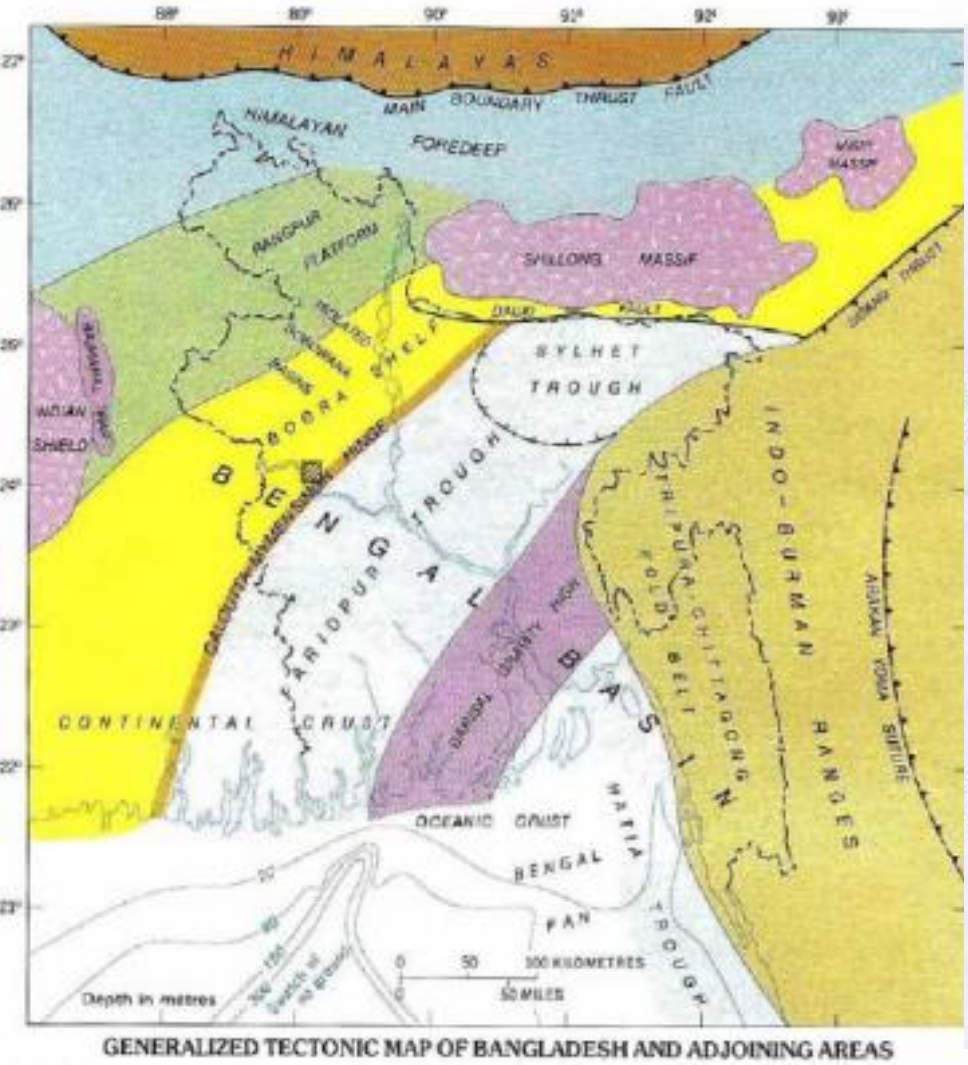
SPACE
CONSULTANT LTD

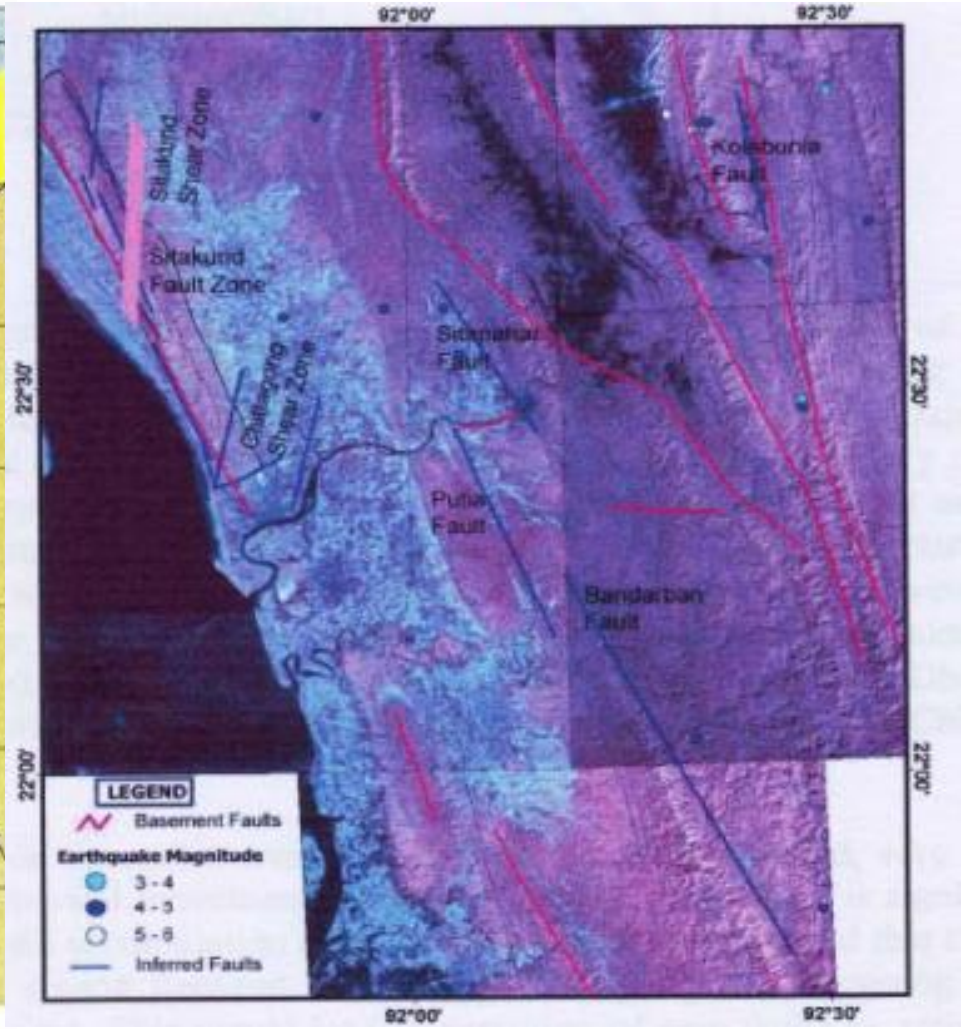
REVISITING BUILDING CODES

In light of Earthquake Risk Mitigation

TECTONIC MAP OF BANGLADESH
& Seismic Fault Line inside Chittagong



GENERALIZED TECTONIC MAP OF BANGLADESH AND ADJOINING AREAS



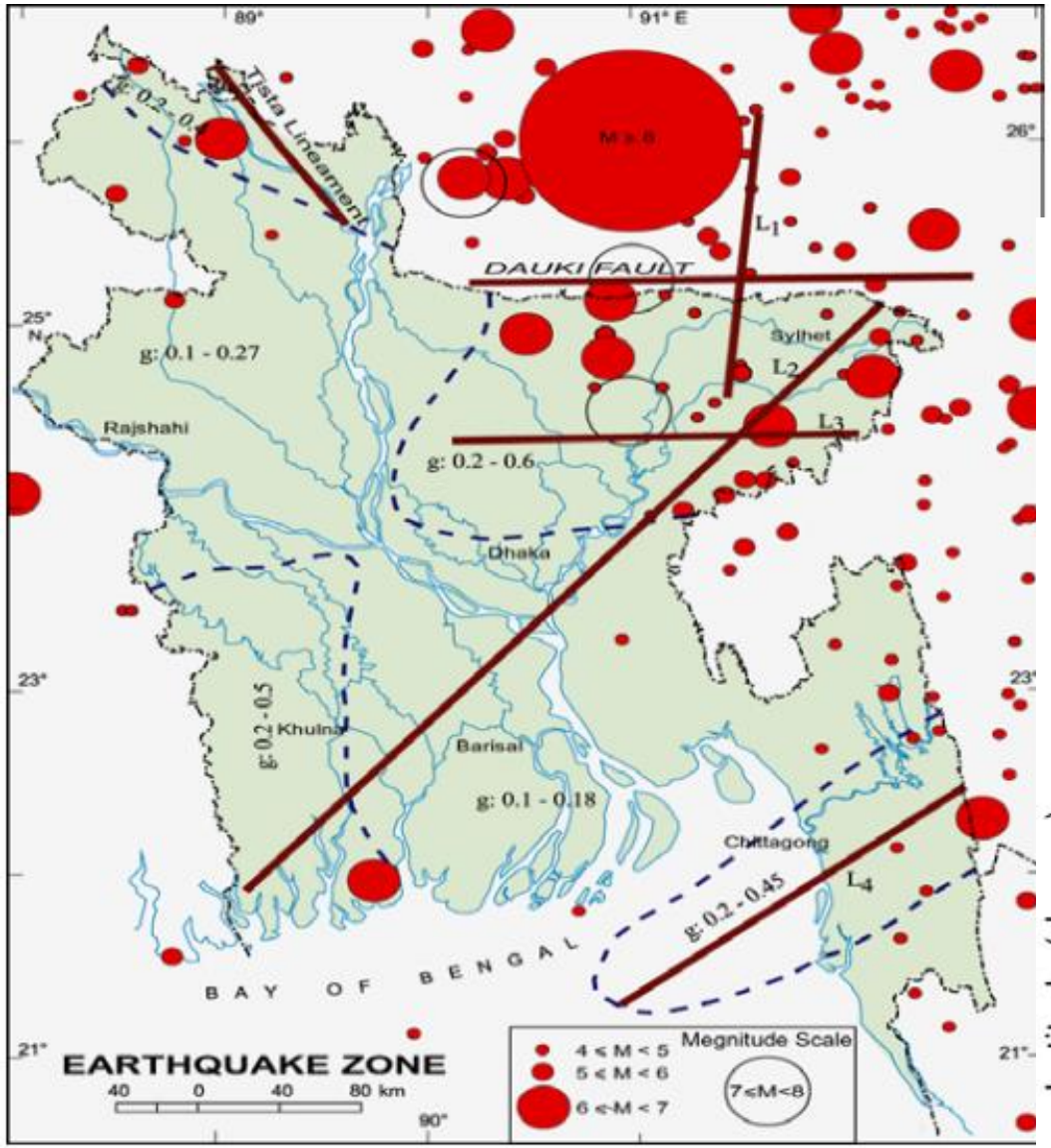


Figure 1: Seismic Activity of Bangladesh

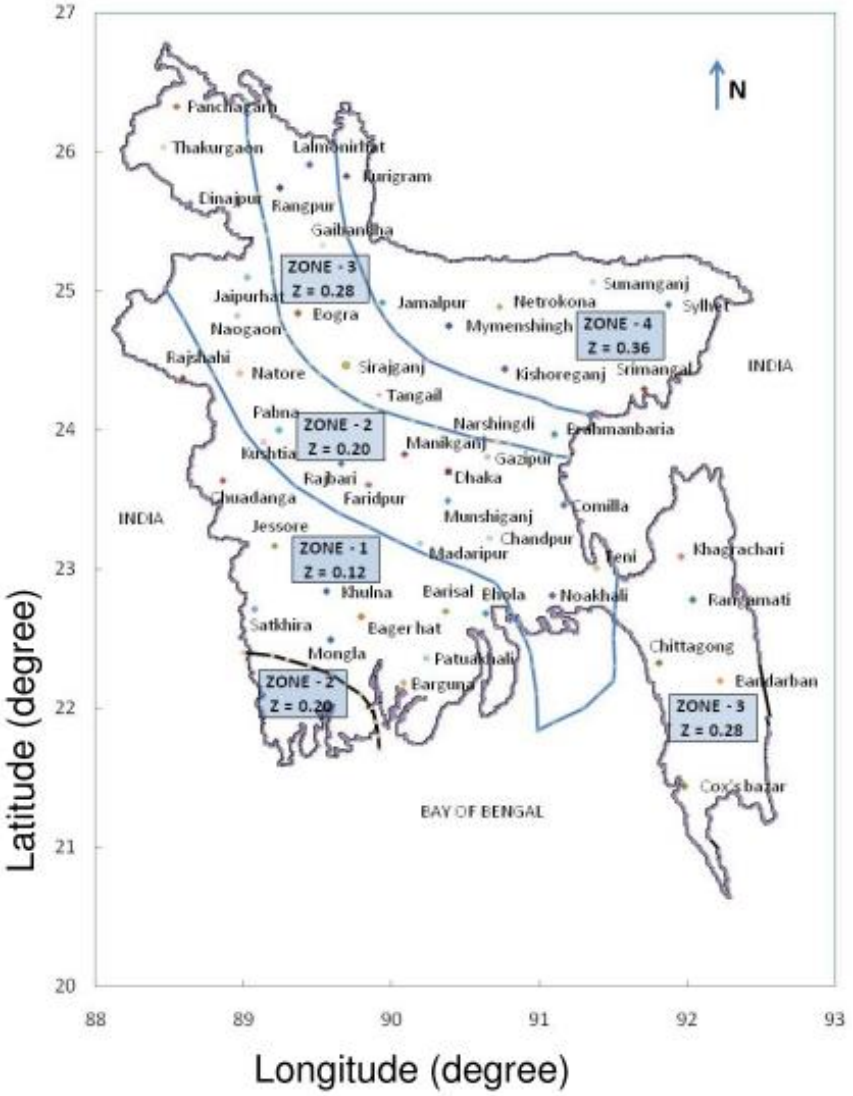


Figure 5 Proposed seismic zoning map for Bangladesh based on a return period of 2475 years

Savar factory building (Rana Plaza)

collapse on 24 April

An early damage assessment (still unpublished) by NGO Asian Disaster Preparedness Centre (ADPC) conducted on the day of the collapse revealed how a building intended for retail merchants was being used for industrial purposes.

It housed five garment factories that employed at least 3,000 workers and placed weight on the floors (including four huge electrical generators on the third and fourth floors) almost six times greater than the building was intended to bear.

Support columns were erected haphazardly. Building materials and methods were below par.

BEGUN BARI _ June 1, 2010

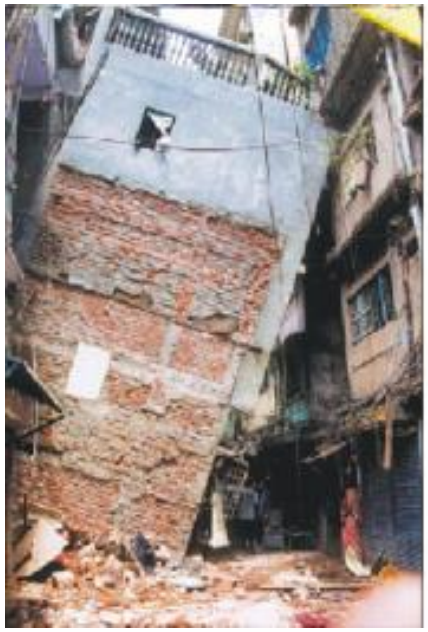
A five-storey building toppled onto three tin-shed houses in Begunbari area at night on 1 June, resulting death to 23 people.

NIMTOLI_3 June 2010

The flames that gutted eight buildings and over 20 shops and Killed 120 people at Nawab Katra of Nimtoli.

PHOENIX GARMENTS_25 Feb 2006

On 25 February 2006 at about 11 hours this 5 storied building complex collapsed living 21 dead and several injured. The building that housed the factory of Phoenix Fabrics a year ago was being converted into a 500-bed hospital. There were also showrooms of Phoenix Fabrics and Phoenix Electronics on the ground and first floors and a number of tin-shed rooms on the rooftop. Experts blamed faulty and unplanned construction for the collapse.



SHANKHARI BAZAR
(Building Collapse)
10 June 2004

11 people were killed in a predawn collapse of a six-storey building built on 200-year-old three-storey foundations at Shankhari Bazar in Old Dhaka on 10 June 2004. The building, was among the 32 structures, built without designs, in Shankhari Bazar that Rajuk marked as highly vulnerable.

Major historical EQs in and around Bangladesh

Date	Name	Epicenter	Magnitude	Comment
11th October 1737	Kolkata	22.60N, 88.40E,	X (in MM) >7 M	India's deadliest earthquake.
January10, 1869	Kachar	Jaintia Hills 25.00 N , 93.00 E	7.5 Depth 50 km.	Sylhet Town. area of 650,000 square miles.
July 14, 1885	The Bengal Earthquake	Bogra Fault 24.00 N, 90.00 E	7.0	damage within a 100 km radius of the epicenter. an area of 6,00,000 square kilometers.
June 12, **1897**	The Great Indian Earthquake	Shillong Plateau 26.00N, 91.00E	8.7	Dhaka-Kolkata.
July 8, 1918	Mymensingh	24.50 N, 91.00 E	7.4 12 -14 km	damage in a 100-kilometer radius of the epicenter
July 3, 1934	Dhubri	24.50 N, 91.00 E	7.1	Rangpur experienced severe tremor
January15, 1934	Bihar-Nepal	Darbhanga 26.50N, 86.50E	8.3	the Ganges Basin;
August 15, 1950	Assam	Arunachal Pradesh	8.5	Felt throughout Bangladesh
23rd October 1943	Dergaon Assam	26.80 N , 94.00 E	7.05	Felt throughout Bangladesh

Major historical EQs in and around Bangladesh

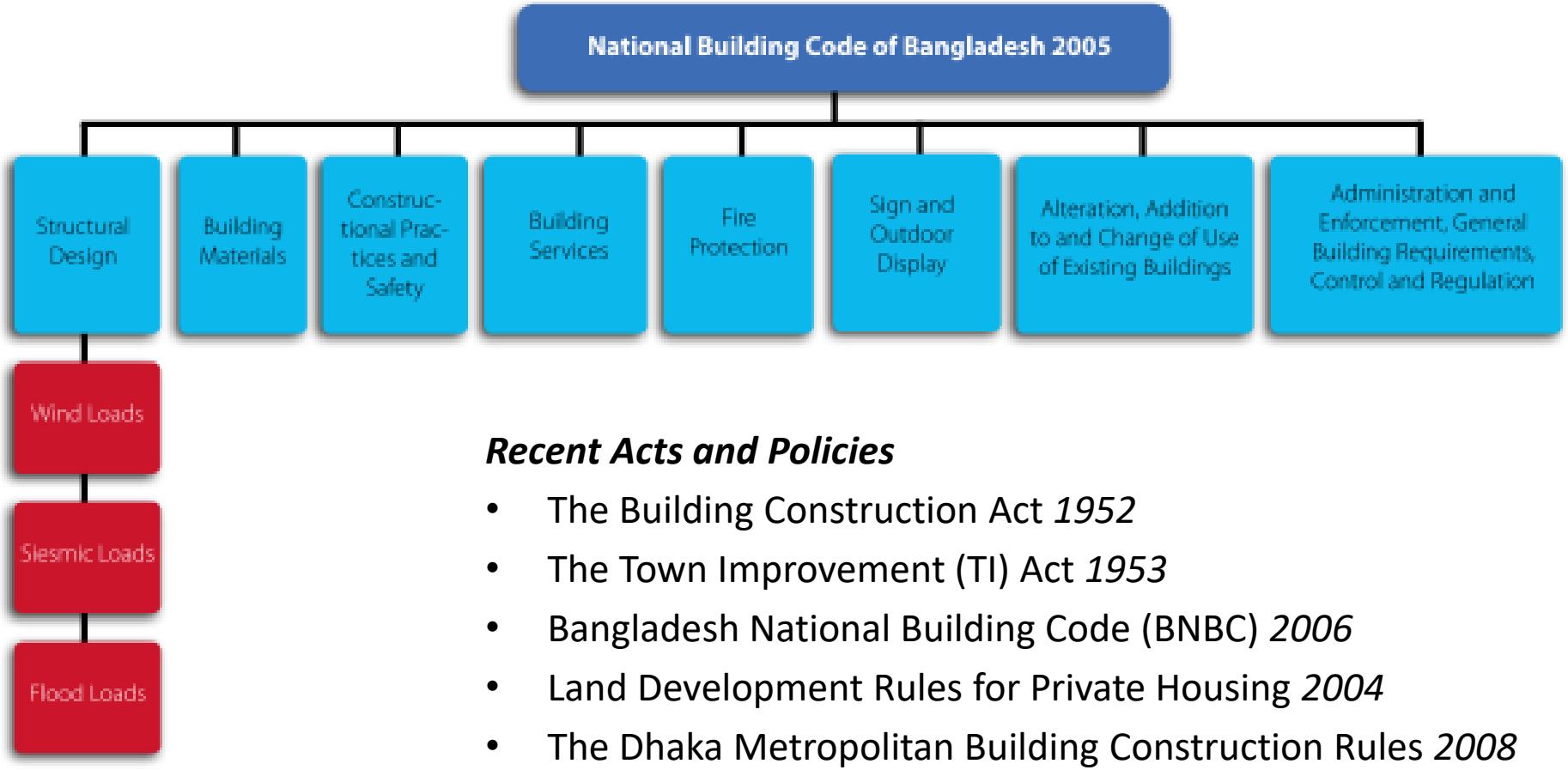
Date	Name	Epicenter	Magnitude	Comment
May 8, 1997	Indo-Bangla border	Lat 24.89 Long 92.25 34 km depth	6 Mb	Felt from Chittagong to Rangpur, also in Sylhet and Meghalaya, India.
November 21, 1997	Chittagong Indo-Bangladesh Border	Lat 22.21 Long 92.83 57 km depth	6 Mb	felt throughout Bangladesh
July 22, 1999	Moheshkhali Island	Lat 21.47 Long 91.90; depth10 km	5.2 Mb	
31st December 1999	Indo-Bangladesh Border Region	21.43N, 91.76E Near Sonadia	Mb - 4.3	triggered a tidal surge that reached heights of 4 feet.
4th January 2000	Bungtlang (Tripura), India	Epicenter: 22.13N, 92.77E	Mb - 4.6	Southern Bangladesh epicenters about 150 km from Chittagong.
19th December 2001	Kaliakoir, Dhaka	23.70 N 90.40 E (IMD)	M 4.2 IMD	Strong tremors (MM V-VI) in Dhaka City,
20th June 2002	Rajshahi	25.80N 88.86E (NEIC)	ML 4.6	Shook buildings for 39 seconds in Bogra and Syedpur.
25th March 2003	Bhutan	27.260N 89.240E (NEIC)	M 5.1	Though the epicenter was in Bhutan
27th July 2003	Barkal-Rangamati	22.85 N 92.31 E Depth–10 km	M 5.6	

Bangladesh National Building Code *(BNBC-1993)*

- The BNBC was published in 1993, but only adopted under the Building Construction Act in 2006.
  - It was developed by the Public Works Department under the Ministry of Housing and Public Works.
  - The Code specifies minimum standards for design, construction, quality of materials, use and occupancy, location and maintenance of buildings

- Consulting firm ***Development Design Consultants (DDC)*** engaged ***Bangladesh University of Engineering and Technology (BUET)*** on behalf of ***House Building Research Institute (HBRI)***

- In December 2009 the ***HBRI*** involved leading experts from ***BRTC, BUET*** and outside to update the code and act within a year and make it available to all
  - A team of 33 experts from BUET and others are gathered for updating the code and the team of BRTC, BUET has submitted the Inception Report in Feb 2010
  - Draft seismic design provisions of the building code have been submitted in Dec 2010



Recent Acts and Policies

- The Building Construction Act *1952*
- The Town Improvement (TI) Act *1953*
- Bangladesh National Building Code (BNBC) *2006*
- Land Development Rules for Private Housing *2004*
- The Dhaka Metropolitan Building Construction Rules *2008*

Highlights:

Integration of Environmental Sustainability

Integration of Disaster Resilience

Figure 1: *Structure of Bangladesh Building Code.*

Environmental Sustainability

Environmental Sustainability	USA	Singapore	Australia	UK	Thai-land	India	Bangla-desh	Philip-pines	Sri Lanka
Material Conservation & Resource Efficiency	●	●	●	●	●	●	●	●	●
Energy Conservation & Efficiency	●	●	●	●	●	●	updating	voluntary	updating
Water Conservation	●	●	●	●	●	●	updating	●	●
Land and Soil Conservation	●	●	●	●	●	●	●	●	●
Solid Waste Reduction	●	●	●	●	●	●	●	●	●
Air Pollution Control	●	●	●	●	●	●	●	●	●

Figure 2: *Integration of Environmental Sustainability in Building Codes and Regulations. Green means integrated, red means not integrated.*

Disaster Resilience

Disaster Resilience	USA	Singapore	Australia	UK	Thai-land	India	Bangla-desh	Philip-pines	Sri Lanka
Wind Load	●	●	●	●	●	●	●	●	voluntary
Snow Load	●	N/A	●	●	N/A	●	N/A	N/A	N/A
Seismic Load	●	N/A	●	N/A	●	●	●	●	N/A
Rain & Flood	●	N/A	●	●	●	●	updating	●	●
Wildfire and Bushfire Resistance	●	●	●	N/A	●	●	●	●	N/A
Landslide Resistance	●	●	●	●	●	●	●	●	●

Figure 3: *Integration of Disaster Resilience in the Building Codes and Regulations. Green means integrated, red means not integrated, N/A means could not be verified or not applicable.*

Building Codes Formulation

- Building Rules in Bangladesh are included in a proper building code issued under scattered laws over various ministries and are therefore less coherent

- Need for performance-based building code,
  - Only states the minimum or maximum values a building design has to live up to,
  - Decisions left up to the owner, developer and/or designer to decide how to meet compliance requirements
  - Allow for more flexibility and innovations
  - Difficult to enforce as it requires a lot of capacity from architects, engineers and local government staff to make and check such computations.

Challenges in Bangladesh Capital Projects

- Unenforced building codes and faulty construction
- Poor land use
- Lack of capacity and awareness
- Lack of clear planning authority and accountability
- Lack of coordination between stakeholders
  - *There is a need to involve develop partners to implement DAP. These partners are DCC, NHA, HBRI, PWD, UDD, LGED to start with.*
- Failure to act on existing updated GIS building stock data for Seismic identification and disaster mitigation
- Corruption in government oversight
- Quality of Low professional standards
- Capital Project Creep during Construction
  - While the building code is usually followed in the design phase, it is often violated during construction

Building Code Enforcement

Success factors

- **Simplicity** in code design – establishing one regulatory body to coordinate enforcement
- Attack the issues from all sides – **build strong linkages** between policy-making, building industry and academia
- Raise awareness – invest in **capacity building** and **community awareness** orientation programs
- **Transfer responsibility** to the private sector – training programs for professionals, contractors and masons
- **Provide incentives**
  - Offer special housing loans
  - Relax zoning restrictions
  - Offer tax breaks

Recent National Initiatives

- Earthquake preparedness including purchasing of rescue gears and retrofitting the old public buildings
  - service installations like hospitals and fire stations retrofit (tremor resistant) to ensure efficient rescue operations
  - The Public Works Department (PWD) and Japan International Cooperation Agency (JICA) have already been working in this regard
- JICA is aiming to improve the technical capacity on the building construction mechanism and retrofitting techniques for the engineers in various government agencies such as PWD, RAJUK, City Corporation.
  - JICA is gradually providing retrofitting training in line with building code to 1200 engineers of PWD and other engineering agencies including those in the private sector
  - The training program conducted under the JICA Technical cooperation project "Capacity Development on Natural Disaster Resistant Techniques of Construction and Retrofitting for Public Buildings (CNCRP)" for improving the technical capacity of the Government engineers on seismic assessment, retrofit design and construction of RC buildings.
- Form a separate authority for strong monitoring on implementation of Bangladesh National Building Code (BNBC)

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

AIT Asian Institute of Technology

Recommendations

1. There should be different types and levels of **sophistication in codes** depending on **design guidelines** specifying which environmental codes to use, instead of trying to integrate all environmental aspects into one general building code

2. Compliance manuals, Building codes, forms and software should be **readily available and affordable**

3. To improve relevance of building codes to the local situation, more **lab testing facilities** should be created

4. Organizations to support local governments to enforce building codes should be set up at the national level – such as an **Institutional framework** with well-defined authority, responsibility and well-trained officials.

5. Enforcement strategies should be adapted to the local context - combination of **incentive and penalty mechanisms**

6. Effective **education and information distribution systems** – with **transparent monitoring and verification systems**

Six Pillars of Earthquake Risk Mitigation in India

1. Ensure the **incorporation of earthquake-resistant design features** for the construction of new structures.

2. **Facilitate selective strengthening and seismic retrofitting** of existing priority and lifeline structures in earthquake-prone areas.

3. **Improve the compliance regime** through appropriate regulation and enforcement.

4. **Improve the awareness and preparedness** of all stakeholders.

5. **Introduce appropriate capacity development interventions** for effective earthquake management (including education training, R&D, and documentation).

6. **Strengthen the emergency response capability** in earthquake-prone areas.

Earthquake Risk Mitigation Strategies in India

- **Review of building bye-laws** and their adoption
- **Revision of codes**
- **Hazard safety cells** in states
- **Capacity building** of engineers and architects in earthquake risk mitigation
- **Training** of masons
- **Earthquake engineering** in undergraduate engineering/architecture curricula
- **Hospital preparedness** and emergency health management in medical education
- **Retrofitting of lifeline buildings**
- Urban earthquake **vulnerability reduction program**
- Mainstreaming **mitigation in rural development schemes**

Best Practice Analytical Framework

Figure 1: *Analytical framework. The six elements of disaster resilience (orange) and the six elements of environmental sustainability (green) should ideally be integrated in the above manner. The elements in the boxes with dash lines are only integrated in the building codes of some reference countries and not in those of most target countries.*

SPACE
CONSULTANT LTD

CONNECT

Engr. Arif M. Khan
+880 17 5568 0801
opusakhan@gmail.com