



NEPAL NATIONAL BUILDING CODE
NBC 000 : 1994



Strengthening Building Code Implementation and Compliance in Developing Countries: A Case Study of Nepal

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Two-Part Presentation

1. Findings of the EERI LFE team regarding Building Codes
2. Overview of Housner Fellows work



Part I: EERI's Response to the 2015 Nepal Earthquake and Observations Regarding Nepal's Building Code



Virtual Clearinghouse

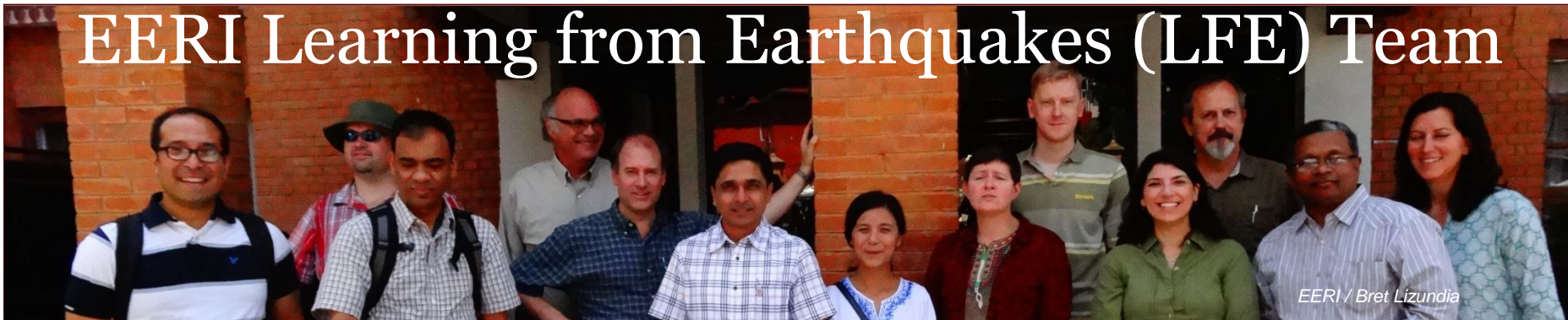
<http://www.eqclearinghouse.org/2015-04-25-nepal/>

- Established within 26 hours of the earthquake
- Goal to be a long-term archive for Nepal Earthquake information
- Visit EERI's Virtual Clearinghouse Website for:
 - Geolocated Data Map
 - Photo Gallery
 - Team Report (*under development*)
 - Reports from other teams and organizations
 - Curated Topic Posts

The screenshot shows the website's header with the date "Monday, July 06, 2015" and a link to "VISIT THE EERI WEBSITE". The main header features the EERI logo and the text "NEPAL EARTHQUAKE CLEARINGHOUSE" with the event details "M7.8 APRIL 25, 2015 AT 06:11:26 UTC". A search bar is located to the right. Below the header is a navigation menu with categories: HOME, TECHNICAL RESOURCES, MAPS AND PHOTOS, MEDIA REPORTS, HOW TO CONTRIBUTE, RESEARCH TOPICS, and ABOUT. A secondary menu lists "CURATED TOPICS", "EERI UPDATES", and "GENERAL INFORMATION". The main content area starts with "Browse > Home /" and a welcome message: "Welcome to the M7.8 Nepal Earthquake Clearinghouse". A large photo shows the damaged Basantapur Durbar Square in Kathmandu, Nepal. To the right, a "RECENT UPDATES" section lists several articles, and a "CONTACT" section provides information for Heidi Tremayne, EERI Program Manager.



EERI Learning from Earthquakes (LFE) Team



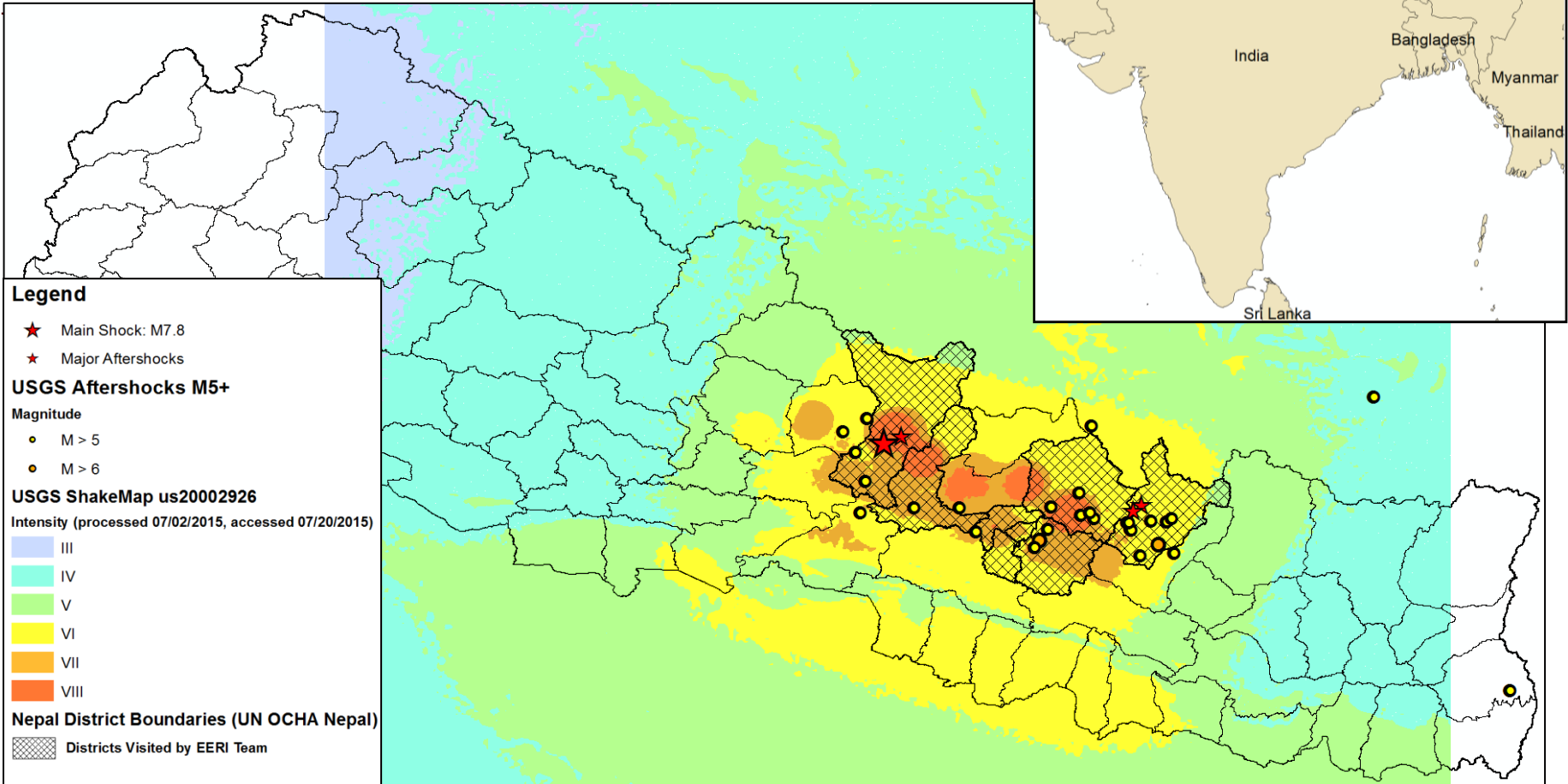
- **Bret Lizundia**, Rutherford + Chekene, San Francisco, USA (Co-Leader)
- **Surya Narayan Shrestha**, NSET, Kathmandu, Nepal (Co-Leader)*
- **John Bevington**, ImageCat Ltd, London, England
- **Rachel Davidson**, University of Delaware, Newark, Delaware, USA
- **Kishor Jaiswal**, USGS, Denver, Colorado, USA
- **Ganesh Kumar Jimee**, NSET, Kathmandu, Nepal*
- **Hemant Kaushik**, Indian Institute of Technology, Guwahati, India
- **Hari Kumar**, GeoHazards International, India
- **Jan Kupec**, Aurecon, Christchurch, New Zealand
- **Judy Mitrani-Reiser**, Johns Hopkins University, Maryland, USA
- **Chris Poland**, CDP Engineers, Canyon Lake, California, USA
- **Suraj Shrestha**, Dharan Sub Metropolitan City, Nepal
- **Courtney Welton-Mitchell**, Universities of Colorado & Denver, USA

* Not depicted in
image above

Special thanks to Dr. Thomas Kirsch (Johns Hopkins University)
and Rubina Awale (Transcultural Psychosocial Organization, Nepal)



Reconnaissance Effort

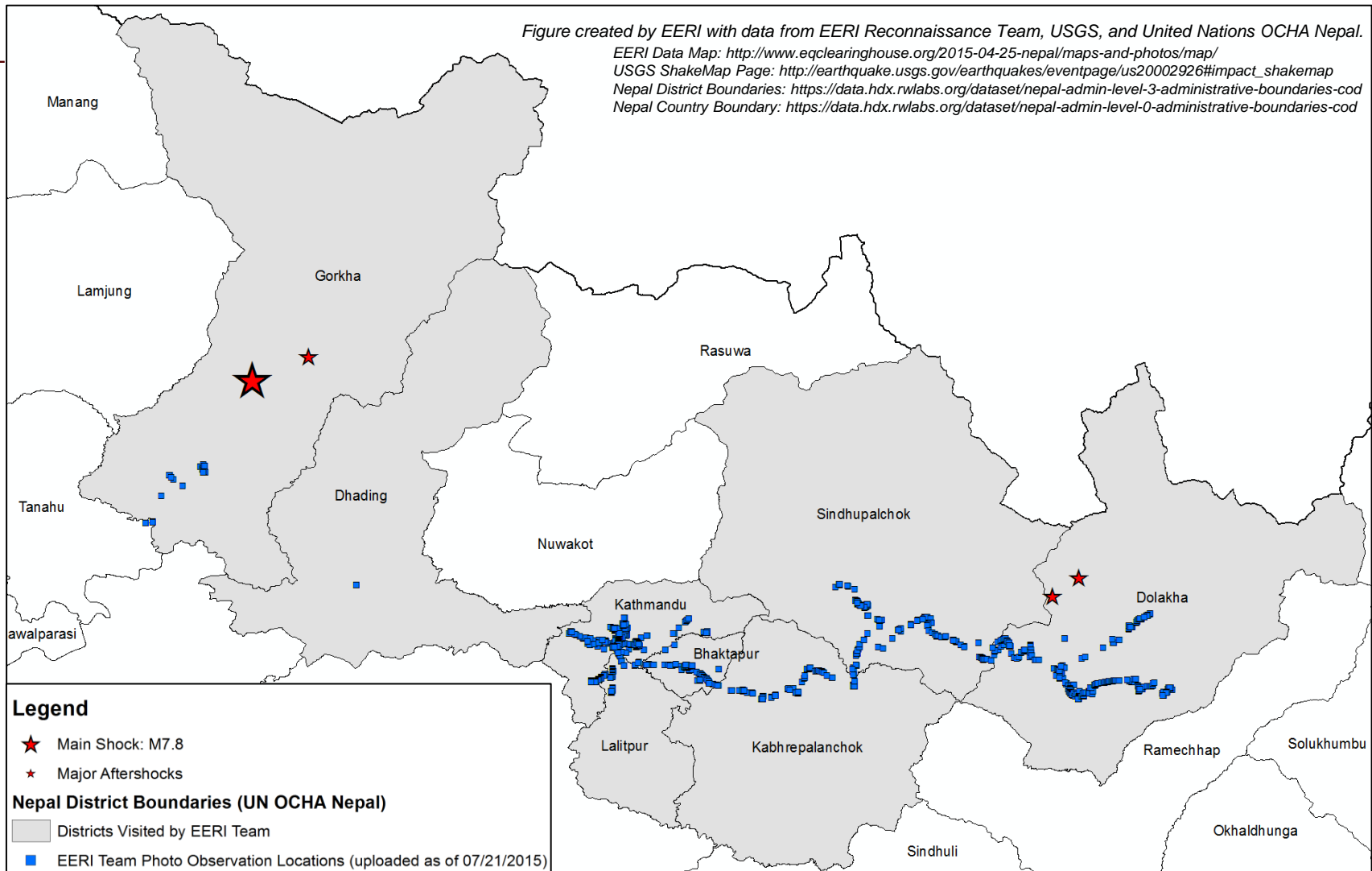


Figures created by EERI with data from ESRI (Environmental Systems Research Institute), UN OCHA (United Nations Office for the Coordination of Humanitarian Affairs) Nepal, and U.S. Geological Survey (USGS).

USGS ShakeMap Page: http://earthquake.usgs.gov/earthquakes/eventpage/us20002926#impact_shakemap
 USGS ShakeMap GIS File: <http://earthquake.usgs.gov/archive/product/shakemap/us20002926/us/1435877532354/download/shape.zip>
 Country Boundaries: <http://www.arcgis.com/home/item.html?id=2b93b06dc0dc4e809d3c8db5cb96ba69>
 Nepal District Boundaries: <https://data.hdx.rwllabs.org/dataset/nepal-admin-level-3-administrative-boundaries-cod>
 Nepal Country Boundary: <https://data.hdx.rwllabs.org/dataset/nepal-admin-level-0-administrative-boundaries-cod>



Reconnaissance Effort

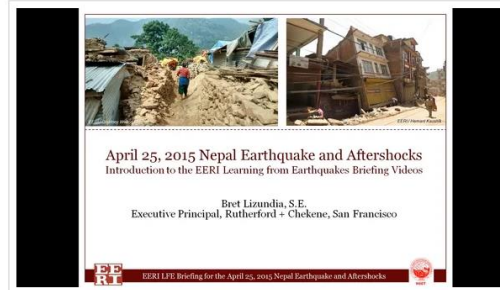


EERI Briefing Series of Videos (www.eeri.org)

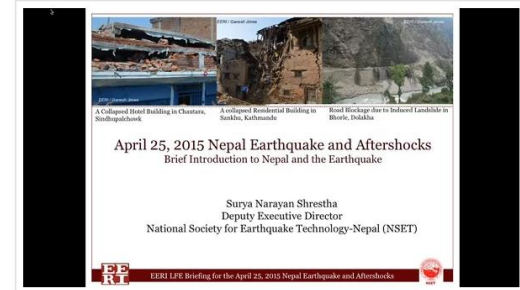
1. Introduction: Objectives, methodology, unique features, team – Bret Lizundia
2. Nepal Earthquake: Geography, demographics, and general damage – Surya Shrestha
3. Seismology and Ground Motion – Kishor Jaiswal
4. Building Performance Part I: Building type overview, RC frame with masonry infill, and woodframe – Hemant Kaushik
5. Building Performance Part II: URM bearing wall, postearthquake safety evaluation, barricades/shoring, school retrofits – Bret Lizundia
6. Health Facility Performance – Judy Mitrani-Reiser and Hari Kumar
7. Social, Psychological and Cultural Factors – Courtney Welton-Mitchell
8. Geosciences – Jan Kupec
9. Emergency Response – Ganesh Kumar Jimée
10. Performance of Cultural Heritage Structures – Suraj Shrestha
11. Building Codes – John Bevington
12. Lifelines – Rachel Davidson
13. Resilience and Community Case Studies – Chris Poland
14. Summary of Findings – Bret Lizundia



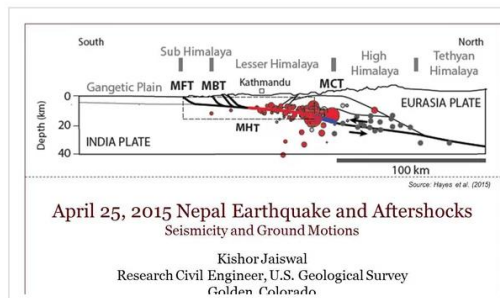
- Easy to view (vimeo)
- Nothing over 30 minutes long!
- Downloadable pdfs available



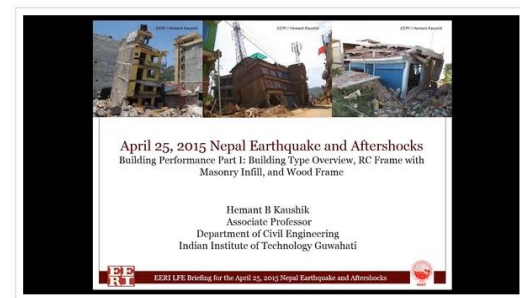
1. Introduction by B. Lizundia, EERI LFE Bri...
1 month ago



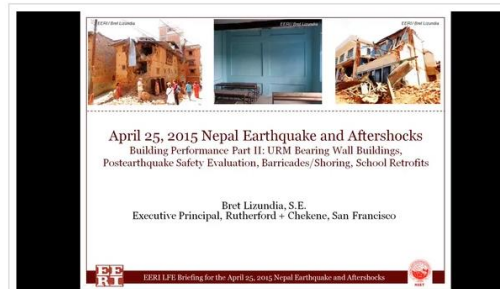
2. Introduction to Nepal and the Earthquak...
1 month ago



3. Seismicity and Ground Motions by K. Jai...
1 month ago



4. Building Performance I by H. Kaushik, EE...
1 month ago



5. Building Performance Part II by B. Lizund...
1 month ago



6. Health Facility Performance by H. Kumar ...
1 month ago



NEPAL NATIONAL BUILDING CODE
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April 25, 2015 Nepal Earthquake and Aftershocks Building Codes

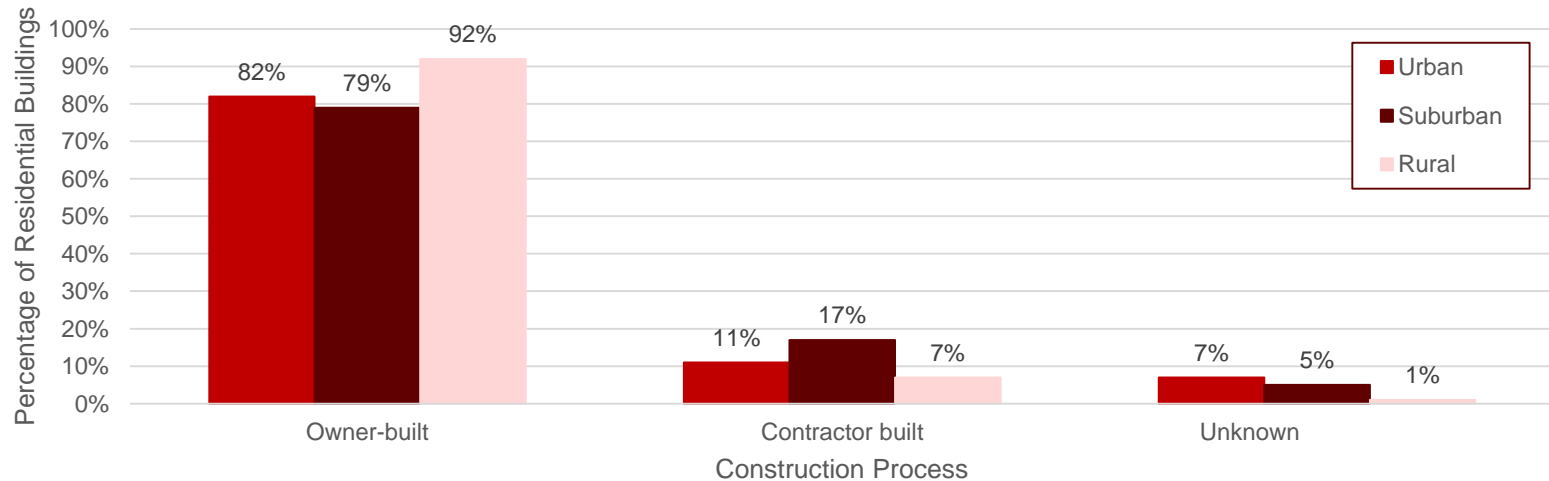
John Bevington, Ph.D.
Managing Director, ImageCat Ltd.
London, UK

The Problem

- Owner-built construction is by far the most pervasive type of construction, even in the most urbanized regions of Nepal (Dixit, 2009).

Construction Process for Residential Buildings in Kathmandu Valley

(Number of Buildings Surveyed = 961)



Source: Data from Building Inventory Survey under the Study on Earthquake Disaster Mitigation of Kathmandu Valley (2000), (Adapted from Dixit, 2009)

Building Performance – The Bad RC Frame with Masonry Infill

Low/Medium/High-rise: All suffered damage

Chautara: 3-story

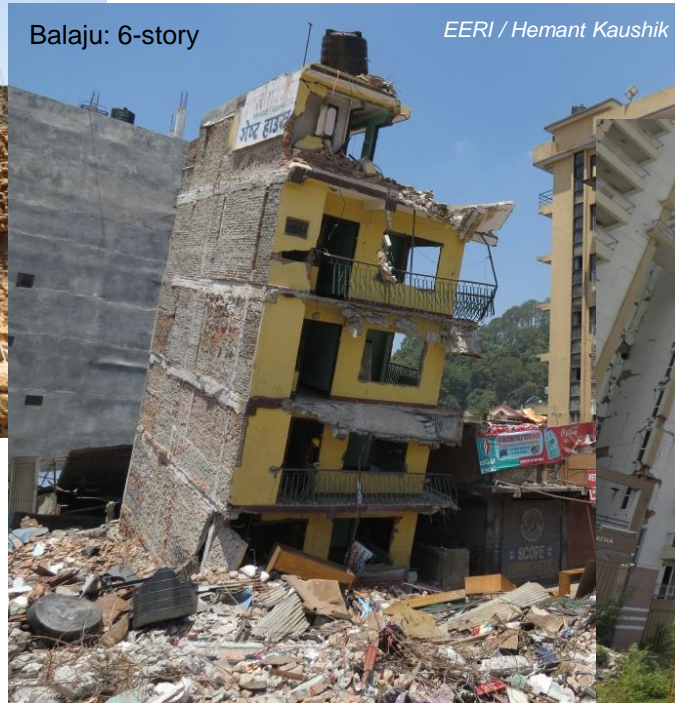


EERI / Hemant Kaushik

Concentrated in urban areas and district headquarters

Balaju: 6-story

EERI / Hemant Kaushik



Most private buildings are non-engineered:

- Non-seismic detailing
- Inappropriate foundation
- Geometric irregularities, pounding
- Improper workmanship, materials

Dhapasi: 17-story

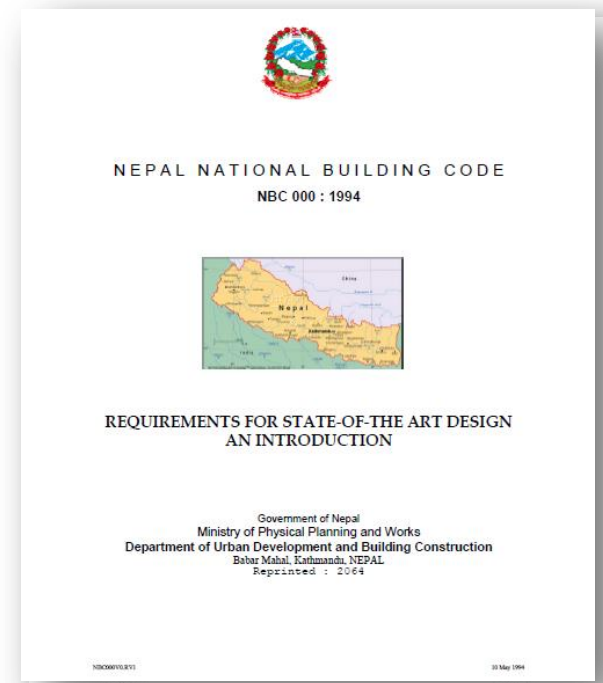
EERI / Hemant Kaushik



Nepal National Building Code 1994

Timeline:

- 1988: Nepal earthquake kills ~700 Ministry of Housing and Physical Planning (MHPP) requests technical assistance from UN Development Program and UN Centre for Human Settlements (Habitat; UNCHS)
- 1991: Proposals requested by MHPP and UNCHS
- 1993: Nepal National Building Code (NNBC) prepared
- 2003: NNBC approved by Government
- 2006: NNBC made mandatory in municipalities (no deadline set)
- 2015: Draft of new Code planned



Source: Government of Nepal (1994)

Summary of Code and Purpose

SN	Type of Building Code	Purpose																		
1	International State-of-Art Applicable codes: NBC 000	Applicable to large building structures. The structures must comply with existing international state-of-the-art building codes																		
2	Professionally Engineered Buildings Applicable codes: <table border="1" data-bbox="241 571 904 868"> <tr> <td>NBC 101</td> <td>NBC 107</td> <td>NBC 113</td> </tr> <tr> <td>NBC 102</td> <td>NBC 108</td> <td>NBC 114</td> </tr> <tr> <td>NBC 103</td> <td>NBC 109</td> <td>NBC 206</td> </tr> <tr> <td>NBC 104</td> <td>NBC 110</td> <td>NBC 207</td> </tr> <tr> <td>NBC 105</td> <td>NBC 111</td> <td>NBC 208</td> </tr> <tr> <td>NBC 106</td> <td>NBC 112</td> <td></td> </tr> </table>	NBC 101	NBC 107	NBC 113	NBC 102	NBC 108	NBC 114	NBC 103	NBC 109	NBC 206	NBC 104	NBC 110	NBC 207	NBC 105	NBC 111	NBC 208	NBC 106	NBC 112		Buildings designed and constructed under supervision of engineers, buildings with plinth area more than 1,000 sq. ft., buildings having more than 3 stories, buildings with span more than 4.5 m and buildings with irregular shapes
NBC 101	NBC 107	NBC 113																		
NBC 102	NBC 108	NBC 114																		
NBC 103	NBC 109	NBC 206																		
NBC 104	NBC 110	NBC 207																		
NBC 105	NBC 111	NBC 208																		
NBC 106	NBC 112																			
3	Mandatory Rules of Thumb Applicable codes: NBC 201, NBC 202, NBC 205	Buildings of plinth area less than 1,000 sq. ft., less than 3 stories, buildings having span less than 4.5 m and regular buildings designed and constructed by technicians in the areas where professional engineers' service is not available																		
4	Guidelines of Remote Rural Buildings (Low Strength Masonry/ Earthen Buildings)	Buildings constructed by local masons in remote areas and not more than 2 stories																		

Source: UNCRD, 2008

Adequacy of Nepal National Building Code

Code does not include:

For new buildings

- A risk-targeted approach for earthquake-resistant design
- Geotechnical issues (e.g. site amplification, soil-structure interaction, slope provision, liquefaction, ridge-top amplification)
- Disabled access

For existing buildings

- Requirements for modifications / retrofits to existing buildings

Postearthquake

- Repair and retrofitting guidelines for damaged buildings
- Guidance on safe demolition of damaged structures



Code Compliance

- Limited code implementation
 - 3 / 58 (19%) municipalities in 2003 (Giri, 2013)
 - ~26 / 191 (7%) municipalities in 2015 (NSET, 2015)
- Mixed picture on code adoption and compliance:
 - Public vs. Private; Urban vs. Rural
- Clear absence of code compliance in rural areas and in informal settlements – issues with Bylaws mean loopholes exist
- Lack of political will and infrastructure to initiate code enforcement measures
 - Field verification activities are limited
- Lack of incentives and enforcement of codes
 - Law enforcement for code compliance is limited

(These are all common issues throughout the developing world.)



Example 1: Development of block of five 17-story apartment buildings
Permit issued for 12 stories



Example 2:

Inappropriate detailing of concrete reinforcement

Nonductile concrete with 90 degree hooks, wide tie spacing and no cross-ties on middle vertical longitudinal bar



Example 3: Rural residential building in Jiri, Dolakha

Permit for two stories was granted. Gradually raised to five stories. Top stories collapsed.

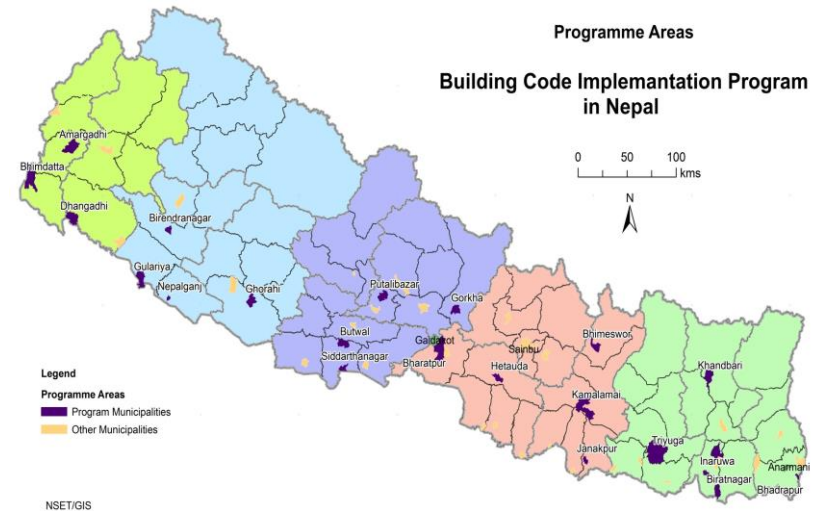
Homeowner used savings to have top three stories removed. She does not intend to replace the top stories.

Potential Improvements

- Take account of occupancy in Code design
- Focus on postearthquake usability
 - Safe and usable critical facilities
 - Shelter in place housing
 - Nonstructural considerations (generators, utilities etc.)
- Clear land use planning in Kathmandu and large cities
 - Safe access and egress in emergencies
 - Dedicated refuge areas
- Nationwide application of Building Bylaws
- The end-goal should be an overall increase in resilience.

Positives Observed: Programs of the National Society of Earthquake Technology Nepal (NSET)

- NSET-US Office of Foreign Disaster Assistance Building Code Implementation Project (NSET, 2015)
 - 24 municipalities (14 active)
 - Supporting municipalities to develop effective mechanisms for code adoption and compliance
 - Enhancing earthquake awareness
 - Improving technical awareness of officials, engineers and masons
- Reconstruction Technology Center in Dolakha
 - Land donated to construct buildings as exemplars
 - Training local masons and engineers
- Numerous public awareness campaigns
 - Earthquake Mobile Clinics
 - Earthquake Safety Day



Source: NSET GIS Dept.

Positives Observed: Additional Programs

- Desire to update and enforce the National Building Code:
 - Department of Urban Development & Building Construction - National Plan of Action for Building Code Implementation (draft)
- UN Development Program Electronic Building Permit System - Lalitpur (Giri, 2013)
- Added public awareness of Code-related issues
 - removal of additional stories
 - complaints about neighbour's repairs



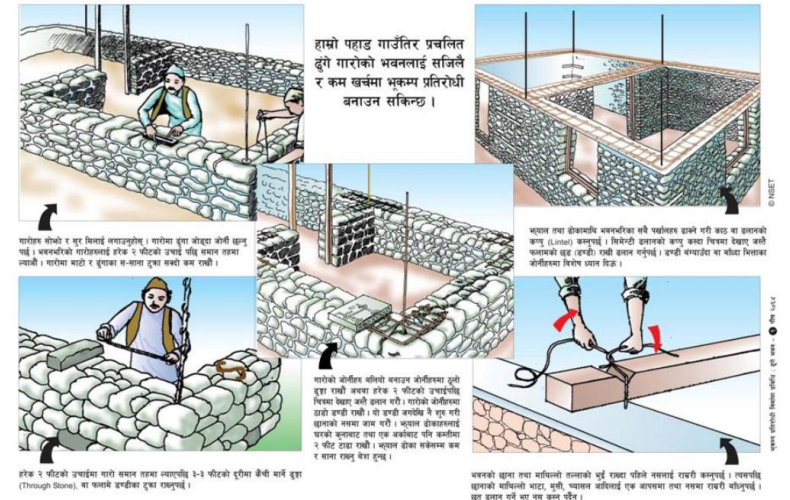
Opportunities

- Continue focus on community-driven activities
- Increased awareness provides better understanding of the consequences of not following codes
(but for how long?)
- Develop *Dos and Don'ts* for basic design using observations from the field
- Engage with international structural engineering community to produce guidelines for preparing code-compliant repairs and retrofits
- Conduct capacity building exercises and local education workshops



NSET

भूकम्प प्रतिरोधी ढुंगे भवन बनाउँदा ध्यान दिनुपर्ने कुराहरू



Summary

- Building Codes exist, yet adequacy, adoption and compliance are key issues.
- There are a number of potential areas for improvement and an update to the Code is planned
- Evidence of code compliance is very low throughout country, especially outside of Kathmandu.
- There is heightened awareness since the earthquakes of the need to adopt the Nepal National Building Code.
 - Need to act quickly to capitalize on this.
- Awareness was increasing, even before the earthquakes, thanks to activities by organizations such as NSET.
 - Public policy needs to increase in tandem.
- Several international initiatives have been established to increase adoption and monitor compliance of codes.
 - Many initiatives are ongoing – a positive sign.

Acknowledgements

- EERI LFE Team Members for their commitment to this effort and continued work to prepare this briefing and the upcoming report.
- EERI's Learning from Earthquakes Program & LFE Executive Committee
- EERI members for donations to the LFE program and membership dues that support EERI
- National Science Foundation Award #1235573 for supporting reconnaissance related to EERI's Resilience Observatory Project
- NSET for their dedicated effort to help coordinate the logistics for this team despite their many other obligations
- New Zealand Society for Earthquake Engineering (NSZEE), U.S. Agency for International Development (USAID) Office of U.S. Foreign Disaster Assistance (OFDA), and U.S. Geological Survey for supporting some team member travel expenses
- The many organizations and reconnaissance teams that shared plans and collaborated: GEER, EEFIT, Disaster Research Center at the University of Delaware, Center for Refugee and Disaster Response from Johns Hopkins University, Center for Disaster Management at Karlsruhe Institute of Technology in Germany, Baldrige & Associates Structural Engineering, CAEE in Canada, IIT & NICEE in India, AIJ & JSCE in Japan, NZSEE in New Zealand, AEES in Australia, and many others
- The numerous agencies, organizations, groups, ministries, and individuals that made time to meet with members of the EERI team while in Nepal

Part II: EERI Housner Fellows Project

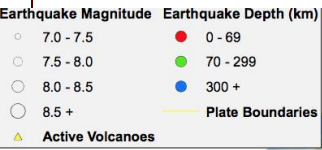


EERI Housner Fellows Class of 2014

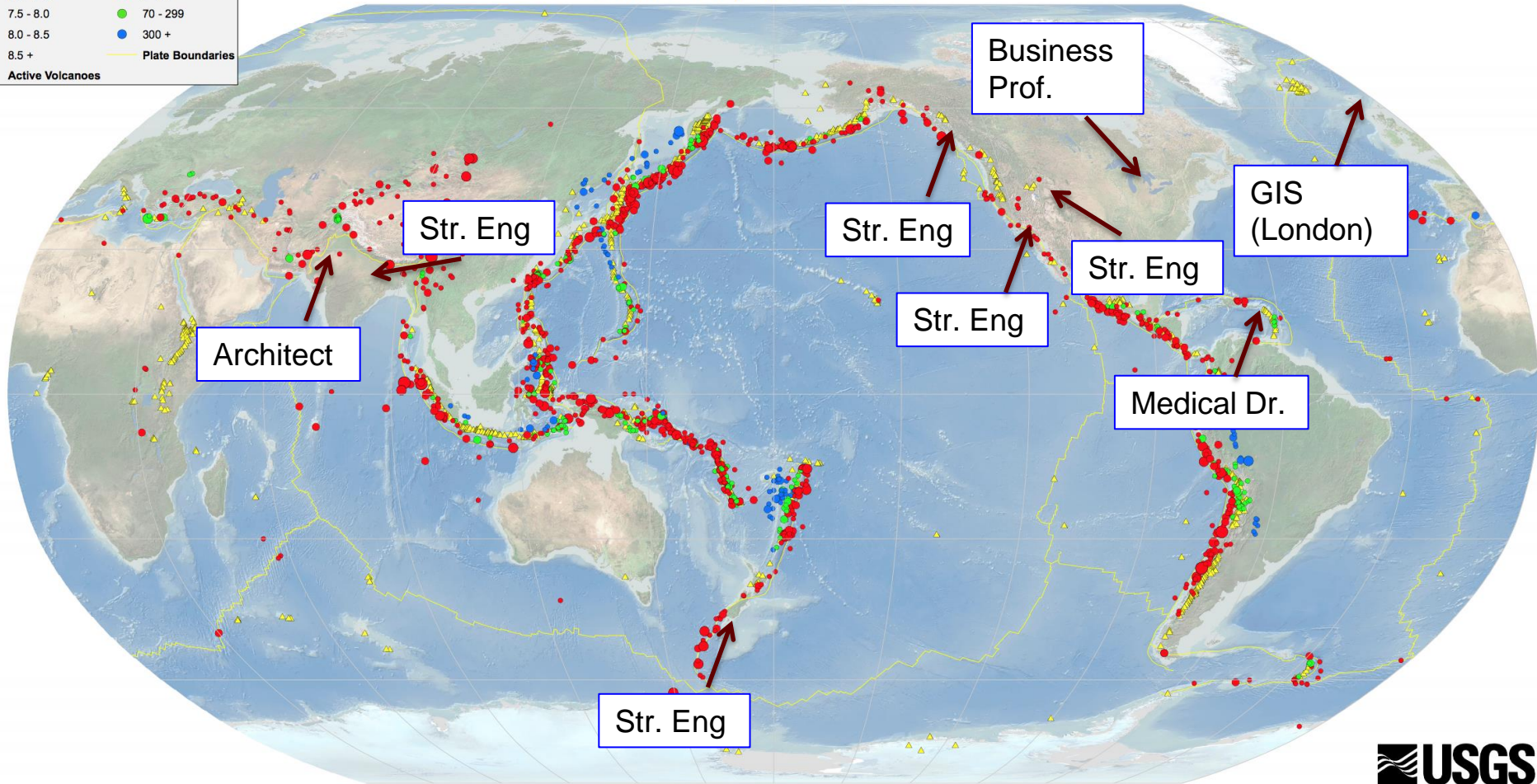
- Earthquake Engineering Research Institute's (EERI) leadership program to train a new generation of leaders and advocates for earthquake safety.
- Class of 2014 initiated in July 2014 with a two-year duration
- Eight members, plus faculty advisor (Lucy Arendt):
 - John Bevington
 - Ayse Hortacsu
 - Kishor Jaiswal
 - Forrest Lanning
 - Garmalia Mentor
 - Ghazala Naeem
 - Surya Shrestha
 - Kate Thibert



A truly global and diverse team!



Global Earthquakes 1900 - 2013



EERI Housner Fellows Program

2014-16 Group Project

Strengthening Building Code Compliance in Developing Countries: A Case Study of Nepal

- Understand issues around implementation and compliance of building codes globally via:
 - A literature review
 - A forthcoming online survey
- Conduct field work in Nepal (expected February 2016):
 - Meet decision makers in selected municipalities (2-4) to understand context
 - Conduct workshops in Nepal for information collection and dissemination
- Prepare a cross-cutting report on general observations and specific lessons

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THANK YOU

QUESTIONS?

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