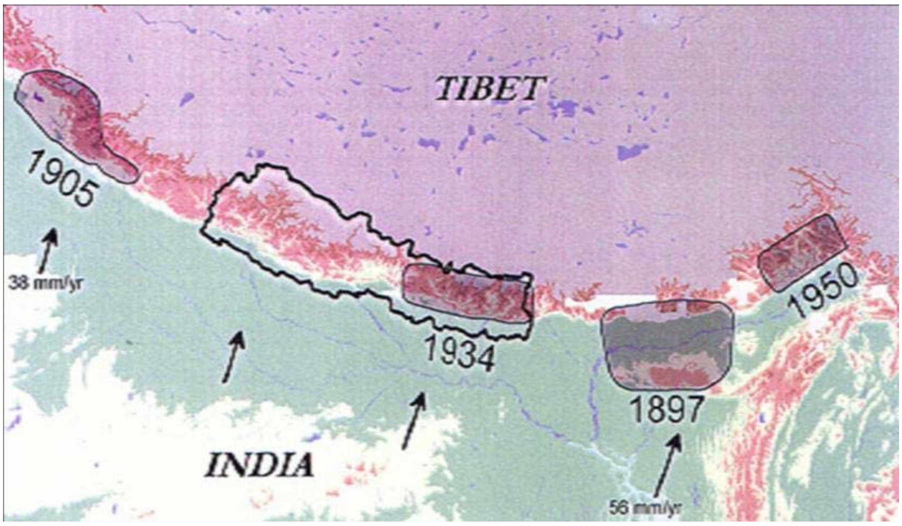
Learning the lessons of the devastated damage caused by Nepal Bihar Earthquake in 1988, Nepali government successfully developed earthquake resistant building code. This paper illustrates the multi-methodological efforts of its implementation conducted by DUDBC, including the challenges in terms of UNCRD's HESI initiatives.

Introduction

Nepal is a highly seismic country, lying between collisions of Indian to the Eurasian plate and moving continuously resulting devastating earthquakes within this region. It is one of the countries where the earthquakes are frequent and sometimes very devastating. Nepal experienced such catastrophic damages in 1934 and 1988 earthquakes. It is related to the presence of active faults between tectonics plates along the Himalayas.

In the context of Nepal, more than 90% of the housing units have been constructed by individual people as per their own needs and budgets. So, most of the houses including engineered buildings in Nepal are highly vulnerable to earthquake of event moderate intensities, due to lack of knowledge of earthquake safety measures. It was estimated that 207,000 buildings were affected in 1934 earthquake in Nepal as one of the biggest earthquake in Nepal which was estimated as 8.5 Richter scale. Another big earthquake occurred in eastern Nepal in August 1988, magnitude of 6.7 Richter scale. As of recent years, most of the uncontrolled building processes are rapidly producing structures of unacceptable standard and prone to the risk of damage and collapse under earthquake.

Figure 1. Seismic Hazard of Nepal



Map courtesy: National Seismological Centre, Department of Mines and Geology

Historical Background

After 1988 earthquake in eastern Nepal which resulted in more than 600 deaths and more than 20,000 buildings collapsed or damaged, including many hospitals and school buildings, drew attention and conscious to the Ministry of Physical Planning and Works (former Ministry of Housing and Physical Planning) the need for changes and improvement in current building construction practices in Nepal. The Government of Nepal, then, requested technical assistance to UNDP and UNCHS (Habitat) to set up a three-year program on "Policy and Technical Support to the Urban Sector" within the ministry. The sub-project of the policy and technical support, namely, "National Building Code Development Project" (UNDP/UNCHS/(Habitat)Nep/88/054) was formulated on 1992-93 within the Department of Urban Development and Building Construction (DUDBC) (former Department of Buildings) to assist the Government of Nepal. A consortium, consisting of international consultants from New Zealand, Canada, USA, commenced the project in May 1992 with the government counterpart from the Department. The major works of the project had been divided into following three sub components.

a) Seismic Hazard Mapping and Risk Assessment of Nepal
b) Preparation of National Building Code of Nepal
c) Development of Alternative Buildings Materials and Technologies

Formulation of Code

The Nepal National Building Code (NBC) provides both regulation and guideline regarding to the construction of building in all regions of the country. Furthermore, designers should use their professional judgment in the adoption of appropriate design standards. The following four different levels of design parameters and construction are addressed in the code:

(I) International state-of-the-art
(II) Professionally engineered buildings
(III) Building of restricted size designed to: Mandatory Rule-of-thumb
(IV) Remote rural building where control is impractical: Guidelines

TABLE 1. THE LISTS OF CODES RELATED TO BUILDING DESIGN WHICH DUDBC-NEPAL HAD ALREADY PUBLISHED

1. NBC 000 : Requirements of State of the Art Design
2. NBC 101 : Materials Specifications
3. NBC 102 : Unit Weight of Materials
4. NBC 103 : Occupancy Load
5. NBC 104 : Wind Load
6. NBC 105 : Seismic Design of Buildings in Nepal
7. NBC 106 : Snow Load
8. NBC 107 : Fire Safety
9. NBC 108 : Site Consideration
10. NBC109 : Masonry Un-reinforced
11. NBC 110 : Plain & Reinforced Concrete
12. NBC 111 : Steel
13. NBC 112 : Timber
14. NBC 113 : Aluminum
15. NBC 114 : Construction on Safety
16. NBC 201 : Mandatory Rules of Thumb : Reinforced Concrete Buildings with Masonry Infill
17. NBC 202 : Mandatory Rules of Thumb : Load Bearing Masonry
18. NBC 203 : Guidelines for Earthquake Resistant Building Construction : low Strength Resistant
19. NBC 204 : Guidelines for Earthquake Resistant Building Construction : Earthen Buildings
20. NBC 205 : Mandatory Rules of Thumb Reinforced Concrete Buildings without Masonry Infill

Revision and Updated to the Codes

As a part of Government of Nepal, DUDBC made revisions and updated to the codes on 2060 BS (2003). It also prepared additional three codes last year besides of the existing 20 volumes of the codes. They are;

Architectural Design Requirements-NBC 206:2003
Electrical Design Requirements-NBC 207:2003
Sanitary and Plumbing Design Requirements-NBC 208:2003.

With the highly commendable and pioneering initiatives taken by DUDBC, all the codes was approved successfully by Cabinet and has been implemented (enforced) in the government buildings compulsory on "12th. Shrawan 2060" (2003). The announcement of 21th Shrawan 2060 means that three more codes on Architecture, Sanitary and Electrical had been added ten years after the enactment of formerly organised building related codes. Now the codes are being implemented as per "Building Act: 2055" (1998) in all public and private building throughout the country after it was activated by the cabinet decision.

The practice of applying building code has already been started in government as well as private buildings. However, this requires massive training as well as dissemination including public awareness programme. The current 23 volumes of the codes are not sufficient for fully earthquake resistant design of building - should be extended as India has more than 1000 codes of its own. It is also absolutely necessary to train the engineers, architects and technicians who will use directly the codes to practice. Simultaneously, it should be done the works for public awareness in general on the importance of the codes. The efforts for implementation of building codes, therefore, are consisted with two components; i) Massive training to the Technicians about the code, and ii) dissemination and public awareness raising programme about earthquake resistance building construction.

Strategy for Implementation of the Codes

The existing building code is more than ten years old. It should be revised incorporating additions, alterations and modification accordingly - We need to prepare new codes. In order to conduct such project, DUDBC found that there would be strong demands for launch international funded programmes for the development of new codes by introducing various global experiences. Professionals often understand the Code's intent but do not know how to conduct the calculations on earthquake resistance design according to NBC and existing seismic hazard mapping of Nepal. Practicing professionals, namely, civil engineers and architects must be given training in order to enable them to design earthquake safe buildings as per Seismic Hazard Map of Nepal.

DUDBC is trying to enforce the NBC in all government buildings and at the same time it is trying to enforce the code in the private buildings through municipalities. After the implementation of NBC, it is believed that the buildings will be more earthquake resistant and will save human lives, the property of the individuals and the wealth of the country as a whole. For the successful enactment of NBC, the Department has set different strategies, some of which are as follows:

a) Illustration of the role of DUDBC’s role and initiative: DUDBC acts as manager, facilitator and policy maker
b) Coordination and corporation of other institution: DUDBC’s coordination with the Curriculum Branch of Universities to endorse NBC in the engineering courses

As privately owned buildings are occupied more than 90% of total buildings of the country, wider and wider awareness to all people is prerequisite factor nowadays. The Department, therefore, is developing different modes in the awareness programs regarding the impact of earthquake in the haphazardly constructed buildings. Awareness strategies targets to give general knowledge about the importance of NBC for the construction of the safer buildings.

Trainings on NBC by DUDBC

In incorporating NBC into the practical construction of buildings, DUDBC put in the highest priority fostering technical personnel and craftsmen: particularly by launching educational opportunities on the implementation process of the codes. In connection to this aspect DUDBC had already trained more than 250 numbers of engineers and architects, 300 mid level technician (overseer and draftspersons) about how to use the building code. More than 4000 artesian and mesons in 75 districts of Nepal had been already trained about proper use of building materials and earthquake resistant building construction with practical and audio visual programs. The department also developed Manual on Building Construction Guidelines (with Earthquake Safety provisions) 5th edition in Nepali.

Figure 2. Training on NBC and Earthquake Resistance Construction for Engineer and Architects

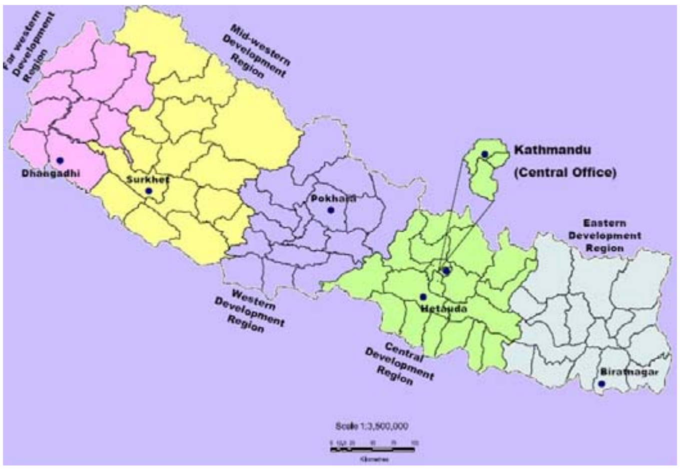
Figure 3. Training on 2D Software Earthquake Analysis Design for Engineers and Architects (Left) and Hoarding Board for Public Awareness on Earthquake Housing Safety (Right)

Meanwhile, Housing Earthquake Safety Initiative (HESI) led by UNCRD Disaster Management Hyogo Office has been crucial milestones of implementing DUDBC's efforts for implementation of NBC. In August 2007, HESI's National Workshop on Effective Enforcement and Dissemination of Building Code was organised by Ministry of Local Development, Ministry of Physical Planning and Works, DUDBC, National Society of Earthquake Technology- Nepal (NSET) and UNCRD. The workshops covered quite wider stakeholders and issues around efficiency of the works for implementation and dissemination of NBC. The second HESI workshop in Nepal was held in 19-23 May 2008 by DUDBC, UNCRD and NSET. The workshop involved successfully 25 officers from various municipalities and DUDBC local staffs. During 5 days workshop, an Action Plan for building code was successfully developed.

Figure 4. HESI National Workshops (2-3 August 2007, Nepal)

DUDBC is also taking a part of the project of Earthquake Risk Reduction and Recovery Preparedness Programme- ERRRP for Nepal. This is a regional programme developed by UNDP Bureau of Crisis Prevention and Recovery (BCPR) with the support of Government of Japan, which was initiated in five high risk South Asian Countries; namely, Nepal, Bhutan, Bangladesh, India and Pakistan. DUDBC has already organised proposals to launch ERRRP in Nepal with the aim to reduce the impact of potential earthquakes on seismically vulnerable 5 municipalities; Biratnagar of Eastern Development Region, Hetauda of Central Development Region, Pokhara of Western Development Region, Surkhet of Mid-Western Development Region, and Dhangadhi of Far Western Development Region.

Figure 5. ERRRP Proposed Project Municipalities



The project in Nepal is expected to launch a mean to enable local governments for systematic implementation of Earthquake Risk Reduction Management, and DUDBC directly commits into the project by launching the project office in the DUDBC premises. The programme is also designed in the context of the International Recovery Platform (IRP) for the fulfilment of the Hyogo Framework of Action (HFA) 2005-2015, which was issued as a part of World Conference on Disaster Reduction in January 2005, in Kobe, Japan.

In the project, following activities are conducted throughout 5 municipalities;

- Earthquake Risk, Vulnerability and Capacity Assessment
- Implementation of Earthquake Preparedness Planning and Safe Construction Practice
- Launching Disaster Recovery Preparedness and Recovery Operations in Post Disaster Situations
- Implementation of Disaster Management Framework by supporting locally appropriate solution for Earthquake Risk Reduction

With these efforts, DUDBC and target municipalities can update profile related to earthquake vulnerability. Also, the project could be good opportunities to conduct various types of trainings, awareness programme including publication and poster exhibition. In the project, it would be focused also retrofitting works and recovery preparedness. DUDBC believes that those programmes could be crucial chance for the implementation of Nepali NBC.

Figure 6. DUDBC's Interaction with disaster management related organisation through ERRRP programmes

Conclusion

Needless to say, earthquake is an unavoidable kind of natural disaster. It has already been mentioned that Nepal lies in high-risk seismic zone. Considering the gravity and magnitude of the earthquake risk, especially those who are involved in design and construction profession and in creating awareness among the people, implementation and local execution of NBC are expected to play significant role in earthquake resistant design of buildings.

Lastly, it is crucial to illustrate that in every structure design and construction works each stakeholders must consider how the earthquake resistant design technique can be adopted using the existing Building Codes of Nepal to safeguard life and property during earthquake. Proper use of NBC, therefore, can be the vital key in reducing Earthquake Risk in Nepal.

Bridging Gap between Engineering and Construction

by Tatsuo Narafu,
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Abstract

Building Research Institute- BRI has found so far that there are huge gaps between engineering methods and actual construction conducted by manual labourers. Whilst it is focused on the issues of implementation of engineering technologies into practices in order to mitigate the damage of earthquake disasters, the paper aims to make policy recommendations on engineering frameworks in order to overcame the differences between methods and practice- firstly to review on-site based feasibility of techniques from workmen to professional designers, which can be added to the knowledge transfers from engineers to workmen, and secondly to review and simplify the guidelines which can be applied to non-engineered constructions. For the latter, technical verification would be necessary to identify effective items in terms of prevention of functional destruction of buildings at earthquake disasters, adding to the efforts to reduce the amount of required items in the technical guidelines in terms of safety and the cost.

Serious Damage of Human Casualties – from Findings of Field Survey

There are devastating damages because of earthquakes, and the main causative factor for casualties is collapsing buildings. There was a very devastating earthquake damage occurring in China again in 2008. So far, Building Research Institute -BRI has experiences of, many times so far, conducting post-disaster surveys. Already there have been many findings that, very intriguingly, many of the reinforced concrete buildings were collapsed. It was quite surprising outcomes for researchers, which leads to see conditions of collapse of RC member buildings; most of failures occur in the junction and connection.

Figure 1. Un-reinforced brick masonry houses in Hongkou, Dujiangyan, Chengdu City, Sichuan Province, China

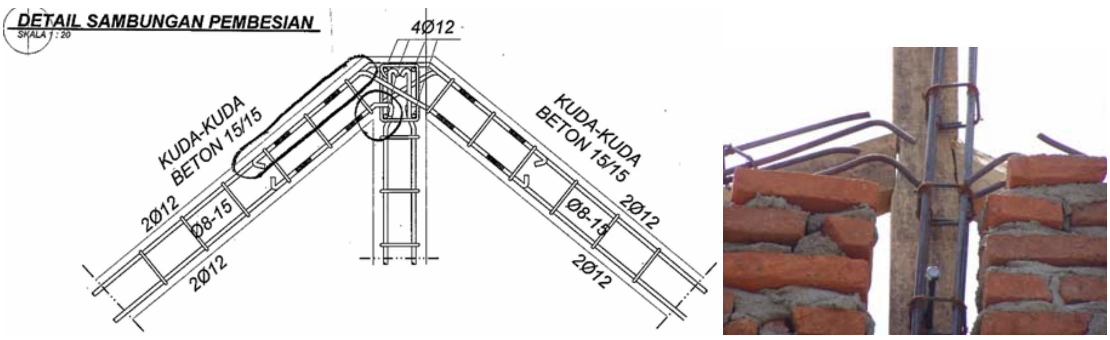
Meanwhile, at least during the field survey that BRI has involved, BRI has not seen any cases of fracture. The reinforced steel bars became loose, came out to the surface, and fell off as a result. When examining these conditions, we found that the Reinforced

Concrete members are bent by design to give some reinforcement in the concrete at the juncture or at a connection part.

Another Approach- from Construction Sites

So far, it is often pointed out that the quality of workers, who had the knowledge, did not pay attention to the aspects on strength of the buildings, as having been rather negligent in completing details of the buildings. But the researcher found that it was not always the case when examining the outcome of on-site monitoring activities. The mission has looked into the facts on how they have been constructed in above mentioned survey activities; construction workers conduct manual works, and they use the leverage, quite simple tool, to make the RC bent. They make an assembly of boxes on the earth and then carry them to the site of construction for the installation. The following figure [Figure 2] shows the RC bent – and such design can be prepared by a professional consultant based upon math equation accurately. Although reinforcing rod bars seem to be quite thin, they are not something to be bent with manual labour- at least it requires non-simple tools for such works.

Figure 2. Gap between Structural Design (Left) and Construction Practice (Right)



The mission team, therefore, frequently makes face to face interviews as follows;

> Researcher: Can a workman follow the details of the design you made at the construction site?
>
> Consultant: Yes, I believe a workman can do this.
>
> Researcher: Can a workman REALLY follow detail of the design you made at the construction site- I have seen that using such tools is not the practice that they do at the construction site.
>
> Consultant: It is not my problem. My duty is only to draw the chart to make the drawing of details of design. I have studied in the university, and I have done what the text book says, so what the workman does in the field is not my responsibility.

Indeed, there are huge gaps between professional engineers who employ the technical accuracy into the works and workmen who put them into practice at the construction site. Such situation in developing countries might be quite hard to understand when getting used to the practices in Japanese construction. The Japanese building society, where BRI has many contacts, says that the people studied in a university need to go to the construction site. Such professionals interact directly with carpenters to see actual works on the site. The carpenters, who have a lot of experiences in their works, often complain to highly educated engineers that carpenters' practices in the field are not same as engineering approach- which might be said "professional approach". The Japanese designer therefore can take into account the practices when conducting their works. In the seismic developing countries however still remains significant gap between what the carpenters do at the site and what the designers do.

It is often said that the construction workers who have less knowledge should learn more from the engineers and designers. There is no doubt that the knowledge transfers from engineers and designers to construction workers are crucial. With such transfer alone, however, it would not be ensured the construction works can be carried out well. In the case of making bend for RC bars, there would not be simple but technically appropriate tools to be developed very soon. In the meantime, there should be bottom-up/ on-site based approach, where it is considered the feasibility of practical incorporation of engineering techniques at the construction site adding to the design instruction granted by professional engineers.

Hereby BRI would like to put this cyclic approach into a policy recommendation on bridging gap between engineering and construction. With the bottom up approach engineers can learn actual condition of construction sites, and elaborate proposal based on actual conditions. Also, in this approach it would be quite indispensable to verify the feasibility of design on construction sites through monitoring/ model projects etc, and make feed-back inputs from construction sites to engineering.

Incorporation of Earthquake Safety Requirements to Non-engineered Buildings

Adding to the application of bottom-up approach in engineering, it should be also mentioned one more important point- Non engineered buildings. The word "non-engineered" might be unfamiliar to Japanese engineers/ researchers on development policy studies, but it signifies "less engagement of engineers / engineering technologies". Here, the TABLE 1 aims to make comparison of engineered buildings and non-engineered in order to clarify the gaps occurred between engineered buildings and non-engineered buildings.

TABLE 1. COMPARISON OF NON-ENGINEERED AND ENGINEERED

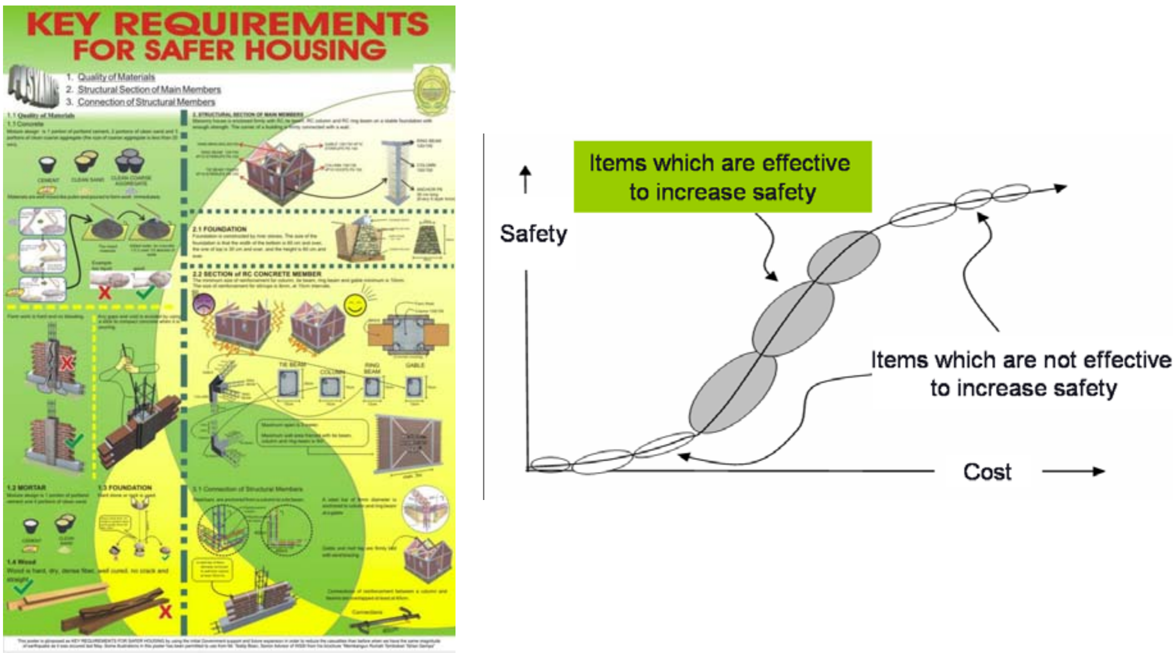
Aspects/ Items	Conventional/ Non-Engineered	Engineered
Materials	Available at the area No control	Usually Controlled in Size, Quality etc.
Construction Workers	Non/ Semi-skilled Workers	Skilled Workers
Technical Intervention	No/ Little Intervention	Intervention in Design, Construction Procedures, etc
Users/ Residents	Low/ Middle Income People	Middle/ High Income People

As it is shown on the table, whilst the materials are controlled in engineered construction, accessibility to the material in the locality would be put in higher priority in selection of materials in non-engineered construction. When constructing houses, the materials are usually heavy and certain amounts are needed. Regarding to the quality of labours as well, engineered buildings have skilled workers whereas non-engineered have non-skilled, or rather frequently residents or house owner themselves construct the houses by their own. Similar issues would be emerged in terms of technical involvement as well. Also, in reviewing the nature of social aspects of different types of construction, it would be needed to illustrate the difference of end-users: low income people tend to use non-engineered construction whereas high income people can be benefited from engineered construction. Therefore, conventional construction is completely different from engineered ones, particularly regarding to feasibility of methods, and appropriate strategies would be needed particularly for non-engineered construction.

There was an example of the reconstruction works of Central Java Earthquake, which was conducted under JICA programme with strong technical support of Teddy Boen (International Expert on Non-engineered Buildings/ Senior Advisor of World Seismic Safety Initiatives), and Iman Satyarno (Professor, Gadjah Mada University, Yogyakarta). The guidelines, which organised by two eminent experts, focused on simple technical requirements. As construction workers in non-engineered buildings have less knowledge of engineering, it is quite difficult to ask them to meet with quite amount of requirements through guidelines. So amongst experts the team put a lot of efforts to reduce the number of items of requirements. The outcomes of works are put into a sheet of poster, and presented before the workers for their application.

The Figure 3 (Right) shows the strategic criteria for the selection of basic requirements in building design in non-engineered housing. Analysing the component of actions taken for the reinforcement, the experts found that there are requirements which can increase the level of safety significantly with less costs in one hand whereas there are what needs more costs with little effects in safety improvements.

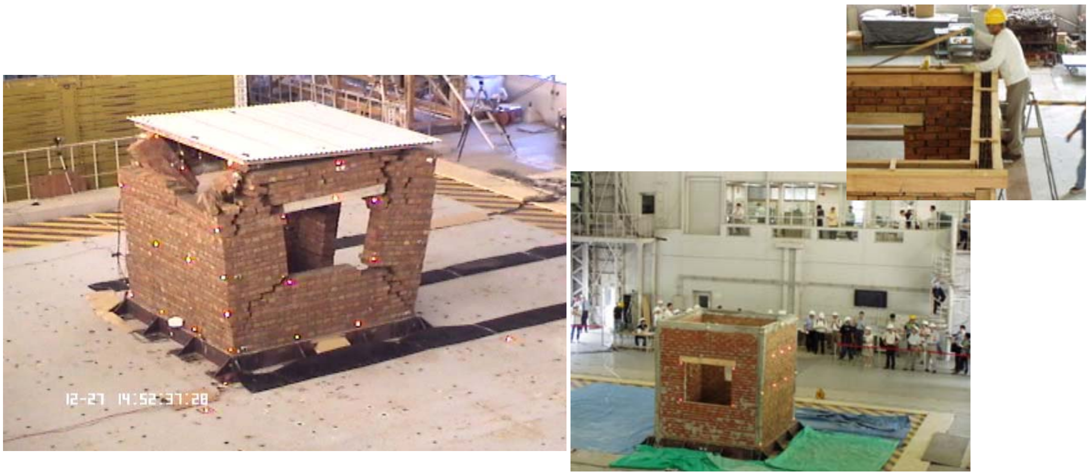
Figure 3. Key Requirements for Safer Housing Presented in Reconstruction Works after Central Java Earthquake, Indonesia (Left) and the Conceptual Image of the Selection of Reducing Number of Items of Technical Guidelines (Right)



In Japan, of course, it is asked to meet every requirement for the construction regardless of the analysis; or rather in order to get 100% scores in construction every action should be performed in the works. Ideally of course, the same things should be done everywhere. But the situation in developing countries is not something to pursue 100% scores- the engineers and development policy makers should put lots of efforts to make 10% scores to 20% or much higher. And the experts have try to launch the basic requirements to make every non-engineered building pass the "exam". In the selection of requirements put by experts, therefore, it is taken into full account "cost versus safety"; the measures which can enable the buildings to achieve high effects with little costs put much higher priorities than others, which cannot disturb local workers.

Taking into account of above mentioned demands in non-engineered construction, technical verification would be necessary to identify effective items. BRI has conducted for example test of bonding strength of mortar in order to improve the bonding methods which can be applicable for developing countries by using the cement with similar mixture ratio in Pakistan or Indonesia. So far BRI also has conducted shaking table experiment twice by using full scale models in Tsukuba; one in December 2007 by using the brick structure without reinforcement and the other in July 2008 by using Confined masonry structure with RC frame, which intended to be applied in Indonesia.

Figure 4. Shaking Table Experiments of Full Scale Models in Tsukuba (2007)



Indeed, as the second clause of the policy recommendation to bridge gap between engineering and construction, it should be raised the approach to focus on critical items in order to achieve more effects in safety measures rather focusing on perfect instalments of overwhelming amounts of measures- exhaustive guidelines are not appropriate for non/semi skilled workers. Particularly Japanese engineers are accustomed to the environment to pursue 100% scores in techniques, which makes engineers to be perfectionalist. For the interest of non-engineered buildings, however, it is required to take the adverse prioritisation in works in order to pursue wide dissemination and basic implementation of safety measures.

Observing the situation here in Japan, it can be also found out that there are many areas of expertise in engineering- from selection of materials, structures, and construction. It might be quite difficult to identify limited items for the safety measures in such situation. At least it is highly essential to take inter-sector consideration for improvements of non-engineered houses; and so far BRI has benefited from cooperation from various areas in the expertise. Such works can be strengthened through discussion, analysis and, crucially, technical verification.

Building Code Implementation

Another Problem
Seismic Protection of Existing Buildings

by Shunsuke Otani,
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Abstract

For the improvement of earthquake resistance of the society, it is important to develop state-of-the-art design codes for new construction, but also essential to assess earthquake damage vulnerability of all existing buildings and, if necessary, to retrofit the vulnerable buildings. The development of internationally uniform earthquake resistant design and retrofit technology is desirable, but may not be feasible because the expected performance (minimum required strength and acceptable damage) of buildings varies from a country to another. Difference exists in (a) seismic risk, (b) hazard tolerance, (c) economic background, and (d) technical development (construction practices and materials).

Introduction

Earthquake engineering is not a pure science which is formulated on rational hypotheses and strict logics. The earthquake engineering has been developed through lessons learned from bitter experience of disasters, and observation and analysis of failures, aiming toward the future improvement of infrastructures construction, disaster warning measures, early relief of the affected, and reconstruction of the society, by reducing possibilities, as much as possible, of repeating similar failures of the past in the future event. With the development of earthquake engineering, the design codes and construction methods for new structures may be revised, new countermeasures may be prepared. However, the safe society may not be realized unless existing structures, designed and constructed using old technology, are also retrofitted to the level of new construction.

The following development and application of technology are needed to mitigate earthquake disaster from construction point of view: i.e.,

(a) Effective earthquake resistant building codes for new construction,
(b) Earthquake vulnerability assessment methods for existing buildings,
(c) Seismic strengthening technology for vulnerable buildings,
(d) Seismic damage evaluation methods for damaged buildings after an earthquake,
(e) Technology to repair damage for immediate occupancy, and
(f) Technology to rehabilitate damaged buildings for permanent use.

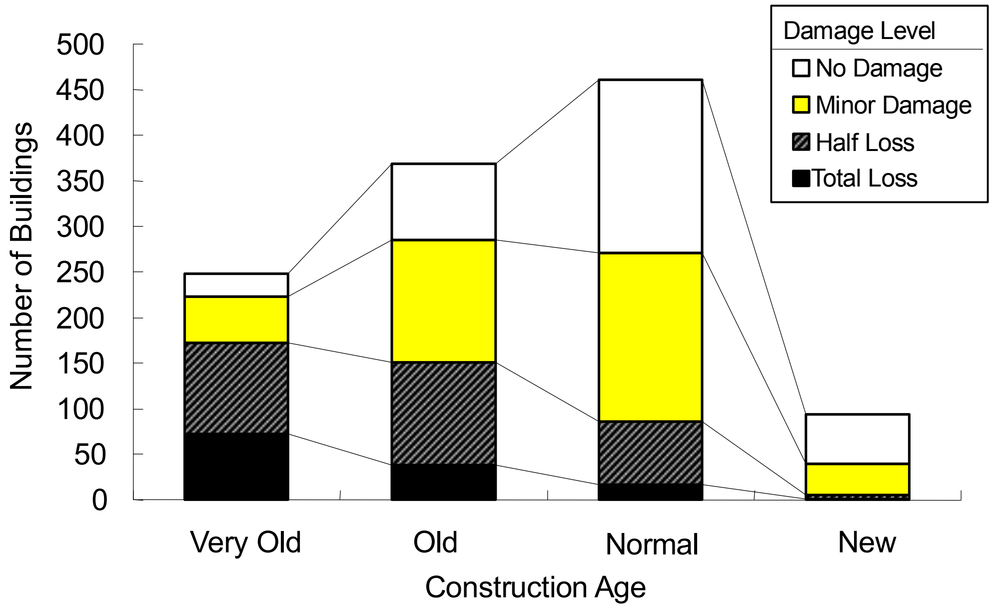
It should be noted that these countermeasures may not be the same from a country to another because the expected performance (minimum required strength and acceptable damage) of buildings varies from a country to another. Each country has different levels of (a) seismic risk, (b) hazard tolerance, (c) economic background, and (d) technical development (construction practices and materials).

During the 1995 Kobe Earthquake disaster, majority of people were killed under the collapsed traditional timber houses with heavy roof and with less earthquake resisting walls. New timber houses suffered much less damage because the roof was built lighter to attract less earthquake inertia forces and more walls were provided to resist earthquake forces. Figure 2 shows the statistics of damage in timber construction in Awaji Island, in which severer damage was observed to increase with construction age. It is true that structural properties of construction materials decay with age, but the decay of material properties cannot explain the difference in damage rate.

Figure 1. Old traditional houses & New engineered houses

- **Heavy roof tiles**
- **Lack of walls**
- **Decay in structural properties**

Figure 2. Damage levels of timber houses with construction age (1995, Awaji)



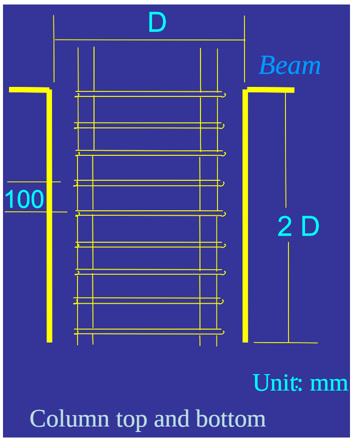
Damage of Reinforced Concrete Structures with Code Change

The 1968 Tokachi-oki Earthquake caused significant damage to reinforced concrete school buildings; i.e., reinforced concrete columns, which deformable length was shortened by non-structural spandrel beams, failed in brittle shear mode. Japanese structural engineers, researchers and the general public believed that the reinforced concrete construction was earthquake resistant, and the reinforced concrete construction had been promoted throughout the country after the 1923 Kanto (Tokyo) earthquake disaster. The government organized an extensive research program to clarify the failure mechanism of reinforced concrete columns under lateral loading, and the code requirements were revised, in 1971, to require closer tie spacing in columns to prevent brittle shear failure and to improve deformation capability.

Figure 3. Tokachi-oki Earthquake (1968)

- **Lack of ductility**

Figure 4. Tie Spacing Requirements in 1971



At the same time, the concern was expressed as to the earthquake safety of existing reinforced concrete buildings in the future earthquake; similar brittle failure might be repeated in existing buildings although new construction might be protected by the code revision. Various methods were developed for the seismic vulnerability assessment of existing buildings against future earthquakes. The reliability of the methods was tested by the damage observation of buildings in the following earthquakes.

There was a significant improvement in seismic design requirements in 1980. Ministry of Construction organized an integrated technical development project, entitled "Development of New Earthquake Resistant Design (1972-1977)." The research findings were reflected in the revision of the building code; i.e., design seismic forces were specified

(a) by story shear (resistance in each story) rather than horizontal forces at floor levels,
(b) in terms of fundamental period of the structure,
(c) using traditional allowable stress design format for serviceability examination, and
(d) lateral resistance at failure for safety examination.

Figure 5. Criteria of "Life-Safety" Performance

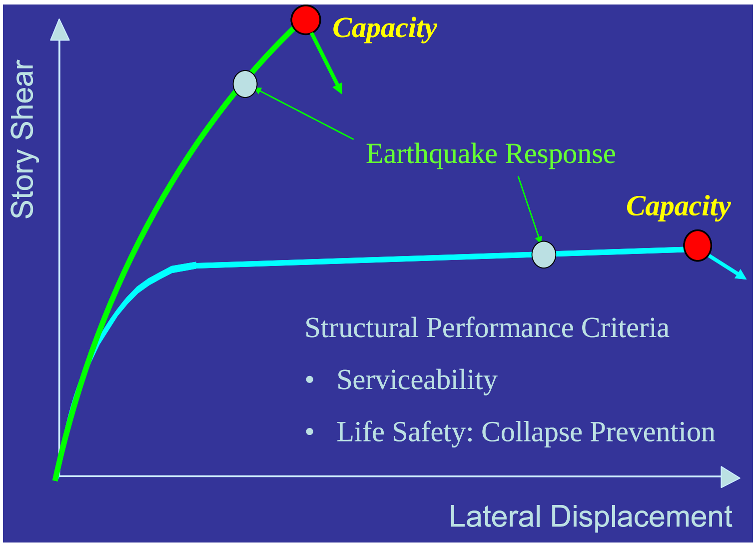
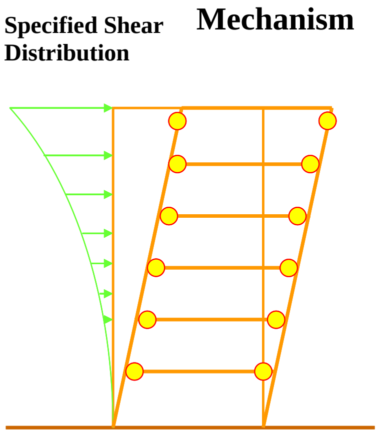


Figure 6. New seismic design requirements in 1981



Collapse due to poor structural planning

The ultimate lateral resistance is defined as the minimum story shear at the formation of collapse mechanisms under lateral loading; the required lateral story resistance was varied with the deformation capacity of the story and the irregularities in structural configuration (eccentricity of the stiffness centre with respect to the mass centre in plan and distribution of the lateral story stiffness along the height).

Let us examine the effect of design code revisions on damage statistics of reinforced concrete buildings. The 1995 Kobe Earthquake disaster clearly demonstrated the superiority of more recent construction as shown in Figure 7. The damage level was classified as operational damage (no damage, light damage and minor damage), heavy damage (intermediate damage and major damage), and collapse (including those already removed at the time of investigation). Buildings with operational damage could be occupied immediately after the earthquake. Buildings with heavy damage needed some or major repair work for the occupancy.

Figure 7. Damage statistics of reinforced concrete buildings with construction age - no soft first-story buildings included (1995 Kobe Earthquake)

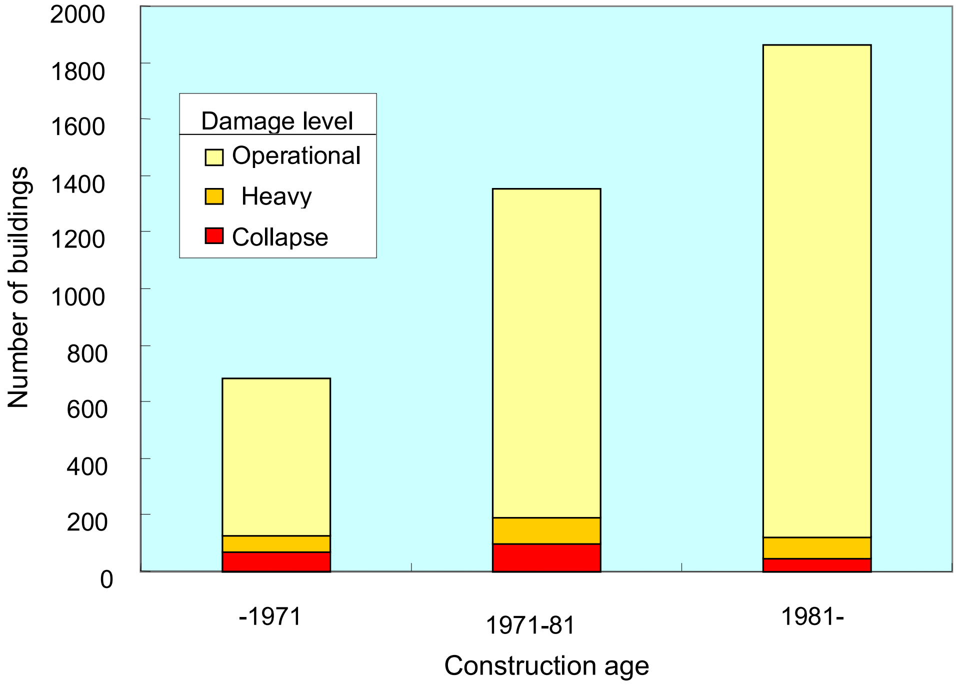
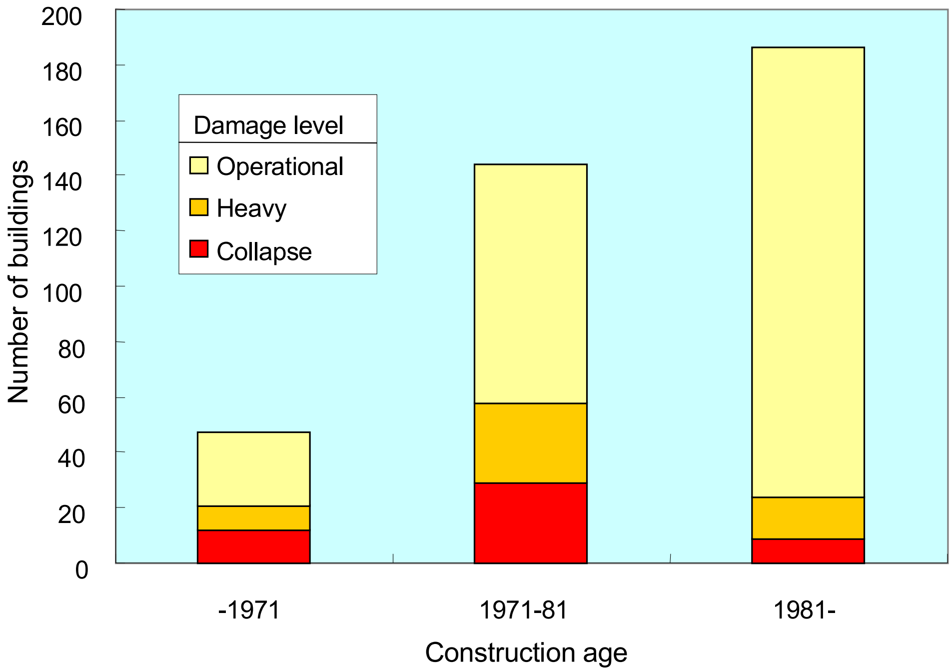


Figure 8. Reinforced concrete buildings in the 1995 Kobe disaster

Most common type of failure in earthquakes was the collapse of the soft first-story construction, in which the lateral stiffness and resistance of the first story were significantly reduced from those of the upper stories by removing structural walls in the first story for building usage (garage and commercial use). The collapse took place in the first story in the form of brittle shear failure of columns because all lateral forces acting in upper floors had to be resisted in the first story. Figure 10 compares the damage rate of soft first-story buildings with construction age. It can be noted that a significant improvement in the safety of the soft first-story buildings with the revision (improvement) of the design code. Almost one half of those soft first-story buildings constructed before the 1971 revision suffered severe damage or collapse. The current design code is not sufficient to prevent soft first-story construction from collapsing.

Figure 9. Soft first-story buildings (1995 Kobe Earthquake)

Figure 10. Damage of soft first-story buildings with construction age

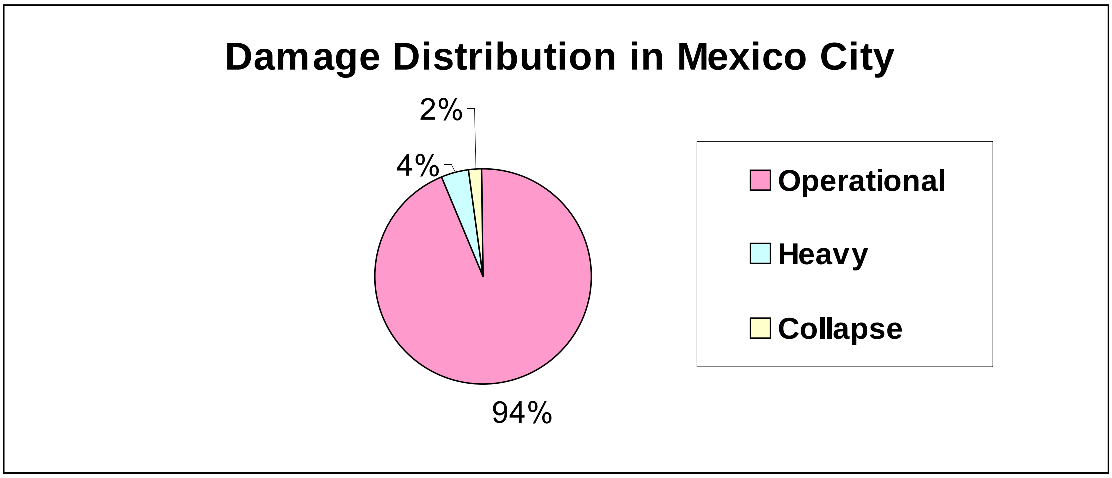


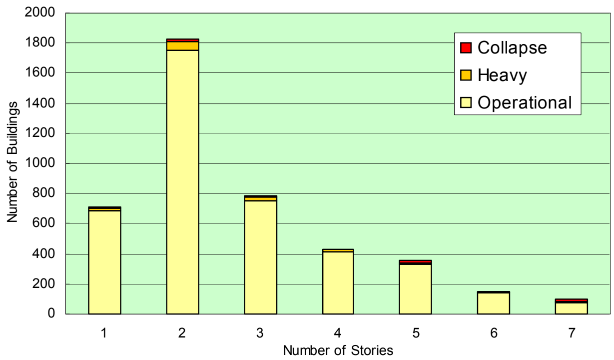
Vulnerability Assessment of Existing Buildings

Most building codes in the world explicitly or implicitly accept structural damage to occur in a building during strong earthquakes as long as the hazard to life is prevented. Indeed, many earthquakes caused such damage in the past. Then, what percentage of buildings suffered heavy damage in major earthquakes? The Architectural Institute of Japan (AIJ) collected damage statistics in Mexico City and Lazaro Cardenas after the 1985 Mexico Earthquake, Baguio after the 1990 Luzon, Philippines, Earthquake, Erzincan after the 1992 Erzincan, Turkey, Earthquake, and Kobe after the 1995 Hyogo-ken Nambu Earthquake. A heavily damaged area was first identified in each city, and the damage level of all buildings in the identified area was assessed by structural engineers and researchers.

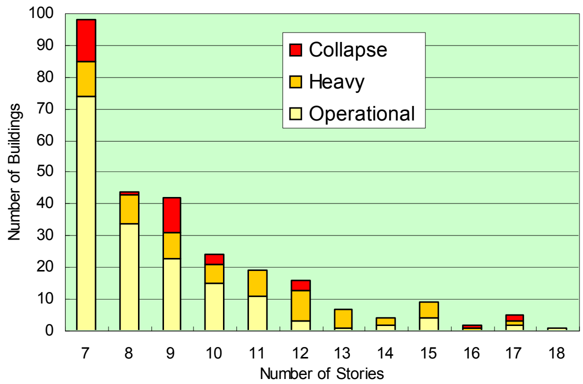
Figure 11. The 1985 Mexico City Earthquake disaster

Figure 12. Damage Distribution in Mexico City





Damage Distribution in Mexico City



Damage Distribution in Mexico City

The damage level is classified here to (a) operational damage, (b) heavy damage, and (c) collapse. There was a significant code change in 1981 in Japan; therefore the damage statistics are shown for buildings before and after the code change.

The damage statistics show that 75 to 95 percent of buildings in severely damaged areas remained operational after the strong earthquakes in Mexico City, Lazaro Cardenas, Baguio, Erzincan, and Kobe. A definite trend is observed in the damage statistics that (a) the percentage of heavy damage increased with the number of stories, and (b) the damage rate decreased with the development of new technology. The damage rate was small in Mexico City because the majority of buildings were low-rise less than four stories high.

TABLE 1. DAMAGE STATISTICS OF BUILDINGS FROM MAJOR EARTHQUAKES

City, year of earthquake	Operational damage	Heavy damage	Collapse	Total
Mexico City, 1985	4,251(93.8%)	194(4.3%)	87(1.9%)	4,532
Lazaro Cardenas, Mexico, 1985	137(83.5%)	25(15.2%)	2(1.2%)	164
Baguio City, Philippines, 1990	138(76.2%)	34(18.8%)	9(5.0%)	181
Erzincan City, Turkey, 1992	328(77.4%)	68(16.8%)	28(6.6%)	424
Kobe (pre-1981 construction), 1995	1,186(79.4%)	149(10.0%)	158(10.6%)	1,493
Kobe (post-1982 construction), 1995	1,733(94.0%)	73(4.0%)	38(2.1%)	1,844

From damage statistics, we realize the importance of identifying the small percentage of those buildings possibly vulnerable in future earthquakes. Therefore a simple procedure is desirable to examine the vulnerability of all existing buildings in a region, spending a few hours at most for a building, and "screen out" the majority of safe buildings. A more detailed and sophisticated procedure, spending a few weeks, may be utilized to those buildings identified as vulnerable by the simple procedure.

In a simple screening procedure, for example, dimensions of columns and structural walls per floor areas may be used to roughly estimate lateral load resistance. The lateral load strength is not a single index to represent the safety of a building, but gives some idea if the structure has a sufficient capacity to resist earthquake motions by strength.

Those buildings, identified as questionable by the simple procedure, must be analyzed by more sophisticated procedure, taking into account, for example, (a) strength and deformation capability of constituent structural members, (b) material properties on site, (c) floor weight, (d) structural configuration, (e) foundation, (f) site conditions, (f) soil-structure interaction, (g) quality of workmanship, (h) importance of buildings, (i) structure's age, (j) installation of building facilities, (k) safety of non-structural elements, (l) hazard history and (m) intensity of possible future earthquakes. The deterioration of earthquake resisting capacity, for example in reinforced concrete buildings, caused by (a) existing cracks, (b) deflection under gravity conditions, (c) uneven settlement caused by foundation deformation, (d) neutralization of concrete, and (e) rust on reinforcement, may be carefully examined at the building site. The strength and deformation capacities of structural members must be estimated on the basis of actual dimensions and material properties investigated on site.

Retrofit of Existing Buildings

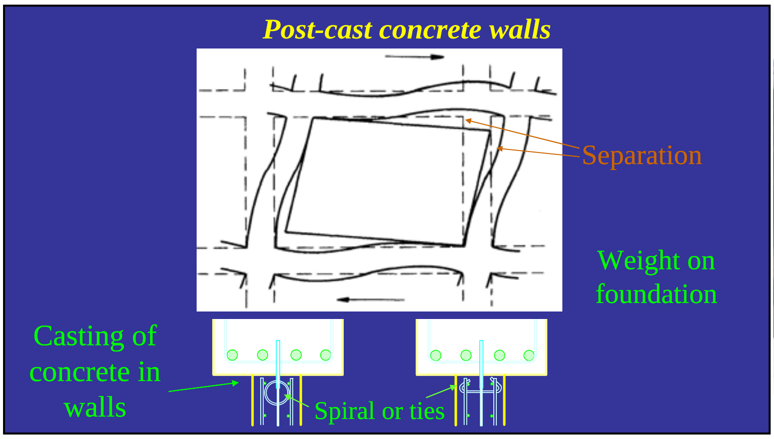
Methods to retrofit structures vary with structural types (for example, moment resisting frames, wall systems, dual systems), construction materials (reinforced concrete, steel, timber, adobe, masonry), technical levels (engineered or non-engineered), floor weight, structural configuration, expected performance (importance and economical levels), and expected intensity of ground motions. General strategy of retrofit is to remove possible causes of damage in vulnerable structures; i.e., lack of lateral load resistance and deformation capacity in comparison to the earthquake demand. If the lateral resistance is low, the building may be damaged under more frequent earthquakes. Large deformation capacity (ductility) is necessary for the life safety under the maximum credible earthquake.

For example, the 1995 Kobe Earthquake disaster revealed the weakness of reinforced concrete columns designed in accordance with the pre-1971 design code. Failure of reinforced concrete columns was primarily in shear at a small story drift attributable to the lack of lateral reinforcement. Larger deformation capacity may be attained by shifting failure mode from shear to flexure; e.g., enhancing the shear capacity higher than flexural capacity by (a) jacketing reinforced concrete columns with steel plates and (b) wrapping reinforced concrete columns with fiber reinforced plastics (FRP). The use of FRP sheets has merit of easy construction work and of light material weight. Placement of gaps between a column and adjacent monolithic spandrel beams, can reduce shear input at the flexural yielding at the top and bottom of the column. Placement of bracing structures (structural walls or steel braces) is effective limiting the response deformation of the structure, thus avoiding the failure of brittle members at a small story drift.

Figure 13. Precast Reinforced Concrete Braces & External Steel Bracing (Japan)

Figure 14. Placement of steel bracing (Japanese Schools)

Figure 15. Detailing of wall-frame connection (Left) and Reinforcement of Columns (Right)



Carbon Fiber Reinforcement

Adobe is good construction materials; e.g., economical, easy to obtain, less demanding of construction skill, and efficient for heat insulation. However, the heavy adobe construction attracts large earthquake inertia forces, and is not strong enough to resist large in-plane shear forces or to resist out-of-plane overturning moment. The reinforcement methods should be developed to maintain integrity of adobe walls, to increase in-plane shear resistance, and to resist out-of-plane overturning at the base.

The occupancy of a building during the retrofit work should be considered in selecting retrofit works. For example, the strengthening work of reinforced concrete columns normally requires the removal of mortar and other finishing materials (tiles) from the concrete surface. The noise, vibration and dust during the retrofit work will not allow occupants to stay in the building.

Figure 16. Effect of Carbon Fiber Sheet Reinforcement

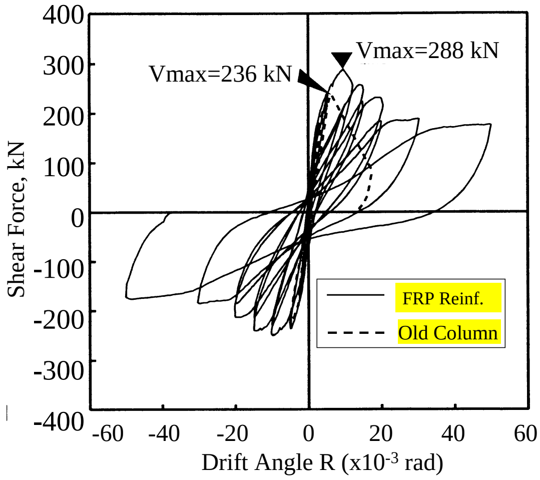
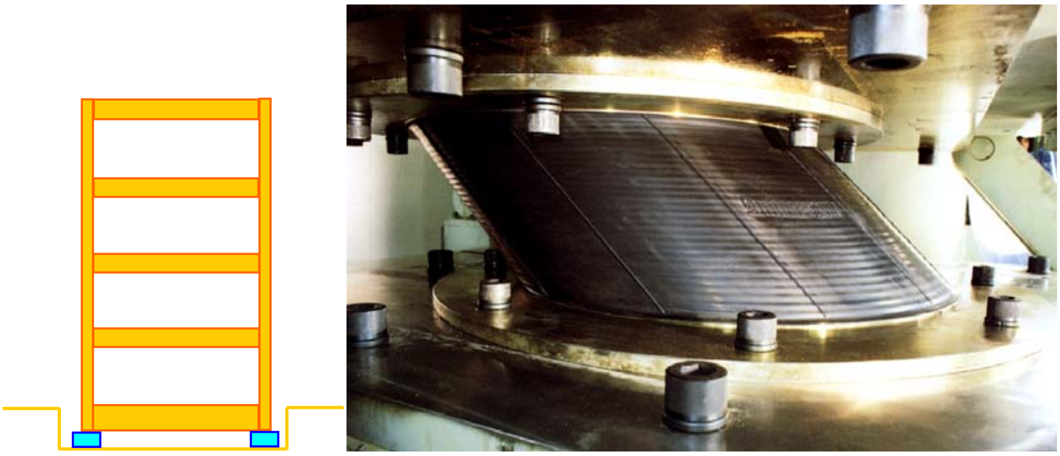


Figure 17. Base Isolation for Retrofitting



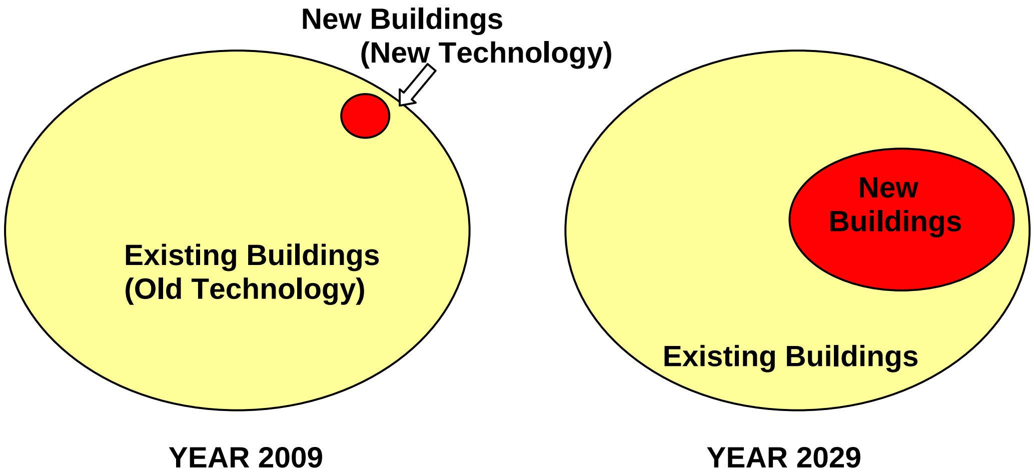
The failure of buildings often takes place in the form of partial collapse in a soft (and weak) story due to shear failure of columns. In addition to enhancing shear capacity of columns, it is highly desirable to increase the stiffness and strength of the soft story by providing bracing members to avoid the concentration of excessive deformation.

The eccentricity between the centres of stiffness (and associated strength) and floor mass causes torsional vibration of a structure, resulting in large deformation away from the centre of stiffness. The eccentricity in floor plan should be corrected during the retrofit work.

If advanced technology is affordable, especially in hospitals for post-earthquake medical treatment of the injured, the earthquake induced inertia forces may be reduced by placing isolation devices at the base. The response of a structure may be reduced by installing tuned mass dampers or energy dissipating devices; different types of energy dissipating devices such as visco-elastic fluid damper, visco-elastic solid damper, hysteretic energy dissipating damper and friction damper are available.

The failure of foundation piles was reported after the 1995 Kobe earthquake disaster. In some structures, the failure of pile foundation is said to reduce the earthquake ground motion input to the structure and limit the damage in the super-structure. However, the cost of damage investigation of foundation as well as the repair work of damaged foundation is expensive. It is normally desired to provide the foundation structure with higher resistance.

Figure 18. Image of the relation of Design Code for New Construction



Concluding Summary

The following development and application of technology are needed to mitigate earthquake disaster from construction point of view: i.e.,
(a) Effective earthquake resistant building codes for new construction,
(b) Earthquake vulnerability assessment methods for existing buildings,
(c) Seismic strengthening technology for vulnerable buildings,
(d) Seismic damage evaluation methods for damaged buildings after an earthquake,
(e) Technology to repair damage for immediate occupancy, and
(f) Technology to rehabilitate damaged buildings for permanent use.

This paper discusses the need of the earthquake vulnerability assessment methods for existing buildings. Statistics of damaged buildings in past major earthquake disasters indicate that relatively small percentage of buildings suffer heavy damage. Therefore, a rough but simple procedure is needed to assess the vulnerability of all existing buildings in a community. More sophisticated procedure may be used if a building is identified as questionable by the simple procedure.

A building, if assessed as vulnerable, should be retrofitted using local technology. Retrofit methods suitable for a locality vary with structural types, construction materials, expected performance, and expected intensity of ground motions. General strategy of retrofit is to remove possible causes of damage in vulnerable structures; i.e., lack of lateral load resistance and deformation capacity in comparison to the earthquake demand.

Experience of Damages in Recent Earthquakes

by Shoichi Ando,
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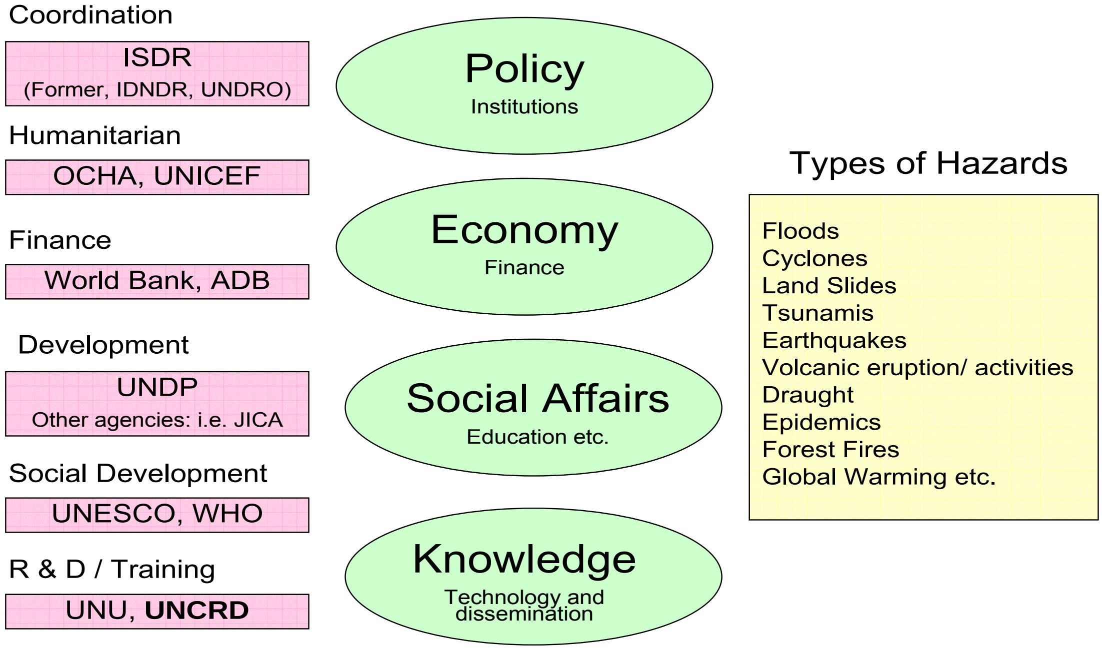
Abstract

This paper records the recent field surveys conducted as a part of activities of UNCRD Disaster Management Planning Hyogo Office. The paper takes up recent five missions to the sites of massive earthquake (related) disasters: Indian Ocean Tsunami (2004), Pakistan Earthquake (2005), Java Earthquake (2006), Pisco Earthquake (2007) and Wenchuan Earthquake (2008), and explains what UNCRD has seen in terms of earthquake housing safety in the context of enhancing regional development.

Introduction

Apart from the main project based mandates, UNCRD Disaster Management Planning Hyogo Office conducts field based survey after the occurrence of disasters in order to see social and structural impacts of disasters, process of reconstruction, and the tips for seeing further preparedness of the disaster. There are several functions for UN agencies' works on disaster management- Coordination, Humanitarian support, Financing, Development, Social development, and Research/ Trainings. UNCRD is in charge of the last function in UN agencies in terms of regional initiatives, and it would be crucial to collect the experience and practices of the disasters in each countries as well as regions.

Figure 1. Area of Works in Disaster Management and UN/ international agencies



Besides of the fact that natural hazards occur constantly so far, the society faces adding risks of disasters as follows: i) expansion of populations and city (urban areas), ii) trends of heavier damages to the poor in the Least Developing Countries, and ii) degradation of ecosystem and/or climate change. Particularly in the case of earthquake, hazards affect heavily not only the least class of the society but to those who have middle incomes. Both groups, then, occupies the major part of the populations in the society as a whole, which obviously leads serious effects to any activitiy in the country. The presentation therefore examines the recent field based survey of disasters in Indonesia (2004 and 2006), Pakistan (2005), Peru (2007) and China (2008), and analyses the lessons learnt in terms of earthquake housing safety.

Indian Ocean Tsunami (2004)

Indonesia has been extremely vulnerable to natural hazards. It is located on the ring of fire, and as such prone to earthquakes, volcanic eruptions as well as to tsunamis caused by seismic activity. The tropical climate with heavy rain showers during the wet season can cause flooding and landslides. These natural hazards combined with high population densities, poverty, often poorly constructed buildings and deficient urban planning, inadequate warning systems and poor institutional disaster preparedness contribute to natural hazards to turn into disasters. Local governments and communities need assistance to realize the urgency of these issues. From experiences in the past as in Aceh after the 2004 tsunami, many lessons can be learned. Physical reconstruction is one aspect of recovery, while socio-economic recovery is another.

Figure 2. Reconstructed House (Left) and Traditional Buildings in the Aceh Region (Right), Banda Aceh, Indonesia, December 2007

UNCRD has visited Banda Aceh in August 2005 and December 2007 (3 years after the disaster). The reconstruction of urban area was being implemented. Many houses and most of public facilities have been rebuilt or rehabilitated by late 2007.

During the second mission, one of the staff members of Syiah Kuala University made us testimonies of his experience. He saw the Tsunami wave of more than 7-8 meters depth when he stayed in his house, and many friends who stayed with him at his house were disappeared in a second. He fortunately survived as grasping an edge of a boat – and he waited until the tsunami activity could be ceased completely. After three months, however, he was severely suffered from the trauma (PTSD) because of the strong shock and feeling of spiritless. Volunteers for psychological care helped him to heal from the trauma of tsunami and loss of many friends.

There were remaining ships in the residential area where is located a few kilometres from the coast line. There are huge amount of construction sites of new houses in the areas. Most of public facilities have been reconstructed while the houses are still under the process of recovery.

Figure 3. Damaged Masonry School (Left) and Remained Ship in the Residential Area (Right), Banda Aceh, Indonesia, December 2007

Pakistan Earthquake (2005)

Barakot is the most heavily damaged city by the Pakistan Earthquake that occurred on 8 Oct. 2005. More than 70 % of buildings in the city were collapsed and the destructed materials still remain all over the city when UNCRD reached to the site in March 2006. The reconstruction work started finally in early 2006, as having improved the weather in winter. New commercial buildings began to be constructed in the market, and the mission visited a bamboo model house constructed by a local NGO in corporation with Bangladeshi team using the bamboo imported from Myanmar, which is in higher quality comparing the local one.

Another model house was built by a Nepali NGO; National Society for Earthquake Technology Nepal- NSET, funded by HABITAT Pakistan and the local government. Their construction system can be adapted only to the new construction. However, because the system is familiar with local construction engineers and technicians, it may be the best way to construct earthquake resistant buildings and houses in the affected areas. UNCRD also had experience to promote same type of (reinforcement) construction system in the past with NSET in Afghanistan, Iran, and India.

Figure 4. Reconstructed House (Left) and Traditional House in the Region (Right), Pakistan, March 2006

Using the mission survey opportunity in Pakistan, UNCRD participated in JICA's workshop in Muzaffarabad in March 2006 on public education on earthquake resistant houses– the demonstration method utilising the shake table test. The awareness methodology was developed and shown by NSET so far in UNCRD's seminars and symposiums as the most convincing method to illustrate the effectiveness of proposed reinforcement for houses. At this time, including PP band system, which is a newly developed skill in recent years, JICA's workshop obtained more than 300 participants who were all attracted by the explanatory remarks conducted by NSET experts. The testing table conserved two typical model houses of scale 1/6- one is reinforced on its walls and columns whilst the other employs no measures- which successfully illustrated the changes created by the reinforcement measures.

In April 2007, a field survey of earthquake hit area of northern Pakistan was carried out in order to get insight of the vulnerability, the efforts of reconstruction and future prospects of seismic construction in the earthquake hit areas. Comparing the situation on the mission in March 2006, the reconstruction of houses and towns then had been achieved significantly. In particular, most of the hospitals have been reconstructed, whilst some of schools still remained as they were affected. The mission found that the cause of the large scale devastation is basically the total ignorance of the earthquake risk and not because of the large shaking intensity. It is observed that some buildings with good construction workmanship, maintenance and compliance with simple seismic consideration like configuration and integrity between structures survived the earthquake in the hardly hit area.

Figure 5. City of Muzaffarabad (Left) and the Operation of Reconstruction Works (Right), Muzaffarabad, Pakistan, March 2006

The damage has concentrated in masonry houses. In general, the quality of material and workmanship, particularly that of mortar and limited concrete works is poor. The traditional construction with wood (or wood and stone) has been eroding and RC construction with brick infill has been emerging. The basic rules and quality of construction of this new typology has been grossly violated. The recovery process of the damaged houses is comparatively in a good momentum. The limited resources available to house owners to rebuild their houses, however, prompted partial/stage construction which leads to undesired consequences; i.e. incompatible construction joints, abrupt change in construction material etc.

Java (Yogyakarta) Earthquake (2006)

In September 2006, guided by Sarwidi, Professor of the Islamic University of Indonesia (UII), UNCRD team visited some important sites where were affected by the May 2006 Earthquake in the south part of Yogyakarta City (approximately 5-20 Km south and south-east of the central areas): a governmental (regional revenue office) building, where its ground floor was totally collapsed as well as the “Institute SENI Indonesia Yogyakarta” and its “Departemen Pendidikan Nasional” in the Sewon District.

The team also visited the reconstruction works conducted by UII in Bantul Region where is the most affected area by the earthquake. For the purpose of public demonstration, the UII constructed, with some financial support from the Japanese embassy, a model house for the local people using bricks with reinforced concrete columns and beams (so-called confined masonry structure) in the middle of the damaged areas and very close to the trunk cross-roads of Pleret District. In order to observe the impacts of the efforts, the mission entered to two forest villages in the district. One of the villages invited BRI expert with professor Sarwidi and conducted village-based testing by using several experimental pieces. The village has also a model house which incorporated earthquake resistant methods before the earthquake, which resulted in success to withstand against the earthquake.

Figure 6. Recovery Works (Left) and the Traditional Construction of Java (Right), Yogyakarta, Indonesia, September 2006

The mission also visited Gadjah Mada University (UGM) in Yogyakarta to see Ikaputra, Prof. of Architectural Department, who has learnt architecture and urban planning at Osaka University. The UGM has evolved several model houses (of bamboo, palm tree and/or wood, which were all non-engineered) for tsunami prone and earthquake prone regions. Using posters, UGM experts conduct efforts of dissemination of anti-seismic technologies and tips for reconstructing/ repairing houses of community peoples.

In December 2007, the second mission of UNCRD was conducted along with the team of Hyogo prefecture to see the reconstruction of vital regional facilities, particularly schools and kindergarden in Yogyakarta Special Province with the guide of the chief of planning section of the Regional Development Bureau of the Provincial government. Hyogo prefecture decided to support for retrofitting the Margoyasan elementary school in the city, which was constructed in 1901 and has approx. 240 students. Meanwhile, the mission found that communities around Plus Mutiara kindergarten, which is located in the Bantul District, have been reconstructed by the mutual cooperation system in the community one and a half year after the earthquake.

Figure 7. Poster for public awareness on earthquake resistant methods for non-engineered houses (Left) and Reconstructed (Temporary) House using local materials (Right), Java, Indonesia, September 2006

Peru Earthquake (2007)

Peru has an old history for developing National Building Code; established in 1963 and enacted in Lima in 1968, and even recently updated incorporating advanced understandings on earthquake safety. With the advanced building code in place, however, the implementation of the code is still not effective owing to various reasons. Particularly, the lack of awareness and sensitization of the importance of the latest building code amongst professionals, lack of capacity of municipal authority to deal with the building and related urban planning issues are the major constraints. In order to achieve the essential objectives of the code earthquake safety, it requires a mechanism to enforce the application of the code, monitoring of its performance, the advancement of the level of understanding and the specific preparation of design / supervision by professionals. More importantly, there is an indispensable need for capacity building of local governments for effective enforcement as well as guidance of citizens for the building code compliance.

Figure 8. Recovery Works (Left), the Traditional Construction in Peru (Right), and the Damage caused by the Earthquake (Bottom), Pisco, Peru, August 2007

The role of stakeholders including the private sector is instrumental for development of building code compliance incentive scheme and social marketing in line with the product specified or implied in building codes. The most challenging issue is to make building code reach to individual houses- be them conventional isolated buildings or apartment houses or public buildings. Though building code applies to all form of houses in Peru, hardly it gets appropriate supervision by municipal authorities for all these construction. There is also tendency amongst small builders that they avoid the procedural rules to follow in compliance with the building code. Enforcing the use of a code demands its application mandatory through the creation of enforcement and inspection system. This can be achieved through developing appropriate strategies and putting a system in place for collection of design data responding to technical questions and checking the actual and appropriate use of the code.

The Housing Earthquake Safety Initiative (HESI) conducted by UNCRD, includes Peru as a target country in Latin America. From its first expert meetings, Javier Pique, Dean of Peru Engineering College was invited as one of the resource person, and identified the essential demands of capacity building of national government and local governments to comprehend the necessary tools for code application- with the appropriate chain of building permit system, planning for human and financial resources for code enforcement through certification and inspection.

Figure 9. A Family Desperate after Losing their House by the 2007 Earthquake (Left) and Damage of Adobe-made House (Right), Pisco, Peru, August 2007

The international conference and the PERU HESI workshop that was coincidently held just one week after the August 2007 Pisco (Peru) Earthquake, established an important foundation to implement the HESI project in Peru. The earthquake that occurred off the coast of Pisco on 15 August 2007 claimed more than 500 lives, most of them died as a result of the collapse of houses. Following the event, safety of houses became a major concern in Peru. Nevertheless, majority of the people remain unaware of the national building code and continue to live in potentially vulnerable houses. Dissemination of the building code, including “adobe” (sun-burned clay brick) related one, is essential for future disaster prevention. Inclusion and mobilization of municipal governments, which are responsible for implementing the Peruvian national building code, is crucial for the effective enforcement of building code nationwide. The country needs better coordination between the central government and local governments. The role of UNCRD is to help improve coordination between the two key players.

Wenchuan Earthquake (2008) in Sichuan Province

With the Wenchuan Earthquake, occurred on 12 May 2008 in the afternoon, the human damage of the disaster amounted to more than 69,000 casualties except the lost and to one millions of people who lost their houses. According to the national announcement and newspaper reports, the following issues were reported in early June 2008;

- Northwest Region of Sichuan Province is affected by the magnitude 8.0 Earthquake;
- The most heavily damaged cities are Dujiangyan, Mianzhu, and Beichuan;
- Many schools were destroyed and children died by the collapsed buildings;
- The rescue efforts have been finalized by almost 10 days after the earthquake;
- Chinese government opened data on disaster affected area from the first stage;

The first mission of UNCRD was conducted early June 2008 in order to verify the main damage and action taken in the community in relation with the implementation of national policy. Although the infrastructure, particularly roads were still under construction, with one month Chinese government were equipped to prepare and disclose the detailed maps of affected areas in the website which enabled to achieve the objectives of the survey. To begin with the mission firstly stepped into central part of Mianzhu city, with a half million populations, which locates 100km north of Chengdu city, the capital of Sichuan Province. Mianzhu city got severe damage in its north-west part, particularly Zhundao town and Hanwang town. Although the central part of the city did not have severe damage the mission found that people were afraid to stay in the apartment houses with cracks. A number of tents were distributed alongside of the trunk road all over the city. As accessing closer to the severely damaged area (Zhundao town and Hanwang town), the mission also found the numbers of destroyed brick houses gradually increased. Comparing to the centre of the city, the towns have a lot of middle storey apartment houses- most of them have one or two storeys and made by pure brick or brick with reinforced concrete frame structure. The town office, which should be essential for management operation in the disaster response and recovery works, was totally collapsed and removed. Several temporary office rooms were built in the plane playground of the office.

Figure 10. Temporary Shelters in Dujiangyuan (Left) Damage on Traditional Construction (Right), and Traditional Construction in the Region (Bottom), Sichuan Province, China, August 2008

The mission also visited Dujiangyan city, part of Chengdu city municipality area, where locates 50km west of the downtown of the Chengdu City, which has renowned historical monuments designated as the World Heritage. Although having attracted tourists, the historic monumental area had a lot of refugees then – no tourist service available at all. Having visited the Libing Middle (Junior-high) School, the mission found that the debris was removed whilst it was distributed dozens of white tents donated by the Hyogo Prefecture through the Japanese government in May 2008.

Having saw the difficulties in the disaster damaged area for recovery operation, through Gu Linsheng, Head of an institute of Tsinghua University in Beijing, who was formerly dedicated as a researcher at UNCRD in Nagoya, and who managed a part of reconstruction works with the request from Chinese national government, the mission obtained the list of issues emerged in the analysis conducted by the authority.

- A total of 16,599 aftershocks of the M8.0 main shock were recorded since May 12, including 226 during the past 24 hours, 8-9 July.
- The official death toll stood at 69,197 as of Wednesday, July 9th, according to the State Council Information Office. The number of injured and missing stood at 374,176 and 18,379 respectively
- According to the State Council Information Office, about 5,461,900 houses collapsed, 5,932,500 houses were seriously damaged, and another 21 million may have need repairs.
- Eventually, the rubble in cities and neighbourhoods will probably be dumped into the fields and valleys of rural areas, although some may be recycled for rebuilding.
- China's military has already disposed of nearly 8 million cubic meters of debris.

• Wen Jiabao, the Prime Minister, signed a regulation on reconstruction which established the "protection of the ecological environment with economic and social development" as a guiding principle.
• Contaminated water is one of the biggest environmental issues after the earthquake.
Contamination sources include:
1) the quake lakes,
2) spill of hazardous materials,
3) factory wastes.
• The government disaster relief fund reached 56.088 billion yuan (8.19 billion USD), including 50.748 billion yuan from the central budget and 5.34 billion yuan from the local budget.
• Domestic and foreign donations reached 56.925 billion yuan in cash and goods, of which 20.479 billion yuan was forwarded to the hardest hit areas.
• About 1.58 million tents, 4.87 million quilts, 14.1 million garments, and 1.84 million tons of fuel oil had been sent to the quake-hit areas.
• As of Wednesday noon, July 9th, 52,418 km of the 53,295 km of roads damaged in the quake, had been restored to service.
• As of Tuesday, July 8th, relief workers had built 447,600 temporary houses and another 23,600 were ready to install. The materials for 50,600 new shelters had arrived in the affected areas

(The National announcement dated on 9 July 2008)

Figure 11. Damages in Middle Storey Apartment Houses- 5-6 Storeys Buildings (Left), Hospital in Hanwang (Right), Sichuan Province, China

The second mission of UNCRD to Sichuan conducted early August 2008, in order to examine closely the reconstruction work conducted by local governments and the issues emerged from the operation. The mission conducted meetings with local government officers, particularly from the Planning Directorate of the Mianyang city, one of the major affected cities in the Earthquake.

TABLE 1. DAMAGES AND RESPONSE ACTION OF MIANYANG CITY BY THE 12 MAY 2008 EARTHQUAKE

Damages on Populations	21,963 dead, 7,795 missing, and 174,000 injured / 5 million populations
Rescued Populations	24,135 persons rescued from the debris/ 188,900 persons hospitalized (around 10,000 persons were transferred to another hospital to have detailed check)
Collapsed Houses	Many in the north-west part of the city (incl. Jiangyou city ward) Rural houses: Total 69 million m^2, 841,000 units collapsed Urban houses Total 6.3 million m^2 collapsed, 57 million m^2 partly damaged (3/4 houses were totally or partly damaged, 1.73 million people)
Industrial Damage	Direct economic losses: 297,840 million yuan
Geological Disasters	2,432 geological disasters including 55 lakes (created by earthquake landslides) The biggest lake caused evacuees amounted to 1.73 million residents early June
Launch of refugee camps	On 13 May (next day of the earthquake) by using large facility incl. gymnasia
Traffic Control	Immediately after the disaster- only emergency cars were allowed
Service provided by the city	Temporary houses, Medical care, Infrastructure repair etc.

Mianyang city has more than two thousand years history and now became the 2nd leargest city in Sichuan with 0.7 million population live in the city central area (70km2) amongst 5 million populations. The city has 22 famous research institutes where guards 170,000 researchers, who are taking the key factor for launching Science and Technology City development of the city to attract people, based upon "scientific tourism"- which is quite unique initiative in China. Just before the disaster in 2007, the Gross Product of the city marked 67,350 million yuan, and connected to Xian, Chengdu, and Chongqing by expressways. The city also has airport which connects to Beijing, Shanghai, Hangzhou everyday.

In the meeting, city officials illustrated their main focuses of the reconstruction / recovery plan as follows;

(1) Housing reconstruction (including farmers' houses)
(2) Infrastructure reconstruction
(3) Industrial revitalization
(4) Agricultural recovery
(5) Tourism rehabilitation
(6) Partnership cooperation
(7) Maintenance, protection and safety
(8) Balanced development (with economy and livelihood)

Brief Analysis and Concluding Remarks

In each site-visit mission, the collapse of buildings causes major tragedies in the earthquake related disasters. In order to achieve resilient social infrastructures with earthquake resistant buildings, cooperation of engineers and governments is essential. As observing the examples of mission to Sichuan, China after the most recent disastrous earthquake, the housing/ sheltering matters put the highest priority in the reconstruction, which is also put the crucial parts of the response operation in earthquake.

Figure 12. HESI Conference in Peru, 2007 (Left) and Field Visit with Seismic Policy Makers at the event for HESI in Nepal, 2007 (Right)

In order to meet with such practices in the field, the UNCRD launched the Housing Earthquake Safety Initiative (HESI) since 2007, and conducted various activities throughout the three (four) target countries: Indonesia, Nepal, Peru (and Algeria, where the activity could not be conducted unfortunately in 2007-2009 due to the UN Security regulations). Amongst various issues around the earthquake safety of housing, the first expert meeting conducted in Kobe, Japan in Jan 2007, successfully identified the necessity of implementation of earthquake-resistant building regulation of various process around the buildings. The HESI launched, therefore, various opportunities for Anti-seismic Building Code Dissemination (ABCD) and capacity buildings in those countries. Such attempts are now spread and shared by other development initiatives in international organizations as well as development agencies; namely, UNISDR and UNDP Indonesia's publication of "Handbook on Good Building Design and Construction", Project conducted by JICA in Indonesia, and the project partner of HESI in Nepal – NSET's various activities. The field survey showed above, then, signifies the strong needs for implementing various measures, including capacity building, on the building related preparedness for various stakeholders, particularly those who might face directly preparedness operation for the disastrous situation; community workers who motivate community residents directly, local government officials who enforce important policy directly at the local level, and the policy (decision) makers at the national level.

Challenges of Building Code Implementation in Nepal

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Abstract

This paper overviews the situation of the building construction in Kathmandu Valley, and illustrates the process of implementation of building code into the practical level in Nepali society. It explains about the approach adopted by National Society for Earthquake Technology- Nepal (NSET) in terms of building code implementation, and illustrates the importance of both "bottom-up" and "top-down" approaches which are additionally effective for spreading culture of disaster prevention in the whole society.

As being a part of the private sector of engineers and experts, discussing on Building code implementation is a difficult task for NSET even if it is the context of Nepal only. Rather, the paper would explain about some of the modalities that NSET has adapted in Nepal on this mission.

Background: Buildings in Kathmandu Valley

Observing the building construction process for residential buildings in Kathmandu valley (see Figure. 1), where is a central part of the country, most of the buildings not only in rural area but also even in urban area are constructed by their owners. Although there are significant increases in sub-urban area in numbers of buildings constructed by contractors, who can work rapidly and take all the responsibility for the buildings, owner-built housings are still common phenomena in the area.

Figure 1. Building Construction Process for Residential Buildings in Kathmandu Valley

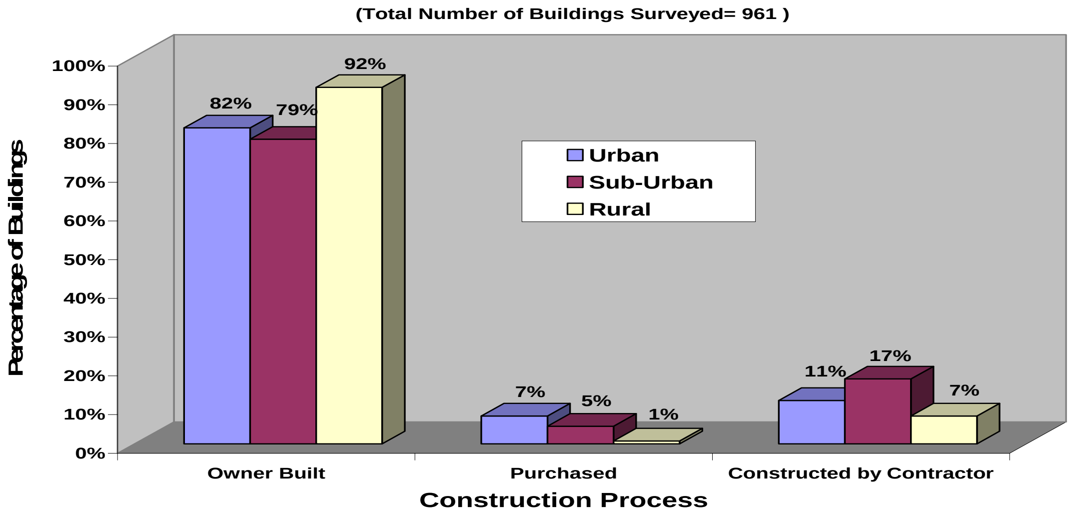


Figure courtesy: Building Inventory Survey under the SEDM (2000)

Meanwhile, the social issues which are surrounding those types of buildings are quite critical. Whilst there are high rate of non-engineered houses in the cities, as long as the building code and building code implementation is concerned, it had been talked about much lower level of awareness in the whole society; policy makers, building professionals, general public including potential house owners, and even educated masses. Ironically, god has created such social atmosphere whilst becoming the destroyer at the time of earthquakes.

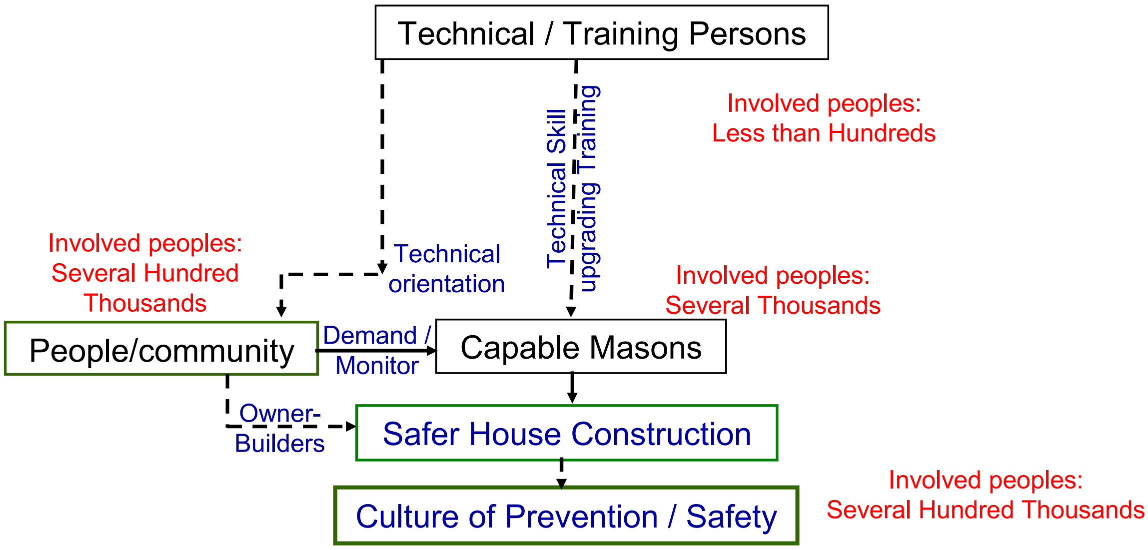
When focusing on technology, it can be found out that the manpower does not reach to the level of what it is required. Some of the local materials remained in low quality including mud mortar and burnt bricks. Regarding to methods incorporated into the building construction, there are some complex process for transmit appropriate methodologies to be implemented. As Sangachhe, director of DUDBC explained in the earlier of the symposium, there are mainly four levels of implementation process of adequate modality of the building construction. First, it is high level awareness, which permits construction to the constructor. Secondly, it is what is considered usually as the code, which transmits the methodologies of (earthquake) safe housing. Thirdly, is the pre-engineered guidelines which was referred by Arya, Professor Emeritus of IIT Roorkee, and lastly, there are guidelines for rural housings. It might be difficult to differentiate many types of buildings from various social and economical backgrounds; from poor to rich populations, but the guidelines and other social functions ensure that any types of the building can be earthquake resistant as long as it can follows adequate modalities with appropriate manpower and materials. Therefore, such processes and thoughts have gone over technology whilst the one also takes into account of resources as one additional factor on the building construction: financial resources – particularly when talking about the least developing countries or economically weak countries where majority peoples cannot afford to the same acceptable level of safety in the other countries. With all of such process and different adaptation of the methodology, earthquake resistant technology can be transmitted and implemented via two distinct types of construction mechanism: Engineered construction and non-engineered construction.

Combining building construction process as well as the mode of transmission of the construction, it can be found out that less than 10 percent of the buildings are engineered which is constructed by engineers, and over 90 percent are non-engineered, by craftsmen or local masons. In terms of pre-construction investment on the other hand, very less investment has been done to majority craftsmen whereas there are a lot of training and fostering process for engineers and even for sub engineers. That is, practically, there is no investment for production of qualified construction workers in Nepal. Therefore, thinking about key stakeholders in housing construction in Nepal, whereas there are clients (owners), consultant which in charge of design as well as construction supervision, contractor of builders, masons, owner builders, and material suppliers, craftsman or craftsmen play(s) crucial roles in non-engineered construction.

Approach Taken by NSET: “Make Unaware To Be Aware”

Meanwhile, owner-built non-engineered buildings do not possess earthquake-resistant features in Nepal. Even engineered buildings do not have compliance with the seismic demand unfortunately as engineering input is limited only to preparing architectural plans not site-based works. Due to political and economic situation, there are phenomena of rapid erection of new unsafe buildings. In addition, large number of already existing unsafe buildings stock is contributing to high seismic risk of the country. Sort of innovative approach, thus, should be taken in order to cope for these problems. Facing huge numbers of owner builders as well as capable masons and hundreds of peoples who know about the techniques, NSET tried to put them together to make awareness on the issues around Building Code Implementation. However, in order to launch earthquake safer housings, dealing with numbers of masons can be unpractical approach in terms of balance of purpose, achievement and efficiency. There are only less than hundreds trainers when there are several hundred thousands construction.

Figure 2. Gaps in Stakeholders of Safe Housing Construction



Facing the difficulties, NSET took alternative approach by organising a very strong technical group of experts which involves academic professionals and professional leaders beyond the country adding to the international cooperation. With the commitment of technical practitioners like NSET, who can contrinuously get feedbacks from the scientific research experts, successfully the initiative could create the platform of interaction of experiences and expertise. NSET also could provide the commitment from our mobile team, which can tell the capable masons in the field to the platform. At the same time the technical operation has been done for making awareness for the common unaware peoples including owner builders regarding to safer buildings. Once unaware people became aware, they can create demands for more capable masons as well as monitor masons. Likewise, ultimately, they could create not only safer houses but also culture of disaster prevention as newly "enlightened" people spread other linkages with the different sectors of the society

NSET learnt that even the process needs to be expanded and brought in more people to make the chain of people's awareness. It is quite huge task and should be conducted under the concept of social mobilisation. Although what NSET conducts is firstly just to give peoples some technical know-how, people begins incorporate learnt skills in social aspects. The process, therefore, needs participation of sociologist, psychologist and then information workers who help dissemination of the culture of prevention. Figure 3 refers to broader scheme of what NSET is implementing at the moment for challenging for dissemination of building code in various corners of the society. Although various inputs would be needed to complete the scheme, it would give whole picture of the strategy to lead us ultimately safer house construction and the culture of prevention of the safety.

Even conducting efforts for creating awareness at the side of civil society, it cannot be enough. Unless civil society gets very strong policy guideline development in the enforcement body, the challenge can be easily failed. It is therefore needed to create awareness at the top- policy enforcement level in terms of monitoring of the process. It should be adequately monitored, educated, penalised for those who go beyond the regulations, and encouraged the process with so many legal and semi-legal instruments: Policy, Standards, Guidelines and Mechanisms, which lead the society to the enforcement. In return from the society, it is needed to enhance the compliance of the community towards the implementation of the building code which explained above already.

Therefore, there is a matching of top down approach and bottom up approach.

Figure 3. Alternative Approach of Code Implementation

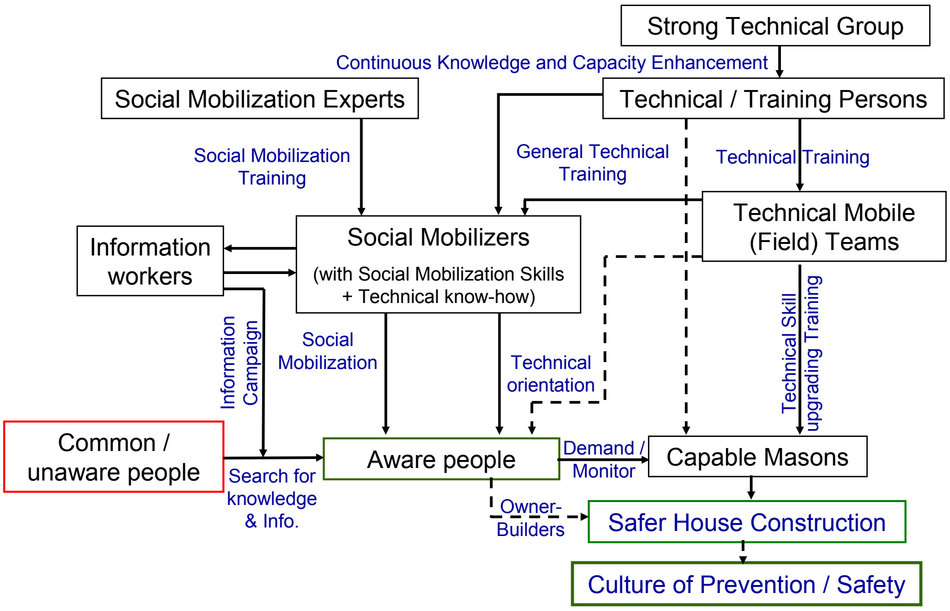
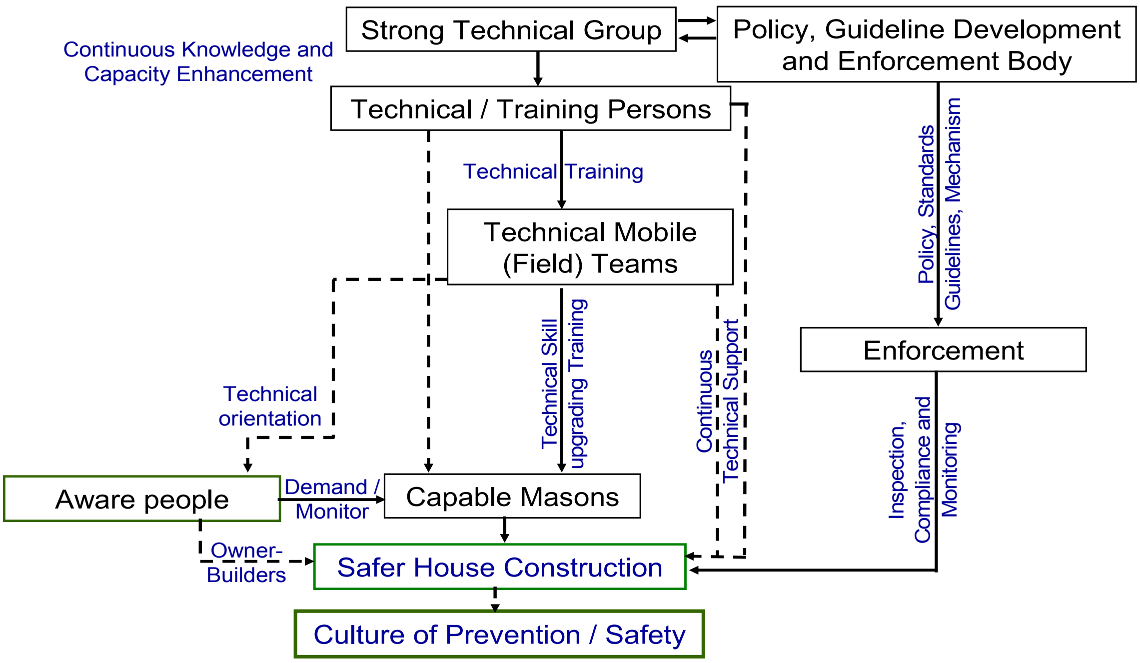


Figure 4. Policy, Standard and Enforcement



The challenges and activities explained so far are conducted with the consolidation of many organisations – not only NSET as a part of civil society, but also with government department as well as social mobilisers. The group initiated the challenge firstly at the one of the municipalities in metropolitan area of Kathmandu Valley – Lalitpur Sub-Metropolitan City. As a result of the work, over 80% of the application of the newly constructed buildings comply the National Building Code since January 2003. The remaining 20% is being carried out with a lot of engagement of the applicants. NSET sees that most of them, at least 15%- and ideally whole 20% would be able to apply the building code without huge problems. In this process, the group could successfully involve not only social mobilisers but building inspectors. Having cooperation between experts of social work as well as technical experts, the project can be successful.

Although the project was quite new, municipalities conducted their work excellently with huge political support including policy guidance. Councillors, the mayor, and responsible staff members have launched separate section in their department: “Earthquake Safety Section”. Of course it is not something to say that the establishment of special section can prove municipalities’ better involvement into the process. We don’t see that the problem was perfectly solved, but it has been made very sound and strong step to us for safer construction.

Similar exercises have been launched in other cities in metropolitan area of Kathmandu, which covers much wider area. It could be very difficult to work with large apparatus where hardly provokes change in their remaining structure and facilities due to the political uncertainties whereas smaller municipalities could easily adopt a part of bottom-up and top-down approaches since 2007. Even though, several other municipalities now successfully make the code mandatory and several other municipalities are now trying, otherwise prepared, to implement into the same way.

The efforts illustrated here is just one of the efforts for implementing Building Code into the field. Working with many stakeholders, the participants to the challenge found that people want the person(s) in charge to launch measures on safety in institutionalised manners by responsible organisation(s) no matter what the institution(s) is(are) – NPOs, NGOs, Governmental institutions and academic institutions. Therefore it is required to devise instrument to help peoples to achieve their own safety.

Varieties of efforts with people

Along with the efforts to implement Building Code into practice, NSET believes that public awareness is absolutely necessary. Through awareness related programmes, mobilisers can contact with the community peoples directly and identify areas to be supported. In awareness programme, there are many modes of involvement including model presentation of earthquake resistant construction technologies and shaking table demonstration. In addition, recently NSET has launched a new term for a part of awareness activities – Earthquake Clinics. It is a clinic like programme- people walks into a clinic and a person in charge answer to the problems. Whilst the clinic deals with each individual, NSET also introduces mass activities; rallies and campaigns.

Figure 5. Shake Table Demonstration, Earthquake Mobile Clinics

Shake table demonstration can be one of the practical methods for awareness delivered to the people. By showing the image of safety directly to the people mobilisers can challenge to the people’s risk perception. These methods can show the risk quite simple manner in front of the community peoples. If the provided object at the shaking table is something which brings effects directly to the community life, the people can observe the importance of safety as a crucial part of their life. NSET is thinking to do such demonstration by putting the table into mobile car- which enables to launch the programme in the entire country. Even though NSET tries to adopt reusable materials for the efficiency, it is important not to compromising in terms of quality of every programme at the same time.

Furthermore, continuous efforts to simplify the modes of varieties of trainings are taking into place; by showing actual construction materials, actual construction methodology and all typology. Regarding to trainings for local masons, by using various opportunities including Earthquake Safety Day, NSET trains thousands of masons with strong support of the government which allocates a lot of efforts. Internationally as well, NSET got support for awareness programme, including supports from Building Research Institution of Japan. With the partnership of UNCRD, NSET could launch opportunities of training programme on code implementation targeting local masons. The involvement of various stakeholders under UNCRD's HESI programme, which could be one of the opportunities of interaction between national government to local masons, symbolises that multi-level implementation of building code should be needed.

Figure 5. HESI Symposium in Nepal and its Field Based Training, May 2008

Concluding Remarks

It is obvious that increased awareness and enhanced capacity of masons help implementing building code effectively and practically. Making decision at the top level alone is not sufficient for the challenge of implementation. It should be needed to have sufficient number of capable professionals in the field. Meanwhile, bottom-up approach is powerful for effective building code implementation. When working on bottom-up approach, there are several tools available. But at the same time, strong policy support and environment is indispensable for such activities. With multi dimensional efforts, it is not impossible to achieve the launch society with earthquake safety of buildings even in weak economy like Nepal.

Framework for Building Code Implementation
An Experience of Housing Earthquake Safety Initiative (HESI)

by Jishnu Kumar Subedi,
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JAPAN

Abstract

The paper reviews activities under the Housing Earthquake Safety Initiatives (HESI) of UNCRD, which has been designed to launch consolidation of the work on dissemination of anti-seismic building code in target countries; Algeria, Indonesia, Nepal and Peru. The project is consisted with four main components- system evaluation of the current institution on building regulations, awareness raising, policy development and capacity building. The reality in the field the project team found that peoples are struggling for implementing building regulations, whilst most of developing countries, particularly the target countries mentioned above, have already a set of relevant codes. By summarising the lessons learnt in the project, the paper sees further challenges for ensuring building safety in developing countries.

Damages to buildings and built environments from earthquakes in different parts of the world indicate the fact that earthquake risk mitigation is one of the most essential task for sustainable development of a city and region. Earthquake risk mitigation requires proper implementation of building code. Limited loss of lives from earthquakes in the United States, Japan and other developed countries with long history of implementation of building safety compared to loss of lives in India, Pakistan, China and other developing countries where building safety measures are not properly regulated is an indicator of how the earthquake risk can be reduced in cities. However, even in the countries with long history of building safety measures, inadequacies in the performance of building are evident quite often. Burby and May (1999) mention that cautionary assessments after the 1994 Northridge earthquake found that "there would have been far less damage had building codes been rigorously enforced." Similar evaluation has been made after the 1995 Kobe earthquake in Japan which resulted in extensive loss of lives and properties despite of the fact that Japan has long history of practicing building safety regulations.

Building code is a tool which can improve performance of the built environment to earthquakes and other natural hazards. A survey conducted by UNCRD in 2006 revealed that most of the earthquake prone countries have already established building codes and many countries have also enacted the codes. However, lack of institutional mechanism, lack of complimentary planning tools e.g. zonal planning tools and lack of awareness about earthquake risk reduction among implementing authorities, designers, builders and general public have contributed to the poor enforcement of the building codes. The "failures in enforcement undermine[s] the effectiveness of building codes and present a challenge in figuring out how to bring about stronger implementation of code provisions." (Burby and May, 1999)

There has been tremendous development in science and technology of earthquake resistant building construction and this development have been translated into practical measures which are documented in building codes, regulations and standards. Despite of this advancement in knowledge base and available tools, the damages incurred in past earthquakes provide challenge on how to translate this knowledge into practices so that the loss from disasters like earthquake can be minimized. Hundreds of thousands of vulnerable buildings world-wide are waiting their fate in future earthquakes and many more vulnerable buildings are being erected.

Observation of damages from the past earthquakes have pointed to the fact that buildings perform the way it is constructed in the field not the way it is designed. In order to mitigate earthquake risk all stages of building construction – from planning to construction and maintenance – are important. A properly designed building may not perform the way it is supposed if it is constructed improperly (Figure 1).

Figure 1. Collapse of a newly constructed building from 2001 Gujarat Earthquake (Left, top), improper detailing seen in one of the columns (Right, top) and a building under construction in Nepal (Bottom, left) where similar detailing is being practiced

Anti-seismic Building Code Dissemination

During 2006, UNCRD sent a questionnaire to national and local governments in many countries to collect information on building safety regulations and on the status of implementation and dissemination in their countries and regions. As a follow-up of the initiative and planning for next phase on housing safety, UNCRD organized expert meeting on Anti-seismic Building Code Dissemination (ABCD) in Kobe, Japan on 17-19, January 2007 to present analysis report on the questionnaire replies and identify pertinent issues. Summary of survey and the expert meeting is given below [1/]:

<u>Status of building code implementation</u>

Most of the earthquake prone countries have building codes

Algeria (Established 1981-83, enacted 1988), Indonesia (1998), Nepal (Established 1994 and enacted 2004), Peru (Established in 1963, Enacted in 1968-70)

Implementation is a key

<u>Challenges in building code-implementation</u>

Capacity of Local Government/ stakeholders (Algeria, Nepal, Peru)

Lack of skill of building control officers

Underpaid staff

No professional trainings and continuing education
Lack of skill/ understanding in designers, petty contractors and artesian
Not enough motivation among engineers on building codes
Social /economic obstacles
Lack of awareness in Public (Nepal, Bangladesh)
Myth –high cost to follow codes (Nepal)
Large ratio of self-built construction (informal)- Peru, Nepal

Housing Earthquake Safety Initiative

Against this background UNCRD Disaster Management Planning Hyogo office commenced Housing Earthquake Safety Initiative (HESI) from 2007 in four project countries: Algeria, Indonesia, Nepal and Peru. The goal of HESI project is to improve the structural safety of houses to prevent damage and safeguard people's lives, property and livelihood from earthquakes through effective implementation of building safety regulations. The objectives of HESI are as follows:

- To raise awareness on the importance of implementing building safety regulation effectively to reduce risk of life and property losses caused by earthquakes

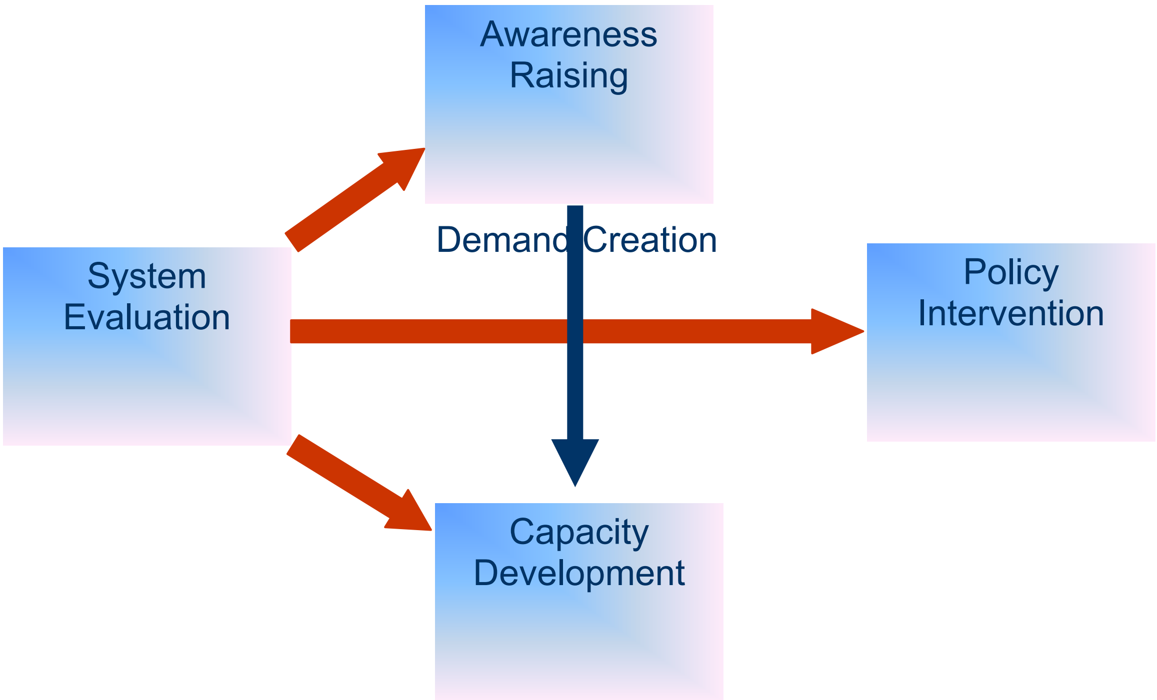
- To develop policy recommendations on improving the safety of houses, particularly that of traditional houses

- To develop capacity of national and local government officials to implement building safety regulations effectively

The four activities under HESI are as follows: [2/]

System evaluation
Awareness raising
Policy development
Capacity development

Figure 2. Four activities of HESI and their inter-linkages

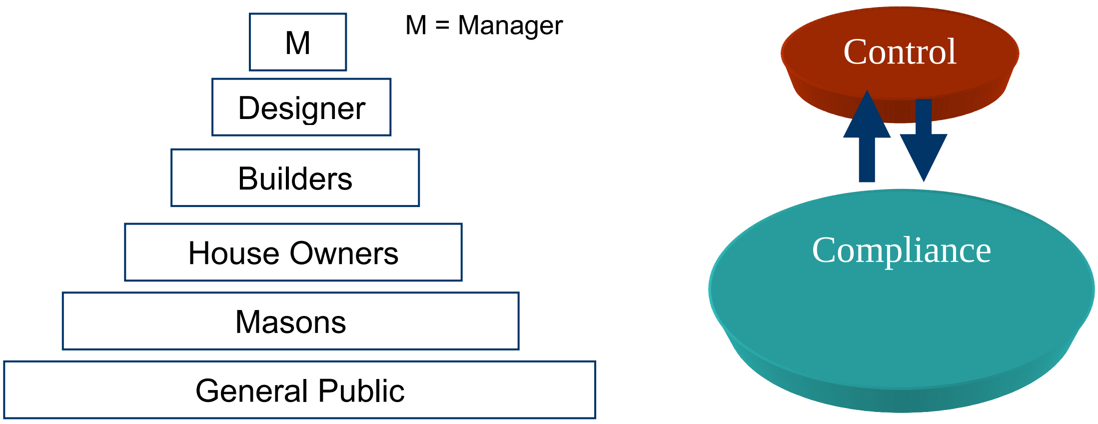


The four components of HESI and their inter-linkages are given in Figure 2. One of the important components of HESI is creating awareness among general public, implementing authorities and policy makers. Awareness creation is instrumental not only in building culture of safety and resilient communities but also in creating demand for intervention in disaster mitigation. The demand ultimately helps in creating conducive environment for policy intervention, in realizing institutional mechanism of code enforcement for the municipal authorities and creating demand for competent professionals.

Enforcement of Building Code: Compliance vs. Control

Enforcement of building code requires intervention to a wide group of stakeholders: from general public to policy makers. Their role is interlinked and non-conformity by any one of the stakeholders is serious impediment to effective implementation of building code. Although the approach and essential tools may be different, it is essential to reach to each of the stakeholders in the pyramid (Figure 3, left). At the base of the stakeholders pyramid is a large mass of general public and at the top of the pyramid is authorities which include municipal authorities and others who are responsible to devise tools and policies. Enforcement through control may be effective at the higher level of the pyramid; however, compliance is more effective at the bottom hierarchy of the pyramid (Figure 3).

Figure 3. Compliance and Control for Effective Enforcement of Building Code



In order to achieve compliance awareness-raising is the most important task along with capacity development and policy tools. Compliance and control have an inter-linkage and they compliment each other. Compliance can be increased and made effective by indirect control tools such as housing loans and insurance; whereas, effectiveness of control relies heavily on compliance. Compliance is effective and achievable strategy for effective enforcement of building code and it has to be complemented by both direct and indirect control tools.

Material quality and workmanship

Despite of existence of building codes and serious intention for its effective implementation, realization of safe buildings in the field requires quality material, good workmanship and awareness in masons, builders and house owners. After 2004 Tsunami, Aceh witnessed rapid growth in construction of buildings and there was influx of many development agencies competing to build largest number of buildings. This intervention in construction of houses demanded large quantity of material supply and large number of masons. However, both were in short supply. The local industry could not supply enough building materials such as bricks and cements and quality was compromised. People without previous experience in construction were involved as masons and carpenters and they were never trained about quality construction let alone earthquake resistant construction.

After field visit in construction sites in Aceh of Training on Quality Construction carried out by UNCRD in August 2008, participants of the training reported many issues about quality of materials and workmanship. Following is the summary of their report:;

Footing of the column is not placed under the ground but is exposed which points to lack of proper consideration in design

The brick quality is so poor that it can be crushed in hand

Poor workmanship was observed in the field where size of the column varies along the elevation and reinforcement bar is exposed.

Figure 4. Problem in design, material quality and workmanship as observed in Aceh

These issues are relevant not only in Aceh but also in other cities around the world. One sided control mechanism for implementation of building can not solve the problem and has to be integrated with other tools in order to achieve safety of buildings and built environments against the earthquakes.

Framework for Building Code Implementation

Building code enforcement needs multi-sectoral intervention and starting point for different municipalities will be different. Depending upon the prevalent building construction practices in the area, available resources within the municipalities, condition of existing industries and awareness and capacity among local masons, the strategy for implementation of building code is different. In order to have a realistic implementing strategy, the municipal authorities themselves need to assess the circumstances, identify the issues and develop a strategy that best suits to them.

With this approach, UNCRD organized a Training Workshop in Kathmandu, Nepal to develop framework for building code implementation for municipalities. Out of 30 about municipalities participating in the workshop, they were grouped into 3 different categories according to their size, types and numbers of buildings constructed per year. The participants participated in group interaction, attended field visit and visited two municipalities – Kathmandu and Lalitpur – which are already implementing the building code. Finally, the participants prioritized activities that they consider as most important for effective implementation of the building code. Priorities listed by one of the groups – group of middle sized municipalities – are given in TABLE 1. Detail outcome of the workshop is published in separate publication (Framework, 2008)

TABLE 1. PRIORITIES OF ACTION LISTED BY MIDDLE SIZED MUNICIPALITIES IN NEPAL (2008)

No	Actions
1	Preparation of implementation process guidelines
2	Training to the technical staffs and consultant overseers
3	Computer based structural designing training to designers
4	Establishment of Monitoring cell/ Field inspection
5	Widening of the scope of Mandatory Rules of Thumb
6	Incorporate the code in the housing loan system
7	Trainings to new masons, contractors and technicians (50 masons, 10 J. Engineers, 5 engineers per 100 buildings per year)
8	Field supervision made compulsory to the public and Class A buildings
9	Commitment of Local suppliers and Local Chamber of commerce for supply of quality materials by sensitizing them

Two priorities are listed as most important: Development of process guideline from the experience of Municipalities already implementing the building code and capacity building of designers and technical persons.

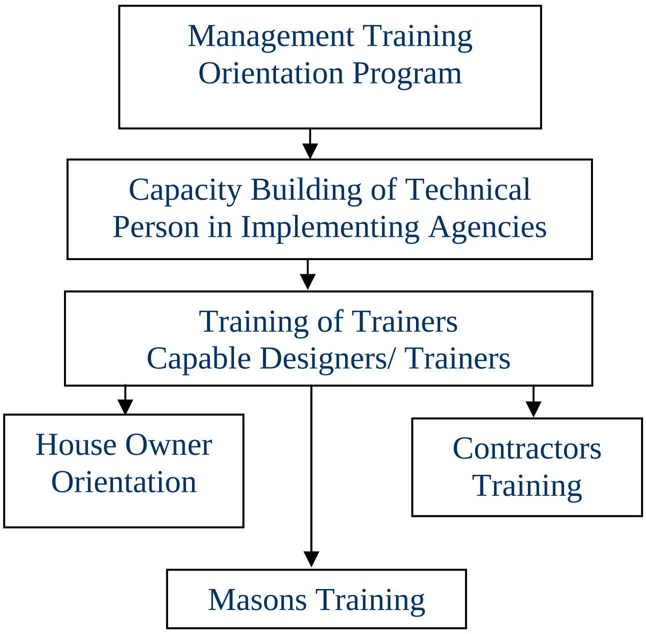
Experience of Building Code Implementation

Lalitpur Sub-Metropolitan City (LSMC) was the first municipality in Nepal to implement the Building Code. Experience of Lalitpur can be instrumental in realization of building code enforcement not only for municipalities in Nepal but also for other countries struggling with building code implementation. As one of the priorities of the Framework of Building Code Implementation was also development of process document, UNCRD in collaboration with LSMC published a handbook on Building Code Implementation: Learning from Experience of Lalitpur Sub-Metropolitan City, Nepal (Figure 5). The document summarized initiation of LSMC and its approach along with organization structure.

The document also provides information on how LSMC conducted awareness raising and capacity building activities in parallel with building code enforcement. The publication gives detail outline of the Masons' Training Program with material requirements and cost estimation sheet, sample public awareness raising program with checklist and cost estimation sheet and check-list for field inspection system.

Figure 5. Two of the publications of HESI project

Figure 6. Flow chart for effective implementation of capacity building program



Capacity Building

Capacity building of technical persons including designers and masons is not an easy task. Hundreds of designers and engineers are involved in design and construction of buildings and thousands of masons are involved. In addition to that house owners, contractors, builders and municipal authorities also need awareness raising and capacity building programs. In order to reach to the widest possible mass and to make the capacity building process effective, a step-wise approach is most suitable.

UNCRD adopted the step-wise approach (Figure 6) which started with Management Training and Orientation Program for municipal authorities and technical persons in the municipalities. The program was followed by capacity building of technical persons from municipalities. As awareness raising and training to Masons, Technicians and Builders require large pool of resource persons, a logical intervention would be to develop trainers by conducting training of trainers and to use them for further training. This strategy can help in creating large pool of capable resource persons and capable masons who are the persons to implement requirements of building code in the field.

Conclusions

Building code is important tool for earthquake risk mitigation. Despite of the tremendous advancement in the technology in earthquake resistant building construction and demonstrated success of the technology to reduce impact of earthquakes, many earthquake prone countries are still struggling with implementation of building code. The earthquake prone countries already have established and enacted building code. Of course it is essential step but not sufficient. Enforcement of building code requires many other initiations which need to be developed in parallel in order to achieve the target of earthquake safer buildings.

Some of the key lessons from observation of building code enforcement can be summarized as follows:

1. Even with existence of code, effective implementation is challenging task and majority of earthquake prone countries are struggling implementation of the code.
2. Scale of implementation and intervention is different in different cities and for small municipalities with majority of construction from informal sector Mandatory Rules of Thumb (Non-engineered Buildings) can help much for enhancing seismic safety of buildings
3. Earthquake risk mitigation requires combined effort of designers, builders, masons, house owners, material suppliers and many others in the chain. Improving quality of material and workmanship is essential to realize safer built environment.
4. Awareness raising programs are essential initial step as it creates demand and in turn can help channel political will for effective implementation of the code.
5. Capacity Building appears to be priority one action required for building code implementation and step-wise capacity building can reduce the time and volume of the work.

Notes

1/ Detail is available from http://www.hyogo.uncrd.or.jp/hesi/hesi_index.htm
2/ Detailed description of HESI and outputs are given in HESI 2007,
http://www.hyogo.uncrd.or.jp/hesi/hesi_index.htm

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Discussion and Closing Session

Discussion on Non-Engineered Buildings and Building Code Implementation

Comments from the floor

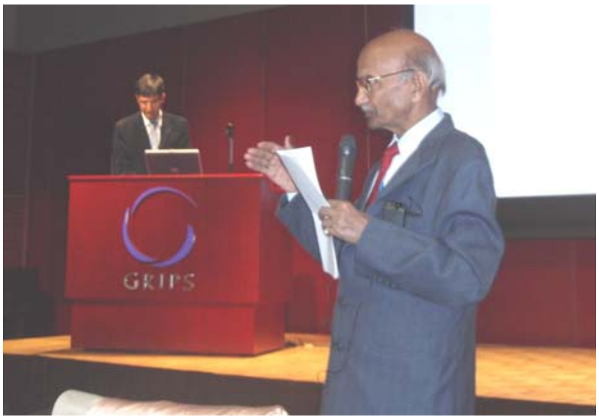
Anand Swarup Arya, Professor Emeritus of IIT Roorkee

The issue of implementation of the code has engaged attention for the last few years, and what we thought is that we should have established institutional arrangement in the country. Now the situation in India we have been having earthquake safety codes since 1962. The codes are prepared for all buildings and all infrastructures; dams, bridges and etc. For non-engineered buildings the codes are launched in 1967. Its implementation is, still, very poor. Why does it happen? It is because our various codes are legally accepted on documents but not mandatory documents. Therefore there's a difference between legal acceptability and mandatory. How do they become mandatory? How they become mandatory only if they go into the municipal building bylaws, then they become mandatory.

As is where the house plan comes for approval, they can be checked whether they have implemented or incorporated all the safety measures and plans and laws. This is the area where to be checked. Now since, in all the municipalities, including municipality and corporation of Delhi, there was no requirement in the building bylaws whereas all building must be designed to the code, it is just depended upon the architectures and engineers to adopt. I, therefore, think the first task for implementation is that, whatever codes we have framed, they must be made mandatorily through the building bylaws of local body of authorities. This should be the first step to move forward for housing safety. What India has done in the Ministry of Home Affairs, where is in charge of management of research on the matter, is to commit into the rural building bylaw. Actually rural buildings bylaw should be also made, and I strongly believe that such actions should be taken as the first step of housing earthquake safety.

In addition, in order to implement codes through the building planning approvals which are obtained from the municipal engineers, it is absolutely required to conduct the capacity building of municipal personnel. It is crucial to make a path for implementation: as there is absolutely lack of the capacity entitled, training should be given effectively for municipal engineers enough to mandatorily enforce the building bylaw, not leaving it to others "sweet" will. They then must check the plan totally before giving approval. For recent buildings, they must declare, in the plan, that they are going to provide all the vertical steels, the types of mortar, etc. Through the building bylaws the checking becomes much easier, and it also brings transparency in construction.

Secondly, it should be needed accountability. Accountability is now granted by signatures of certain forms to be submitted along with the building plan: the owner certificate, the builder certificate, the structural designer certificate. These names should be clearly noted on the record of municipalities. If something happens, they are to be accountable to the matters.



Securing two key elements: transparency and accountability, the codes are now ready to be implemented through all the state governments, local bodies of authorities. Implementation has still been done by some municipality, but it is quite crucial to commit various stakeholders in institutional manner enough to continue over ages. However, with just doing something temporarily the action cannot be long lasting. So what is raised here- the work that I have conducted in India, and the case of Nepali colleagues cannot be adequate. Those pieces of works should be adopted intuitionally for lasting effect.

Iman Satyarno, Professor, Gadjah Mada University, Yogyakarta, Indonesia

In the implementation of code or standard, there should be law enforcement. What would be happened if a construction worker who knows that they met details written required according to the code? What should be done to him? If the seller of the brick, quality is low, what should be done to the brick seller? If there is no law enforcement, the practice of non compliance can be repeated again and again. This is the problem which everyone faces. Although having implementation the society misses in the implementation.

However, in practice, there is no legal enforcement. I suppose this is the key factor to successfully implement all the codes and the standards. Probably it is quite sarcastic to say that construction workers who missed making a joint should be sent into the jail. Criminalisation and penalisation of incompliance of the code would be probably one of the solutions but I don't think it could be a good idea.

Anyhow, it is sure that something must to be done. In Yogyakarta, after the earthquake, it seems that all the construction workers follow the guideline. They obey the codes – but also they still fear that the disaster may happen again if they make a mistake. After several years in the future, however, they probably forget it then. In such situation, if there is law enforcement institutionally as Professor Arya mentioned, the quality of the construction could be guaranteed as sustainable for the longer use.

Carlos Cuadra, Associate Professor, Akita Prefectural University, Japan

I would like to comment on the problem of informal construction of the rule. Maybe as one of set of problems, we can found that the owners are incompliant of laws. Why so? Because the land has not in the situation to obtain a construction licence as it is required to show the land certificate of ownership. Many settlements were taken by people, and the people take the land by themselves. They divide the land but they don't have certificate which refers that they are the owner of the land. The problem starts here. Then, at constructing formal building, people needs a land certificate, which could be impossible procedure for them. As they cannot get the document, they start construction by themselves. Of course, it is not exactly them to construct-as in practice they work with some masons usually.

The other problem that I would like to raise is that the vital facilities which constructed under ordinary rules can be failed during earthquake. Hotels, for example even a hotel which should have been constructed in accommodation with the code regulation were failed. They obtained license for the construction - but what can be the reason for the failure? I think in that case, their failure was the lack of knowledge of engineers. Unfortunately good professionals are concentrated in big cities, not rural areas which covers majority of the parts in most of the countries. There are not good professionals in rural areas. Dichotomy of "rurality" and "urbanity" in engineering and distribution of professional engineers should be one of the major areas to be tackled.

Shoichi Ando, Coordinator, UNCRD Disaster Management Planning Hyogo Office

I would like to make remarks on how to implement the building code. There are two issues on this work. The first issue is, as is the Peru case, whether owner will take a formal procedure of building code. The owners sometimes feel that tax office will impose tax to their own property. Also, the proportion of non-engineered building can be prevailing one of amounts of formal building due to the current tax system in some countries probably. In addition, another preoccupation to implement building code is that whether the owners will take that the formal procedure spends so much time that the owners might face more problems in construction. Some politician may even think that building code implementation may prevent economic development. Actually last year or two years ago, in Japan, some delay in building permission procedures caused slight economic recession, which leads to a kind of social problem. From the experience of Japan, however, the building permission procedure is nothing to do with tax system anymore in the country. Fortunately Ministry of Finance didn't rely on Ministry of Construction. Then there is no connection between for the moment the tax system and building permission system in Japan.

The second issue that I would like to raise is on the relation between economic recession or the delay of the procedure and the application of building codes. Normally the Japanese building code permission system allows that local government has to give permission within 3 weeks in case of rather larger building. For small buildings or detached houses, the permission has to be given within 7 days. Meanwhile in other countries normally it takes one or two months for checking or permission system. These requirements are rather strictly followed in comparison with other countries. If having a kind of transparency in procedure, the delay of the procedure which might lead economic recession would be nothing to do with the application of the codes.

Concluding Remarks

by Kenji Okazaki,
Professor,
National Graduate Institute for Policy Studies (GRIPS)
JAPAN

Thank you very much for your participation today to the symposium. As having worked for UNCRD Disaster Management Planning Hyogo Office, I believe that I was asked to make a wrap-up comment on today's discussion.

Reviewing the discussion

Today we have discussed Building Code implementation. Arya, Professor of Emeritus of IIT Roorkee delivered a great presentation based upon his knowledge and expertise on non-engineered building policy. The own experience was shared from Indonesia by Teddy Boen, International Expert on Non-Engineered Buildings. He showed us various issues around non-engineered houses in the process of reconstruction in Aceh: he raised critical issues in international development aid policy as well. Regarding to Nepal, where it has been introduced building code recently, Sangachhe, Director of DUDBC, shared the outcome of their activity and efforts of the implementation. Narafu, Senior Coordinator of BRI highlighted the fact that the engineering technology cannot be accurately implemented into the construction site, and discussed the gap between the engineering and construction.

Otani, Professor of Emeritus of the University of Tokyo, gave technical insight about retrofit and the application of various methodologies with specific examples. He also raised the issues of existing buildings, which are not covered with the current building code. Ando, coordinator of UNCRD Disaster Management Planning Hyogo Office, explains about the field survey conducted under UNCRD's mission, and applying the lessons for strategy buildings for the future activities on housing earthquake safety. From Nepal, Amod Dixit, Executive Director of NSET showed various mindsets in the activities in terms of the implementation of building code in the field. The experience in Nepal illustrated that it is required to introduce strongly policy support. Lastly, Subedi, Researcher of UNCRD Hyogo Office, referred to what UNCRD has done in the HESI project for dissemination of building code implementation, particularly on institutionalisation for obtaining compliance of building regulations as well as efforts of putting codes mandatory, which was also agreed by Arya in the discussion.

Further Challenges for Housing Earthquake Safety by Policy Arrangements

Obviously, efforts of institutionalising of policies on compliance of Building Code are essential and indispensable. When it is said "compliance" – it might be somewhat "top-down" words, but inter-disciplinal inter-directive measures should be taken including awareness-raising as well as capacity buildings of staff members who would conduct monitoring activities of the codes. But even disseminating and implementing building code, even in Japan, cannot achieve effective protection of existing buildings, which do not apply the updated codes and/or became unsafe against earthquakes due to deterioration of the building. The importance of awareness raising, sensitisation of the issues, capacity buildings and education was raised by most of presenters today at the symposium. It might be unpractical to expect the all existing buildings can be safe enough against the earthquake disasters just by dissemination of building code through such channels.

In my opinion, I found that there would be some sort of factors, in our society, which prevent from exercising the code into practice. There are, for instance, some measures taken in which “non-compliant peoples” can get more benefits than “compliant peoples” do. Whilst building codes ensures the seismic safety of the buildings, victims, no matter if they are compliant to Building Code or not, could be supported equally by (public) mutual aid funds after the disaster. In case of Japan, at maximum 3 million yens would be paid to the victims from Socioeconomic Rehabilitation Aid Funds without asking for the quality of destroyed houses. Earthquake Insurance, as well, which supported 550 billion yens (80% could be paid from National Revenue, which is directly input from the tax), would be probably paid mostly to those who did not follow the code. After all, code-followers would be granted less rights to spend tax money whilst non-follower could be justified to spend a lot of tax money; not only for reconstruction funds but also for response operation such as removal of debris and instalment of temporary houses.

Therefore, there should be new mechanism to create more incentive in peoples to be directed to follow building codes: more benefits would be granted to followers of the codes whereas the benefits to non-followers should be re-considered by focusing more on the aspect of humanitarian needs rather than reconstruction supports in general. Justice for followers, therefore, would be essential for creating incentives for the compliance in the society. This means that the aid system should be reformed to make enable those, who followed very well the code but unfortunately face house destruction, be provided maximum and the fastest support for reconstruction and recovery. Another option would be differentiation in payment of tax and insurance based upon the situation of compliance. With such efforts to institutionalise compliance of the code, I believe that the earthquake resistant engineering and technique can be disseminated widely, and implemented deeply in the society.

ANNEX

Expert meeting on Housing Earthquake Safety Initiative

Indonesian Earthquake Problem

by Teddy Boen,
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Senior Advisor of World Seismic Safety Initiative- WSSI
INDONESIA

Abstract

Almost every year earthquake disasters occur in many places in different parts of Indonesia and cause damage and destruction to non-engineered buildings. Despite of the many human casualties and the severe impact on the regional economy and development, it seems that relatively little is being done to prepare, prevent or mitigate the effects of future earthquakes. The Yogyakarta (27 May 2006), West Sumatra (6 March 2007), Bengkulu (12 September 2007), Dompu (Sumbawa, 25 November 2007), and Simeulue (20 February 2008) earthquakes are repetitions of all past occurrences and is a demonstration that not much has been done with regard to non-engineered buildings. With the re-occurrence of the same mistakes until today, it is time to review about "the earthquake problem in Indonesia". This paper discusses about some important issues for Indonesia to ensure that all non-engineered buildings are earthquake resistant.

Key words: non-engineered, code, technical competence, research, retrofitting

The Problem

Every time there is a damaging earthquake in Indonesia, all printed as well as electronic media provides a wide coverage about the earthquake related problems. Various government agencies/departments announce plans to take care of the problem. Many experts and scientists are being interviewed by newspapers, tabloids, magazines as well as TV stations and issue numerous opinions regarding what has happened and offer solutions to prevent similar happenings in the future. Needless to say, all "experts" that were interviewed considered their field of expertise as the most important and therefore, the media is filled with all sorts of opinions which are confusing the common people. The actual real problem is the damaged or collapsed of non-engineered buildings during the earthquakes and very few are highlighting the need to make all non-engineered buildings earthquake resistant. Subsequently many seminars, workshops, trainings related to earthquakes are held. The community is lead to believe that their earthquake safety is taken care of, until the next earthquake shows that not much has been done since the last damaging earthquake. With the damages and casualties that occurred in the past two years, among others in Yogyakarta (27 May 2006), West Sumatra (6 March 2007), Bengkulu (12 September 2007), Dompu (Sumbawa, 25 November 2007), and Simeulue (20 February 2008) it is high time to do some introspection with regard to "what is the Indonesian earthquake problem". It must be admitted that since the largest tsunami in modern history Dec 26,2004 in Aceh and the repeated earthquakes in the last two years, there is no drastic change in earthquake related matters, such as the enforcement of seismic resistant buildings all over Indonesia. Also, no regulations related to earthquakes resistant buildings have been changed. In Aceh and Yogyakarta during the reconstruction, most of the buildings are still being constructed following the old practice, prevailing prior to the occurrence of the damaging earthquakes.

Normally, after those damaging earthquakes, the government should have a comprehensive plan related to earthquake resistant development. Also, until today no requirements have been issued related to retrofitting of buildings. As an example, Indonesia enforced a compulsory primary education, on the contrary many school buildings collapsed in past earthquakes. The damages that occurred in Yogyakarta, West Sumatra, Bengkulu, Dompu, and Simeulue showed that simple houses collapsed claiming human lives. In Yogyakarta, with the assistance from JICA there is an ongoing activity to introduce the Building Permit System (BPS) for simple houses in villages, however, so far the code for non-engineered buildings is not yet developed. A BPS is part of an enforcement of a code (ref. [1/]).

It is very common that every stakeholder in earthquake matters tends to think that its role is the most crucial in addressing an issue. Therefore, there are always differences of opinion between scientists, geologists, engineers, administrators, social scientists and NGOs on how to solve the problem. Some stakeholders would say that mass awareness campaigns are needed to create a demand for safe buildings. Others would say that more seismic instruments are critical. Many recommend tsunami early warning system and drill exercise for the purpose. Or would think seismic micro-zonation must be prepared before any progress can be made. Administrators explain that everything is taken care off and many other statements, opinions. All those different opinions are important, however, no one will disagree that the problem will simply go away if somehow all buildings are built earthquake resistant. It is very clear, unsafe building stock, particularly non-engineered buildings, is the problem and the solution is to (a) ensure that all new non-engineered buildings are earthquake-resistant, and (b) all existing non-engineered buildings are made earthquake resistant over a period of time through well thought retrofitting suiting the local culture.

Ensuring that All Non-engineered Buildings are Earthquake Resistant

Some important issues for Indonesia to ensure that all non-engineered buildings are earthquake resistant as follows;

1. Public Awareness

A program concerning the safety of buildings when shaken by earthquakes will be easily implemented if there is awareness in the society. It is easy to implement safety programs if the public is well aware of the seismic risks. The Dec 26, 2004 Aceh tsunami and the repeated disastrous earthquakes within the past two years could in fact be used to create awareness concerning earthquake risk, however, since no concerted and systematic efforts were done, the government / authority missed the momentum to start while the awareness is still there.

Information concerning the need to build earthquake resistant buildings, to use good quality materials and to adopt earthquake resistant features must be continuously and consistently disseminated to the community. This shall be made as the main target of the government, to create awareness for the need to build earthquake resistant, non-engineered buildings. Awareness of the need for house owners to incorporate earthquake resistant features in buildings as they are constructed. This activity will require a variety of commitments and adjustments on the part of the government. The first is enacting a national housing policy which recognizes the role of non-engineered buildings, supporting activities to improve this type of housing and developing a public awareness program concerning asseismic construction practice should be the immediate goal.

2. Technical Competence

Forty years ago, the author introduced the subject earthquake engineering into the curriculum of the Civil Engineering Department of one University in Jakarta and currently almost all civil engineering departments in Indonesia teach the subject. The subject is only taught at the undergraduate level and is focussed on engineered buildings. Non-engineered buildings are not being taught and the subject building construction is lately not taught intensively. In the last twenty-five years, many engineers, architects, government administrators, contractors got their post graduates in earthquake engineering at various reputable universities abroad. However, to date, similar damages to non-engineered buildings still occurred after earthquakes as demonstrated in the past two years; implying that some rethinking must be introduced with regard to earthquake engineering in Indonesia.

Besides the non performance of engineers in this regard, there has also been a considerable decay in the capabilities of artisans and technicians associated with building trade. A mason today has far lower competence than one two decades ago. As explained earlier, most structural engineers, architects and consultants might be familiar with “engineered” buildings, however, do not consider non-engineered simple houses as part of their trade. Non-engineered buildings are considered too simple for engineers and are left at the discretion of the foremen (ref. [2/]). In actuality, not many engineers have the capability to do structural analysis for non-engineered people’s houses, and already forgot about the correct way of laying bricks, mixing concrete, preparing correct reinforcing detailing for seismic resistance. This unfortunately resulted in the poor quality of the houses built so far in Aceh and Nias, that were supervised by engineers and architects who were supposed to have the very basic skills needed for earthquake resistance. Equally true is the fact that currently it is very difficult to find artisans who still have the qualifications to appropriately construct a simple house.

No doubt non-engineered buildings must be introduced in the earthquake engineering syllabus and the subject on building construction must be refreshed. However, a lot more remains to be done to raise the competence of engineers and architects regarding non-engineered buildings. It is essential for the successful implementation of improved construction practices for earthquake resistance that engineers and architects be familiar with these requirements. Therefore, the competence of engineers and architects entrusted with design and supervision of non-engineered buildings should be upgraded. Equally important is to raise the competence of the construction workers.

It is also suggested that professional societies should work closely with universities to develop courses of study for engineering and architectural students related to effects of earthquakes on non-engineered buildings. It is essential that information on improving building designs to better resist earthquakes be made available to engineering and architectural students. This can be done by holding seminars, workshops, special lectures and formal courses.

3. Guidelines for Non-Engineered Buildings and Information Dissemination

The current Indonesian seismic code does not regulate non-engineered buildings. A seismic resistant code for non-engineered buildings is urgently needed. The code should be a performance code rather than a specification code. The code should be more an expression of desired results than a set of instructions on how to attain that. Minimum building standards based on building performance and emphasizing the safety of the occupants should be developed by the government for non-engineered buildings. For the purpose, all existing/available materials should be adopted and not try to re invent the wheel. The code must have clout, because codes are of little use unless it is backed by a powerful enforcement agency and a comprehensive inspection service. Effective communication of correct techniques for earthquake resistant houses is essential. Although the technology may be known by engineers/architects and those involved in housing development, simple materials, easily understandable to the villagers must be developed and disseminated. One of the major constraints found in Aceh and Yogyakarta was a lack of imperative to adopt construction methods for seismic resistance. Among the contractors, engineers, architects as well as construction workers, little or no awareness of earthquake risk exists; therefore, attempts to introduce new practices did encounter difficulties. Due to the long interval between events, even those who experienced earthquakes often felt the threat was too remote to warrant change. House owners were aware of seismic activity, however, tremors of recent memory failed to drastically affect their houses, they felt that their houses were strong enough to withstand earthquake shaking. Construction habits will be dictated by tradition, popular trends, availability and cost of labour and materials. Concurrently, efforts to enact legislation against erratic building habits in villages should also be encouraged.

4. Seismic Retrofitting of Existing Non-Engineered Buildings

In Indonesia, the sophistication required for undertaking retrofitting has not been adequately articulated. In Aceh, several NGOs assigned the design of seismic retrofitting for a large number of poorly built houses to some structural engineers/ engineering firms. Unfortunately, no effort was made to ensure that the individuals/firms are capable of delivering such services, or that the expectations from them are realistic. It is becoming clear that many of those individuals/firms had no expertise for such a task, particularly for Indonesian non-engineered buildings. Some facts about retrofitting need to be recalled: Retrofitting is a corrective measure and therefore, almost all corrective measures are usually costly. It requires considerable expertise and technical know how when the objective is to achieve better than life-safety performance. Judging from the huge number of houses all over Indonesia that must be retrofitted, it is very urgent to develop consensus documents on seismic assessment of existing non-engineered buildings, and criteria for seismic retrofitting. The documents should contain solutions to make those buildings earthquake resistant utilizing locally available materials and workmanship and suiting the local social, cultural, ethnographical, economical as well as political conditions. It is basically activities which can be carried out by homeowners with minimal financial and technical assistance, and do not require extensive reconstruction or modification of the existing building. To do that, a lot of preparation and background work is needed before a serious effort at retrofitting can be launched and the government / authority must not miss the momentum to start while the awareness is still there. The government should first make a policy decision that retrofitting of houses is in the interest of the government and should develop an appropriate framework to encourage such activities. Subsequently, the government must designate agencies to serve as coordinator for housing improvement activities.

5. Research and Development

Methods of construction in Indonesia differ from methodologies used abroad, particularly with regard to non-engineered buildings. Therefore, several technical problems require indigenous research and development. There is a clear need to focus research on "engineering" of earthquakes as against the focus on "science" of earthquakes that many researchers have been doing. It is important to put in perspective that earthquake safety is a rather challenging engineering problem requiring decades of focused work, and that even though science is important, engineering aspects shall not be trivialized or ignored. The contributions science can make to reducing earthquake disasters are necessary and needless to say that if possible, the best approach to earthquake problems is to work on all the fronts simultaneously: engineering, science and instrumentation, public awareness, public policy, etc.

Much can be learned from foreign research results and in principle some of the results could be applied provided they are adjusted to suit Indonesian conditions. For Indonesian non-engineered buildings, technological solutions wherein the common man can construct an ordinary earthquake-resistant house with locally available resources are needed. Such technology can be found by studying the site specific information and adhering to the local culture. In this regard, most probably foreign consultants must learn from Indonesia and not the reverse. It is precarious to know that for the reconstruction of the minimum size houses in Aceh after the December 26, 2004 tsunami, more than 2000 foreigners were in Aceh for the purpose, more so, to learn that the majority of the houses built are not earthquake resistant (ref. [3/], [4/], [5/], [6/], [7/]).

Concluding remark

The problems as elaborated above are similar in India (ref. [8/]). In the author's opinion, the Indonesian earthquake problems are equally valid for most developing countries.

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Efforts for Anti-seismic Building Code Dissemination
UNCRD's Housing Earthquake Safety Initiative (HESI) 2007- 2009

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Abstract

The paper records and analyse activities conducted under UNCRD's Housing Earthquake Safety Initiative 2007 – 2009 (except workshops conducted in Aceh-Indonesia in Oct 2008 and international symposium in Tokyo in Nov 2008), which focuses particularly on Anti-seismic Building Code Dissemination (ABCD), The paper also defines the directions to go for the future activities on housing earthquake safety.

Outline of HESI

In January 2007 United Nations Centre for Regional Development (UNCRD) Disaster Management Planning Hyogo Office launched a project titled "Housing Earthquake Safety Initiative (HESI)". The project aims to improve the safety of houses and protect them from earthquake disaster through effective implementation of building code. The project is implemented in Algeria, Indonesia, Nepal and Peru. Although building code is only a part of large dialogue of building safety, it is important and key element. Under this initiative, UNCRD provides an international information exchange platform to share policy experiences. The activities included perception and implementation gap analysis of target countries, awareness raising among the stakeholders, developing policy recommendations on improving safety of houses and developing capacity of national and local officials to implement building safety regulations effectively. One of the major activities envisaged in HESI is creation of platform for networking, information exchange, sharing of knowledge and sharing of good practices in mitigating earthquake risk throughout the world.

The project aims to improve structural safety of houses to reduce impact of earthquakes in life and livelihood of people through effective implementation of building safety regulations. Because the collapse of buildings and houses is the single largest cause of human deaths and economic losses resulting from earthquakes, anti-seismic building code dissemination (ABCD) and effective enforcement of control systems can reduce the loss significantly. Though many earthquake prone countries now have building codes, there is serious challenge for effective implementation of the codes because of lack of awareness, lack of institutional mechanism for implementation and insufficient capacity of authorities.

Preliminary Survey of HESI

The HESI project attempts to rectify the situation through its 4 core activities: system evaluation, awareness raising, policy development and capacity development. In November 2006, a pre-survey on building code enforcement was conducted involving a number of countries in the world. The responses obtained uncovered the existence of vulnerable houses spread in a number of earthquake prone countries. In Peru, for instance, non-engineered houses, which are built without proper structural safety considerations, account for 60 percent of the total building stock in the country. The survey also found that although many responding countries indicated that they have building codes in place, the codes are not effectively implemented due to a number of problems including lack of capacity of building officials and low level of awareness among public and building professionals on the code itself or the safety aspects of houses.

Figure 1. Four Components of HESI Activities (Left) and HESI Expert Meeting in Kobe, 2007 (Right)

Although building code is a technical document to be used by technical persons, the stakeholders responsible for enacting, managing, implementing and observing the building code are at different levels from general public to the national government. Even though legal provisions make the building code mandatory and non-compliance to it subject to legal actions, control is not a practical approach to implement building code. This fact can be observed from the implementation of building code in different countries. In Nepal, it has been mandatory from 2005 in all Municipalities to implement the building code. However, only three out of 58 municipalities have initiated the process. Peru has long history of enactment of building code, but there is significant gap in implementation in the field. This is true for many other developing countries as well.

HESI Expert Meeting in Kobe

UNCRD held an expert meeting on Anti-seismic Building Code Dissemination (ABCD) project for Housing Earthquake Safety Initiative (HESI) in Kobe in January 2007. The representatives from India, Indonesia, Japan, Nepal and Peru joined it. The following are the key points raised at the meeting:

Role of the private sector in building code implementation should be explored including the private sector in building permit process might make the process more efficient. Peer review can be useful if there aren't sufficient municipal engineers to examine all buildings.

It is required to establish a strategy in order to enforce building code to existing buildings and not only to new constructions in developing and developed countries. There is a need for training and capacity development, including the strengthening of existing training institutions towards safer non-engineered housing. Guidelines will suffice for non-engineered houses. Technical research should be done to set the minimum specifications such as size, width of walls and the use of columns. They have to be readily understandable for people with no technical background.

There is an immense need for awareness raising how to educate communities and technicians about the importance of making safer houses. Information hasn't tricked down to communities and individual house owners. Community-based activities are the key. There is an issue of setting policy priorities, governments tend to devote more resources for primary health, basic education and infrastructure development and pay little attention to earthquake resistance of non-engineered houses

Awareness raising and Dissemination

Compliance is difficult to achieve without awareness. House owner who is aware of the practical measures to reduce earthquake risk in building prefers to follow the standard which is not only cost effective but also saves life in case of earthquakes. A large group of general public, who is aware of the impending disaster of sitting in vulnerable buildings, not only comply with the building code provisions but also create demand for trained technicians, trained masons and trained builders. Therefore awareness raising and capacity buildings are inter-related tasks and features as one of the key components in the approach of HESI for effective implementation of the building code.

The awareness of general public has three parts: first, they know the risk and try all means to reduce the risk; second, they know that incorporating earthquake resistant measures in new construction doesn't increase the cost significantly; and third, they know that such measures need to be considered from the very beginning of construction i.e. from the planning process. Once house owners have this awareness there will be increased demand for trained technicians and masons. In order to cater to the public demand, a large pool of trained technicians and masons is required and this process requires a well planned approach: From top to bottom the number of required trained persons increases by geometric ratio. Therefore, capacity building requires a systematic approach where first tier of trainers are developed who can serve as trainers for next tier. This approach is effective not only in developing large mass of trained manpower but also in developing such manpower in a short time.

Disseminating building code is an effective tool to safeguard houses from earthquake disaster. However, a number of challenges are expected as UNCRD implements the HESI project in Algeria, Indonesia, Nepal and Peru. Two selected challenges are mentioned. The first challenge is to define the process that is appropriate for individual country contexts. Each country has diverse stakeholders of housing safety and the relationship among them might differ. Each of them might require a unique coordination approach. The second challenge is to disseminate the code to communities. In order for a building control system to work, there have to be not only knowledgeable, well trained and highly motivated suppliers of building code but also demanders for building code implementation. The system will always have a loophole unless people who pay for houses demand that their houses be made safe. It is imperative to have a system of punishment for violators of the code, and the house owners and other community members can be part of the enforcement body. The role of governments, both national and local, is enormous given the fact that they have to be technically capable to enforce the code as well as to be able to convince and motivate professionals and the public to comply with the building regulation.

HESI National Meetings in Nepal and Peru

Raising awareness on the earthquake-proof buildings and the importance of enforcement of building regulations is one of the core project activities. In this regard, the first national workshop was held in Nepal and Peru in August 2007: 1) to raise awareness among policy makers from the national government and code implementing local governments, and 2) to identify problems that hinder effective building code enforcement. In Nepal, for instance, only three municipalities currently implement the Nepal National Building Code. The two-day consultative workshop in Nepal was attended by over 70 participants from the Ministry of Physical Planning and Works (MPPW), Ministry of Local Development (MOLD), mayors and executive engineers of 20 municipalities, UNDP, NGOs, academia and the media. The One-day workshop in Peru was held immediately after an earthquake that claimed over 500 lives in August 2007, and was attended by 30 participants from the Ministry of Housing of Peru including Vice-Minister, universities, the media and other relevant institutions.

UNCRD in partnership with MOLD, Department of Urban Development and Building Construction (DUDBC)/ MPPW, and National Society for Earthquake Technology –Nepal (NSET) conducted a two–day workshop in Kathmandu on 2-3 August 2007. One of the objectives of the workshop was to find country specific problems in effective implementation of the Nepal National Building Code (NBC). The workshop, attended by senior officials and engineers from the Government of Nepal and municipalities all over the country, underscored the fact that capacity development of local authorities is necessary for effective implementation of the building code. A survey among the participants was conducted which showed that 91 percent of the participants were familiar with the building code before attending the workshop. The survey, however, showed that 53 percent of the attending municipalities do not have building bye-laws for implementation of building code and all of the municipalities expressed their desire to develop building control system in their municipalities. As the second step of the HESI project in Nepal, a training workshop on “Building Code Implementation" was organized on 19-23 May 2008 for engineers/planners/architects from 25 Municipalities all over the country. The workshop was organized by UNCRD in partnership with the DUDBC/ MPPW and NSET.

After five days of lectures, field visits and group discussions, the municipalities were asked to draft actions which are most essential in their municipalities to implement the building code. The municipalities were divided according to their size, population and number of constructions per year into large (Group A), medium (Group B) and small (Group C). The municipalities recommended series of actions in 5 different aspects of building code implementation: Design aspect, municipal laws and bye-laws, field inspection and monitoring, quality control and capacity building and awareness raising. They further discussed within the groups and came up with priorities of action for building code implementation in large, medium and small sized municipalities.

Conclusion

The results and future direction of the HESI project are as follows; in case of Nepal, institutionalisation of building code enforcement is expected to result in better coordination between the MPPW and municipalities that are responsible for code implementation. Institutionalisation means more periodic and vigorous training activities for municipal engineers, which will have a direct impact on the effectiveness of building code implementation. The Executive Officer of Kathmandu Metropolitan City committed to establish a new section for building code enforcement in the near future. Learning from public dissemination initiatives by other municipalities is expected to increase similar activities nationwide. In case of Peru, HESI is expected to contribute to safer housing involving a wide range of stakeholders in the presence of increased awareness of the need to make houses earthquake resistant following major earthquakes of 8 October 2005 in Pakistan, 27 May 2006 in Java of Indonesia, 15 August 2007 in Peru and 12 May 2008 in China. The final results of HESI will be disseminated during in 2008 and 2009 through various international events including the nest Global Platform for Disaster Risk Reduction (GP/DRR) in 2009.

The conclusions arrived from the HESI / ABCD including problem identification workshops in 2007 and training workshops in 2008, are very important in order to understand the process of building code implementation in developing countries.

• Mandatory Rules can help much for enhancing seismic safety of buildings in urban areas;

• Checklist for middle size buildings for capable municipalities, for others support to check design will be provided;

• Capacity building appears to be priority one action required for anti-seismic building code implementation;

• In order to incorporate building permit process in the building code existing system can be modified and clearer legal provisions can be devised;

• Political and social acceptability of the urgency to implement building code and the roles of municipality, national government, engineering and/or architectural councils, professional associations, academia in its implementation needs to be enhanced;

• Awareness raising programs creates demand and in turn can help channel political will for effective implementation of the code;

• Municipal engineering professionals have pivotal role in developing systems for effective implementation of building code by: 1) Creating demand and 2) Establishing system for addressing the needs;

• In case of earlier implemented countries, illegal buildings caused problems. Illegal building construction without permission should be decreased by promoting incentives, awareness raising, capacity building and political measures.

For further information

Outline of the HESI/ABCD project: http://www.hyogo.uncrd.or.jp/hesi/hesi_index.htm

Preliminary survey on anti-seismic building code:
http://www.hyogo.uncrd.or.jp/hesi/survey.htm

Outcomes of the Expert meeting for ABCD in Kobe:
http://www.hyogo.uncrd.or.jp/hesi/exp_meeting.htm

General conclusions from Peru workshop: http://www.hyogo.uncrd.or.jp/hesi/peru_ws.htm

General conclusions from Nepal workshops:
http://www.hyogo.uncrd.or.jp/hesi/nepal_ws.htm

Extracts of Discussion on Earthquake Housing Safety conducted at the Expert Meeting

Chaired by Teddy Boen

Regarding to "Indonesian Earthquake Problem" (presentation conducted by the chair prior to the discussion / Incorporation of non-engineered issues into engineering

Hidetomi Oi
JICA has been developing retrofit-related initiatives in El Salvador for past five years with particularly focusing on structural examination and building methods of adobe made houses, which are widely used for poor peoples in the country. Now we are going to its second phase of the project on house retrofitting for poor peoples. My concern, regarding to the presentation on Aceh case which focusing on "retrofitting" of new houses, is on method of retrofitting: whether there is a housing retrofitting method to be applied to poor populations in the region.

Teddy Boen
Yesterday's session [ref. earlier papers written by Arya and Boen] stressed that for non engineered buildings we must use marginal cost with materials available on the site. For example, when a professor of a university in Tokyo introduced new methodology he asked me if it can be applied to Yogyakarta case. Without doing basic research, I could say it would not be acceptable to Yogryakarta. Apparently it was correct that they built good example which nobody came up with. But it should have been applied with local materials. The methods after all, after the launch of one model building, it was rejected in Yogyakarta. In other countries as well: Nepal and Pakistan, the situation is the same.

Anand Swarup Arya
When I visited Nepal to explain about non-engineered buildings, we have tried to do retrofitting by examining the structural safety, utility and the cost: including painting, and other additional payments we need. And we found that the retrofit project cost much less than replacement and rebuild of the house. So I recommend strongly retrofitting in seismic zones. Back in India, I am teaching buildings- like caring human body. But there are some factors to demolish those buildings in the society. But even adding some costs for improvements of the buildings, retrofitting costs much less than replacement, and in urban planning it should be taken full account of utility of retrofit methodologies as well as efficiency. Retrofitting should take main parts of mindsets of engineers. When engineers enter to the seismic zones, even in Nepal and Pakistan, they try to remove all the buildings. So I strongly believe that such mindset should be changed totally. Therefore, now in India, the guideline was developed: assessment, retrofitting techniques, and repair, restoration. Such sets of guidelines are legally accepted document. Therefore, in order to enhance the initiative for retrofitting, institutional arrangements should be launched.

Teddy Boen
Yes, we have the same phenomenon in Indonesia regarding to mindset problems on retrofitting. But the retrofit works should not be something for psychological retrofitting by making major changes in the buildings without quantifications. The important thing in retrofitting is to identify the components to be restored / strengthened.

Marqueza Reyes
First of all, thank you very much for input. Although it was a highly specialised engineering related topic, it was very clear not only for engineering experts but also for non-engineers: including me. My question is about on Tsunami- as the input was more on earthquake. I am wondering if there is already acceptable performance of housing regarding to Tsunami.

Teddy Boen
What we must be more concern is earthquake shaking and not tsunami. This is because tsunami is a collateral hazard and is relatively a rare phenomenon compared to earthquakes.

Maybe one tsunami is out of 100 earthquakes and in a particular area only. For example, if you live in coastal areas in Western part of Aceh, you need to build earthquake resistant two story building and make the sleeping rooms on the second floor. Many papers wrote that the tsunami "wave" in Aceh was 40 m high, but there is no evidence. If we look at mosques along the coast that survive the tsunami, the walls and windows between the columns on the ground floor were wiped out, but people who climbed to the roof of the mosques were saved.

Tsunami is not a wave; tsunami is a wall of water which approaches the coast with a velocity 50 km/hour. In Aceh, people who were on the second floor of their houses were saved. However, if your building is not earthquake resistant, earthquake shaking could damaged or caused collapse and could claim lives.

Amod Mani Dixit
Have you analysed the remains on palm trees? I saw the picture of a (tall) palm tree affected by tsunami.

Teddy Boen
In Aceh, almost all houses destroyed and walls are broken into pieces by the tsunami. Those wall pieces were carried by the tsunami and sometimes bumped into coconut trees and those pieces formed a stake of debris along the coconut tree trunk. And the wall of water climb along this wall of debris, sometimes reaching the coconut leaves. Tsunami wall of water very strong and scoured the beaches and moved the mud along the beaches / rivers into land. That is why after the tsunami, 1/3 of Banda Aceh is full of black mud and because the flow was very strong, many victims were “impregnated” by the black mud and dead bodies are blackish.

Anand Swarup Arya
We have already drafted a tsunami-resistant structural design home which will be used for offshore structures. Meanwhile, for onshore, the technique that is being suggested is to build two or three storey reinforced concrete column with in-fill walls. And you must not use the ground floor permanently for something: use it for play area or something others. So the in-fill wall will be like fuse: when the first wave comes, those walls will give way, the columns will remain standing, the building will remain standing and then no danger from tsunami.

Amod Mani Dixit:
Now I have one more question regarding Banda Aceh. I was also unfortunately there so that you might count me as a “tourist engineer”, that is tsunami expert that you criticised. What I was surprised then that nobody talked about the destruction of earthquake because there was time gap between tsunami and earthquake. I must guess that there must have been several destructions by the earthquake.

Teddy Boen
Magnitude is not equivalent to degree of damage. In Aceh, the epicentre of the M9.0 earthquake was approximately 125 km from Banda Aceh. Therefore, even though the magnitude is substantial, the damage by shaking only occurred to buildings that were very poorly built. One of the engineered buildings that collapsed is the hotel building and witnessed by participants of the 10K marathon gathered on an open area closed to the hotel. The participants of the 10K marathon were not to concern because they were saved on an open area. Thirty minutes after the earthquake, the first tsunami water entered the city, but the deep of the water was approximately only 30 cm.

People started running to the centre of the city which is closed to the main mosque. Five minutes later, the second water "wall" with a height of 2 m came and than subsequently followed by the third. The second one wiped out almost everything. One case worth mentioning is the prison located behind the main mosque. Prisoners were locked in cells and died in their cells. People run to the main mosque and up to the second story the tsunami level stopped just at the level of the last stair. Thousands of people were saved in the mosque that was some kind of miracle. In Aceh, many of the mosques remained standing.

I was asked by a Malaysian reported to explain as an engineer why the mosques are standing. I replied as follows; "I think nobody dares to steal from God." If you built my house, maybe you dare to steal the cement, or the reinforcing bars. It is not only phenomena in Aceh. In Thailand and Sri Lanka, almost all religious buildings survived the tsunami.

Anand Swarup Arya
It is not God's mercy. I have seen churches collapsed in Baroda I have seen temples collapsed. I have seen mosques collapsed. In North Yemen a mosque collapsed killing 200 children who were using the mosque as a madrassa, as a teaching place. So please do not be misled that God's house is safe. God's house is as unsafe when it is built by man, not by God.

Teddy Boen
Many mosques in Indonesia that collapsed usually were built after 1965, after the 1965 coup d'etat. At that time, if you did not go to the mosque, you will be branded as a communist. Therefore, even though people were very poor, they built mosques with whatever materials they had and needless to say, they were very poorly built.

In Indonesia, we stress the important of earthquake resistant buildings, particularly hospitals, schools, religious buildings, etc. among others by creating earthquake awareness. However, because the interval between two events is long, we tried to tell people to build earthquake resistant houses, if necessary providing them with technical assistance. Such pilot project was launched in Yogyakarta with Gadjah Mada University students and professors. Students assisted community based initiative; this is what is community-based all about. They assisted the people almost 24 hours – they give the guidance by saying "You do this, you do that".

Now we have building codes or comprehensive documents. But people do not read them. Even for me – five books, I have difficulties in reading. This is why we translate the codes into posters. For poor people, they must know the "how" only and leave the "why" to the engineers to explain.

Amod Mani Dixit
I have one comment on your project. It seems that your poster is too much crowded with information. I think maybe you should make two or three posters. Containing everything into one poster might be too much of information for peoples.

Teddy Boen
No, we put one poster for one type of reinforcement; so it can not be too much for people. Guidance on timber reinforcement and concrete reinforcement are put in different posters. The poster size is big enough, and it can not be problem – it is big enough to read easily. So, people look at it and say: "Oh, I make the foundation like this. I mix the concrete like this". Otherwise they have to look into several pictures.

USAID saw the posters, provided the fund for printing and distributed to people for free. In my opinion, you must make similar posters. I visited many villages and asked whether they understand the posters and explained the parts that they do not understand. From my experience, those posters are well accepted and understood.

After the Yogyakarta earthquake, I analyzed the one-brick thick masonry wall buildings that remain standing. Apparently one-brick thick masonry walls are more stable even though without reinforcement compared to half-brick buildings.

Surya Bhaktha Sangachhe
We have recently the flooding problems in

Eastern Nepal and far Western Nepal. Many people are displaced because the river has changed the course and the whole villages have been washed out in Nepal and in Bihar. Now JICA has a program now for poor people on land and preparedness: it has gone from the tradition of the community I think the posters are very useful tool.

Teddy Boen
I developed theses posters. Why? – It is to get through what you want to poor people. Poor people are very humble and honest people. Once they see a computerized drawing or they see a lecture note, then they might say "I never attend the school". They get scared. So psychological-wise you must give them as many drawings – if possible in free hand. If drawing in free hand, they might think: "Oh I can also do this". So that is why I made the posters as simple as possible. Do not put too many explanations because they get scared off and they do not read, particularly some of them are illiterate.

Surya Bhaktha Sangachhe
What I am to say is, the new engineers do not know the detailing particularly when the teaching is something wrong. The real carpenters that are the experienced carpenters are better than these new engineers.

Teddy Boen
Yes, exactly. When I went to ITB, I got lectures regarding the theory of bricklaying and at the same time to practice bricklaying. At that time, I did not pass because I did not pool a chord to lay each layer of brick.

Surya Bhaktha Sangachhe
I agree. From the last 3 years my department is being entrusted to reconstruct the buildings which have been damaged during the last 10 years of insurgency. We have the problem about new engineers have been sent to the site and they do not know the detailing. I found it a very difficult point from the new engineers and then as we have mentioned that we have made this detailed – corner detailing, T-joints…

I Wayan Sengara
That's because of change in curriculum. I think before 1970s and 80s, most of the constructions handled such methods: it is first to like lay a bridge, bricks and so on. But after 90s, the engineering look for the high rise buildings. They forgot about the non-engineering structures but they do not realize that most of the victims come from this kind of building.

Amod Mani Dixit
Actually I had a fight with the institute. The engineers, even the professors, they say they can do mason training. I, then, say "no, you can't". First thing that you have to start is respecting the mason: this is the first course in mason training. So they say "no, no, no, what you are talking?" Then I say "you are not allowed to teach. I will ask you to sit in the mason training. Once you go together with the mason, only then you can start teaching given a mason". They said that I was crazy. They really thought, still perhaps some of them they thought that I was crazy. But I did not allow them. I did not put my NSET logo in the certificate that they distributed. The reason is because it was wrong. They gave masons so much of knowledge which masons did not understand at all. They were not living with masons. They were not eating with masons during the lunch. They had lunchtime separately- they did not talk about their family or their houses. So they are detached. Engineering has been mystified so much in our country that people are absolutely scared of the engineers.

Anand Swarup Arya
Can I just cite you one attempt that we have made for mason training because this is an important issue for this discussion. We have

just got one booklet where all mason training published by the UNDP in New Delhi, which is a 6-day hands-on training program after giving them some knowledge about what happens during the earthquake, showing pictures, and explaining many theories. Then, the real thing starts – how to make the mortar, how to lay the bricks for earthquake safety, how to lay the vertical sheet, etc. During this 6-day training, they are required to construct one room using all the details. Now, the manual for this training is already printed out. I have checked every bit of it and approved, then only it was printed.

Now, the second book that we have got prepared is for the training of that trainer or the training of engineers who will be supposed to train the masons. It is important to know that trainers also need to be trained. Trainers are told what they have to do before the class come; which means, all the materials get ready beforehand.

For them also, a training manual has been prepared and he is told what he has to do before the class comes – get ready for them all the materials everything ready. And so that is training of the trainer. Also a manual has been prepared. I hope that they will make these books available free to any country or anybody who would like to have a copy of those. In my view, such kinds of materials will give the real practical tips for training of the trainers, for masons and the training activities delivered to masons in the field. I have insisted the training must include a factor of hands-on. That is, they should do something during the training period so in 6 days training; they will start with the foundation, they will raise the walls, they will raise the roof also, and they will prepare one room during the training. This is the information I would like to pass to you.

Amod Mani Dixit
Regarding to the problem of training of craftsmen and others, in many developing countries what I have seen is that they do not produce the instructor's manual. They just produce the handout to be given to the masons whereas instructor's manual is not produced. When we produce the instructor manual, we have the instructor manuals as well as the handouts for the masons, just a carry-home document. For the instructor's manual, it provides advices to the engineers starting from how to talk to the mason; set of instruction and information is prepared. I guess perhaps similar to what Professor Arya has produced.

This is not what engineers do. They criticise us by saying "Are you to teach us something? You are from an NGO and trying to teach us?" That is why I am requesting engineers to make instructors manual an official Nepali document so that the training for trainers could be an educational method acceptable for all, not only for NGOs.

Teddy Boen
I agree with Amod. In Indonesia I suggested that all universities should go back to basic; re-introduce subjects concerning building materials and building constructions. How can an engineer instruct a mason if they do not even know how to lay bricks? In Aceh, I found that poor construction is allowed because the facilitators / inspectors do not know that it is poor construction.

For your information, 30 years ago, I already prepared a detailer's manual for small buildings in earthquake areas. Now it is planed to be published by CSI – Computers & Structures, Inc. It will be printed in two languages. Although the manual was written 30 years ago, it is still relevant. It has a lot of drawing – so people can see "do like this, do like that". So if I may suggest to Nepal, Nepal should translate the code into a poster – so that you have a very comprehensive code for non-engineered buildings.

Amod Mani Dixit
Our building code of Nepal provides for mandatory rule of thumbs which we have translated into Nepali language but not into posters. But the problem is, Professor Arya and Professor

Otani, our universities teach our students how to design a 30-storey building not a two-storey building. And the entire teaching profession is geared towards fulfilling the demand of developed countries. I do not find good engineers in Nepal now. Everybody has migrated somewhere outside of the country. So, I have to take whatever remaining, patriot ones, and then start teaching them because they also have not been able to learn engineering methods necessary for the country.

Shunsuke Otani
I hope you are not blaming engineering education in universities. I do not think we can ask students to learn how to lay bricks, masonry works and so on. I do not think it is our subject to teach at universities. I think you should develop training schools for workers. I understand the differences between masonry trainings and higher education for engineers. In universities, we have to abstract the phenomenon, develop theories and teach those theories to students. Student will learn the theories or basic ideas, and then develop her/his own ideas. This is the important part of the university education and I do not think it is possible for a student to learn how to mix concrete. We do not have much time anymore. Education on practical techniques should be done at other place. Our engineers or our graduates will never mix concrete on site. That is not our job or a graduate's job. I think there should be some separation.

Amod Mani Dixit
But they should understand the logic of mixing concrete and the logic of laying the bricks. Engineer should be able to distinguish a bad concrete from a good concrete.

Teddy Boen
It is different in Indonesia and Nepal compared to Japan. In big cities like Jakarta, engineers just call the concrete mix factories and stipulate the strength they want and the concrete truck mixer will deliver to the site. The engineers do not have to know how to mix it. However, in villages engineers must know how to lay bricks and how to mix concrete. If engineers do not know, how do you expect the poor people to know?

Anand Swarup Arya
I agree with Professor Otani on this subject. Earlier when I was a student, we were taught such things during construction. We were taught also carrying out surveys on the practice although those subjects are completely out of the syllabi of engineers. Rather, as the demands on the engineers are now for major structures whilst major structures are coming in almost every country.

Therefore, the answer to the problem is that we have to bring this subject in a strong way in our junior engineering polytechnics and industrial training institutes and that is where are to be trained and then they become the trainers. Now people like me who have spent more than 50 years in profession, we started from seeing the bricklayer's job to the most sophisticated computer analysis applicable to what they were showing vibration of the mathematical model. Who will do it if engineers don't do so? I think these are areas of work to be shared. At the national level we cannot expect full involvement of high-level engineers whilst we also need in large numbers. So, we should have industrial training institutions and the diploma polytechnics for doing this job and learning these traits. The engineers, of course, should have exposure, maybe by way of 2 days training or 3 days training – then they can put their theoretical ideas also into work.

Amod Mani Dixit
But the philosophical question is, do you mean to say that for non-engineered construction, the engineers trained by universities should not be involved or you want to detach it?

Anand Swarup Arya
They need to be involved – but in a very small way, not in the way that you would like to

have them for trainings of the masons, I do not think so. I got the manual done and I could be with the engineers who will be the trainers for a day to explain the whole philosophy of the things around the non-engineered construction. As somebody said, earthquake occurrence is the mother of earthquake engineering. I have learned through observations in earthquakes. I have learnt in Bali earthquake, in Katmandu, and in so many other areas how the constructions and bad construction, good constructions were being done. But since it was more personal interest, most engineers will not like to do that – let me tell you very frankly. Most engineers will not even like to go to such badly affected areas and most engineers will not like to go at the engineering construction sites. They will be very happy sitting in air conditioned rooms and doing the computer work and design work.

Amod Mani Dixit
What I raise here is a much deeper question. Shall we confine dissemination of our imitative only to the technicians or training-school graduates whilst the Government in our case only looks at you – an engineering university? Engineers trained at Stanford or Tokyo University are rated much higher than graduates of training schools. Now in this discussion if I presume that the graduates of the training school should be better knowledgeable for my non-engineering construction than Stanford or Tokyo University- graduates. But the government as well as the society listens to high educated engineers- so my problem is not going to be solved.

Shunsuke Otani
I do not think we should separate engineered construction and non-engineered construction. Our graduates from universities do not have to do non-engineered construction and so all of our graduates cannot do the construction of non-engineered. Some may do. For example, some of our graduates will teach at universities but not all of them. They would go to design office and they would go to some construction site. So some may go to non-engineered construction site. But you are expecting all of our graduates to do non-engineered construction. That is not the case.

Anand Swarup Arya
I think some of university graduated engineers will look at also government offices, university buildings, large hospital buildings. Who will do so if they do not do so? Not every engineer will be able to do that. Therefore, I think the ability of the engineers will determine who will go here and who will go there. It is a job.

Shunsuke Otani
Also Mr. Teddy Boen is involved in non-engineered construction whilst he is a graduate of engineering. But he is designing very tall buildings as well.

Teddy Boen
I do both, engineered as well as non-engineered constructions. That is why in Indonesia, engineers must know about non-engineered constructions as well. If we ask engineers whether they know non-engineered construction, they would said "Yes, I know", while in reality it is not the case.

In Nepal also, you might be qualified to deal with engineered constructions but not necessary non-engineered houses. I think such gap is not good for the country because the majority of the people build and live in non-engineered buildings. In closing, I would like to mention about one good example in Padang, after the September 12, 2007 earthquake. There was a hospital that was damaged and there were cracks in the walls. The hospital director immediately (the following day after the earthquake) just patched and repaired the hospitals by themselves.

Shoichi Ando
In regard with the political solution on involvement of engineered to non-engineered structure, as Professor Otani mentioned, University students learn only a little small part of the non-engineered construction in Japan. Through learning on structure, culture, and multiple viewpoints on the wooden structure, which is Japanese traditional non-engineered structure, we absorb some idea on Japanese history of non-engineered structure a bit. So far we have categorised Japanese architects in three classes through political involvement- first class, which is engineered, second class and third class. Second class architect is qualified as high level carpenter. It is a kind of expert of non-engineering structure but we call it second class architect or second class structural engineered. And later, the ministry established the third class- it is a kind of wooden class architect; which is not so popular in Japan at the moment. By recognising both sectors under categorisation of a set of policies on architecture, Japanese policy tries not to divide the engineered and architects into non-engineered person. But it is just a categorisation- second class architects can be applied to the first class architect exam after some experiences.

Jishnu Kumar Subedi
Just I want to add that in the discussion whether or not to include non-engineering construction is because majority of the constructions are non-engineered construction. There is a demand for non-engineers who can talk about or discuss non-engineered construction. But the demand from the student side is different. Because I come from the engineering institute (Nepal Engineering College), so demand is totally different. They want to go for high-rise buildings. Our institute now has started just for rural engineering which focuses on aspects of non-engineered construction. So that might be one approach to consider this problem.

Also, as Professor Arya mentioned, the key has been capacity building. UNCRD has conducted questionnaire based survey on mechanism of building codes, and found there is a necessity of capacity buildings on matters related to codes. Therefore, HESI 2007-2009 have focused on the issue- and the challenge is still continuing. What I want to mention, just to summarize, is that, there is already existence of knowledge base. We have codes, guidelines, and everything. Therefore, maybe it is a good idea to translate that code into something understandable to the local masons and others. And in Nepal there is a good practice of these mandatory rules of thumb, but which is a very thick document. So it should be translated into something comprehensive. Therefore through HESI works, such opportunities are always available: to see how to upscale local experience to the country-wide level. Also, I would like to mention that we work with various local partners including NGOs as well as academic institution; and the implementation of our work would be done with the cooperation of those stakeholders.

<ins>Regarding to current issues and the way to go</ins>

Shoichi Ando
As it is shown in various materials prepared by Ministries, for example, since past 25 or 30 years ago, some efforts of disseminating building code have been done here in Japan. And now, the current Japanese issue is retrofitting of houses, particularly after Kobe earthquake. Firstly, for non-engineered construction, self-checklist was developed by the ministry with supervision of Tsuneo Okada, professor of the University of Tokyo. Besides, the ministry has prepared very thick document on the concrete structure as well. Meanwhile, I would like to introduce you that the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Government of Japan, prepared the guide and set of good practice booklet for promoting retrofitting of school buildings. It refers to total assessment system of all Japanese schools including how to select the schools to be retrofitted.

Jishnu Kumar Subedi
I would like explain the school safety with based upon experience of UNCRD's initiative on school earthquake safety. What our coordinator, Ando, has mentioned is that earlier in Japan

we have no policy to retrofit all the schools. Particularly after the Kobe Earthquake they realised that the schools built before 1980 which were using the previous code had some deficiency, so maybe 60% of the educational facilities were considered to need retrofitting. The MEXT organised a guide, which is a very comprehensive one and it will be very useful and not only for schools but other buildings as well that information.

Shoichi Ando
Regarding to school retrofitting, the MEXT is subsidising for its cost. However, cost for assessment of school building is subsidised not by the MEXT but by the MLIT (Ministry of Land, Infrastructure, Transport and Tourism). Therefore, school is just a part of the building related policy under the MLIT – MLIT prepared the subsidy system to assess all types of buildings even if it is private sector. The ministry subsidises to local government if local government prepared the plan to assess all the building in their municipality.

Amod Mani Dixit
So private hospital buildings are also subsidised or being assessed by MLIT?

Shoichi Ando
It is subsidised by MLIT through local government. The cost is around 200 million (US) dollars per year, only for assessment. But if the retrofitting cost is maybe 100 times bigger than assessment cost- so it cannot be done at the same time.

Jishnu Kumar Subedi
Japan has a very comprehensive policy for school retrofitting; comprehensive in the sense that they have included all the components; how to assess vulnerability etc. The major part as far as I remember is transparency; not to hide the information and to make it public. Then, the publics take it as very important issues. With regard to the experience of retrofitting under UNCRD for School Earthquake Safety Initiative (SESI) the outcome documents would be issued in early 2009, and shared to the stakeholders of HESI as well.

Amod Mani Dixit
If you endorse the translation of English reports into posters, do you think that you can include it in your further project? Shall we put proposals?

Teddy Boen
Yes, I will assist you.

Amod Mani Dixit
Very good. But somebody should provide the research also on this regard. So can we make proposal for the next phase of HESI?

Shoichi Ando
The next phase of HESI from 2009 to 2012, the budget will be decided by the MLIT, Government of Japan, soon. MLIT also would like us to focus on the existing building. Therefore this time I appreciate all the participants that very useful information, especially for the existing building – how to deal with existing buildings.

Presenters at Symposium, Nov. 2008

Anand Swarup Arya (India)

Professor Emeritus of IIT Roorkee / National Seismic Advisor, Ministry of Home Affairs, Government of India. Expertise in earthquake engineering, he has supported recovery from Gujarat Earthquake in 2001 as well as formulation of guidelines on Anti-Seismic Safety buildings in U.P. and Kashmir Winner of UN Sasakawa Disaster Prevention Award in 1997. He has contributed as advisor of many projects under UNCRD- including IndESI- India Earthquake Safety Initiative 2001-2004.

Teddy Boen (Indonesia)

Leading expert on earthquake engineering in Indonesia / Senior Advisor of World Seismic Safety Initiative WSSI. He is considered as the founding father of modern earthquake engineering in the country. During the recovery from earthquake and tsunamis hit in Aceh in 2004, he has contributed a lot for retrofitting of buildings in the region. He is international expert on non-engineered housings.

Surya Bhaktha Sangachhe (Nepal)

Director of Department of Urban Development, Building and Construction (DUDBC), Government of Nepal (-2008). He has long experience for slum development issues as well as Heritage Conservation in many parts of Nepal, particularly at Lumbini, Patan, Bhaktapur and Kathmandu. He has developed so far manuals and reports on Building Regulations Bylaws for municipalities of Kathmandu Valley as well as Land Pooling for financial strategies for development of urban infrastructure.

Tatsuo Narafu (Japan)

Senior Coordinator of Building Research Institute- BRI (PhD in Engineering, Tsukuba Univ.). After graduating from University of Kyoto, he worked for Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Government of Japan. He moved to BRI in 2003 and has been dedicated to earthquake engineering research globally. Not only coordinating some international research initiatives conducted by BRI, he is involved, as expert, development project in Indonesia and Peru launched by development agencies such as World Bank.

Shunsuke Otani (Japan)

Emeritus Professor of the University of Tokyo. After graduating from University of Illinois (PhD in Engineering), he has taught at University of Illinois, University of Toronto, The University of Tokyo, and Chiba University. He is one of the international leading experts on RC Structural Engineering, and awarded with many prizes.

Shoichi Ando (Japan)

Coordinator of UNCRD Disaster Management Planning Hyogo Office. After graduating from the University of Tokyo (PhD in Engineering), he has been engaged into Housing policy, Urban Development Policy, and Disaster Mitigation (building and urban context) at MLIT, Government of Japan. Contributed for the establishment of CISMID – Japan/Peru Seismic Disaster Centre in Lima, and dedicated to Department of Environment of OECD- Paris as Chief Management Officer.

Amod Mani Dixit (Nepal)

Founder and General Secretary of National Society of Earthquake Technology – Nepal (NSET), Mr. Dixit also serves as its Executive Director. He is a renowned geologist, and has been closely studying the affects of earthquakes mainly in the Himalayas – particularly India, Pakistan and Nepal. He has 30 years of experience of working in areas of landslide, erosion and flood hazard mitigation including 20 years of efforts in earthquake risk reduction. Contributed article to World Disaster Report 2002, organised by IFRC, and awarded with RONAST Science and Technology Promotion Award 2005 (by the Royal Nepal Academy of Science and Technology)

Jishnu Kumar Subedi (Japan)

Researcher of UNCRD Disaster Management Planning Hyogo Office. After graduating from Saitama University, Japan (PhD in Engineering), he has been involved in teaching and research on Earthquake Engineering and Disaster Risk Reduction as Vice Principal/ Associate Professor of Nepal Engineering College before joining UNCRD.

Kenji Okazaki (Japan)

Professor of National Graduate Institute for Policy Studies (GRIPS), Tokyo, Japan. He has been engaged into Housing policy, Urban Development Policy and International Cooperation at Ministry of Construction (former MLIT), Government of Japan. He has also worked for United Nations Economic and Social Commission for Asia and the Pacific (UN/ESCAP), Bangkok, and the Secretariat for International Decade for Natural Disaster Reduction (IDNDR), Geneva. Before joining GRIPS, he worked at UNCRD DMP Hyogo Office as Coordinator.

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Front: Some Extracts from UNCRD's field survey on damages caused by Java Earthquake (2006) in Yogyakarta
Front-Back: Building Code/ Guidelines prepared by Lalitpur Municipality Office, Nepal- photo prepared by UNCRD Disaster Management Planning Hyogo Office