WELCOME

Structural Analysis & Design I

Structural Analysis & Design I

Major Md. Soebur Rahman, PhD
(Civil & Structural)

(Behaviour and strength of Fully Encased Composite Columns)

Instructor Class B
Military Instituted of Science and Technology
soeburrahman@gmail.com
Office: Faculty Tower 1
Room: 715

Structural Analysis & Design I

- **Course Code: CE 311/ EWCE 311**

Course Name: Structural Analysis & Design I
Total credits: 4, Class: 4 hrs/week
EWCE : 3 credits, Class : 3hrs/week

Course Objectives

To analyze the statically determinate linear structural systems such as simple beams, cantilever beams, three hinged arches or frames, or compound structural systems and trusses subjected to dead and lateral load /or moving loads, to draw internal force diagrams and to calculate the displacements.

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Course Out line/Topics Covered

Stability and determinacy of structures; analysis of statically determinate trusses and arches; influence lines; moving loads on beams, frames and truss; analysis of suspension bridge.

Wind and earthquake loads, approximate analysis of statically indeterminate structures: braced trusses, portal method, cantilever method and vertical load analysis of multi-storied building frame; deflection of beams, trusses and frames by energy method (strain energy, principle of virtual work, Castigliano's theorem).

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Outcomes of the Course

- **Learn how to analyze statically determinate and indeterminate structures.**
- **Learn how to determine lateral load on structure at different area in Bangladesh.**
- **Get knowledge on various types of structures and their behaviour.**
- **Axial load on a column from different stories**

Structural Analysis & Design I



Recommended Sources/Refs

1. **R.C. Hibbeler, "Structural Analysis", Prentice Hall 2011,(8 th Ed.)**
2. **C.H.Norris,J.B. Wilbur,İ.Utku, "Elementary Structural Analysis", Mc.Graw-Hill,1991.**
3. **T.C. Shedd and J. Vawter, "Theory of Simple Structures" Second Edition**
4. **Aslam Kassimali, "Structural Analysis", Fourth Edition**
5. **Bangladesh National Building Code(BNBC,1993/2020**

Course Assessment Policy

- **Class-tests/Assignment 35%**
- **Final exam 60%**
- **Attendance & Assessment 5%**

- **Total Four class test a mid term will be taken in this course.**

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- **Exam Notice**
  - **Informed**
  - **No excuse**
- **Code of Conduct**
  - **Maintain discipline**

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Lecture Schedule

- Earthquake and wind load (Cl 1- Cl 6) Ref BNBC 2020

  Assignment and test-1

- Approximate analysis of statically indeterminate structures (Cl 7 to Cl 15)

  Assignment and test-2

- Deflection of beams, trusses and frames by energy method (Cl 16 to Cl 26)
- **Assignment**
- Review (Cl 27 and Cl 28)

Final Exam

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How to Get good Grading in structure

- Be regular and follow the classes
- Clear idea about free body diagram
- Observe variables
  - Load (vertical/inclined/ horizontal)
  - Moment
- Observe boundary conditions (supports)
- Think in different way
- Practice regularly

Structural Analysis & Design I

- **Analysis: detail examination of the elements/data**

- **Design : It is the creation of a plan or convention for for the construction of an object**

Loads

- DL (Structural element, Partition wall, FF)
- LL (BNBC 2020, Ch-2)
- Lateral loads
  - Earthquake load (BNBC 2020, Ch-2)
  - Wind load (BNBC 2020, Ch-2)

Earthquake

An **earthquake** is a phenomenon during which **strong vibrations** occur in the **ground** due to **release** of huge **energy** within a **short period of time** causing **sudden disturbance** in the earth's crust on the upper mantle.

In other words it be defined as a sudden transient motion or series of motions of the ground originating in a limited region and spreading there in all direction during an earthquake, the ground motions cause structures to vibrate and induce inertial forces on them.

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Inside the Earth

- Inner Core
  (radius -1290 km)
- Outer Core
  (thickness -2200 km),
- Mantle
  (thickness -2900 km)
- Crust
  (thickness -5 to 40 km,.

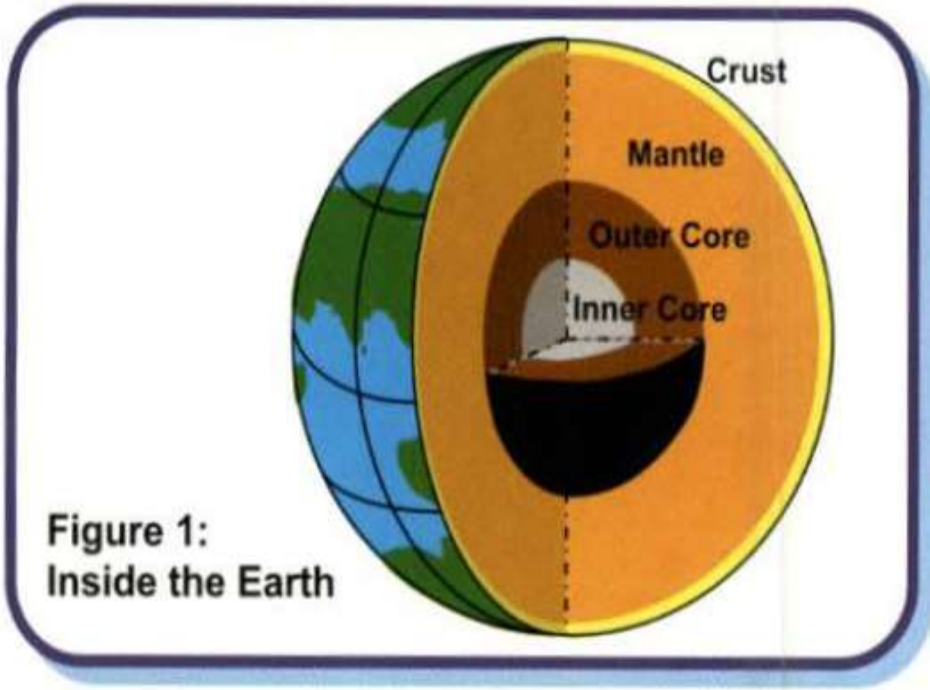
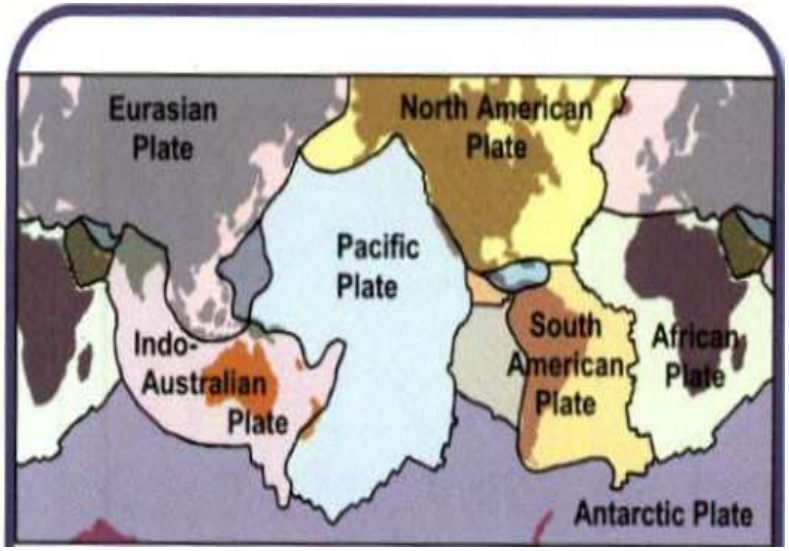


Figure 1:
Inside the Earth

Causes Earthquakes

- This sliding of Earth's mass takes place in pieces called Tectonic Plates.

- The surface of the Earth consists of seven major tectonic plates and many smaller ones



Major Tectonic Plates on the Earth's surface

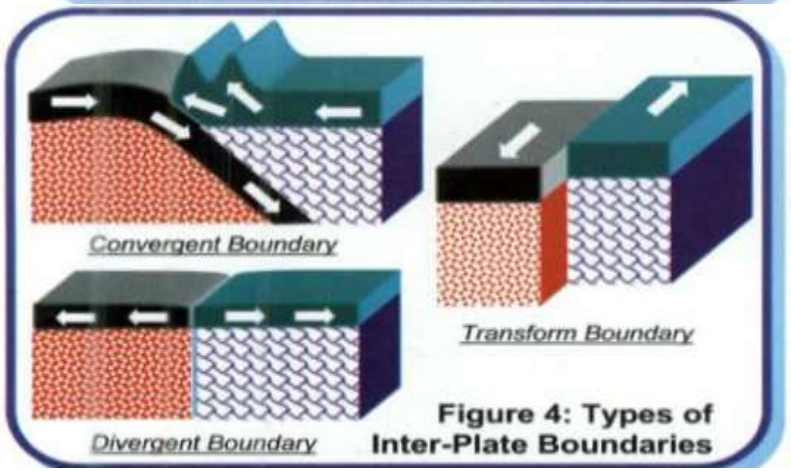


Figure 4: Types of Inter-Plate Boundaries

Requirement for structural Drawing

- Most earthquakes in the world occur along the boundaries of the tectonic plates and are called Inter-plate Earthquakes (1897 Assam (India) earthquake)

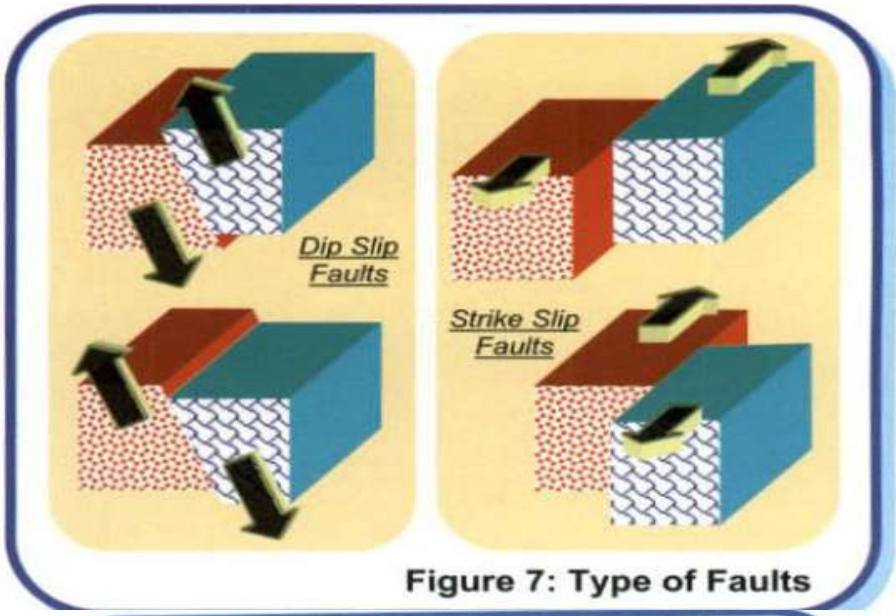
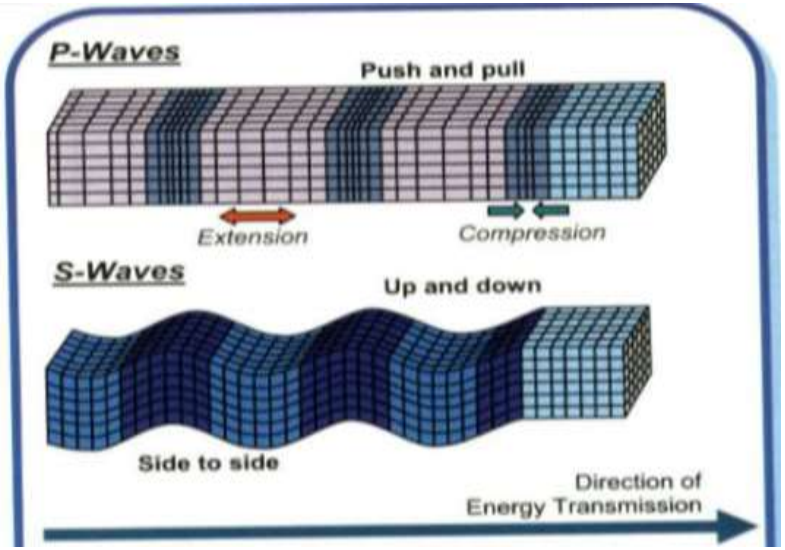


Figure 7: Type of Faults



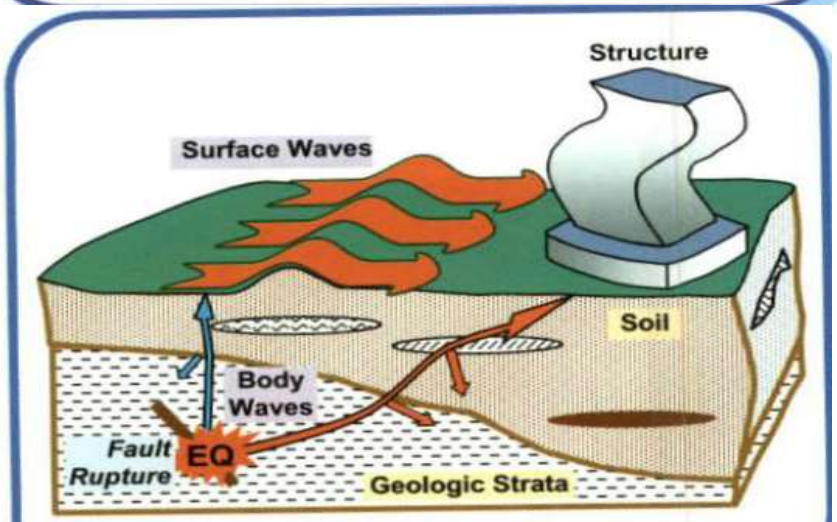


Figure 1: Arrival of Seismic Waves at a Site

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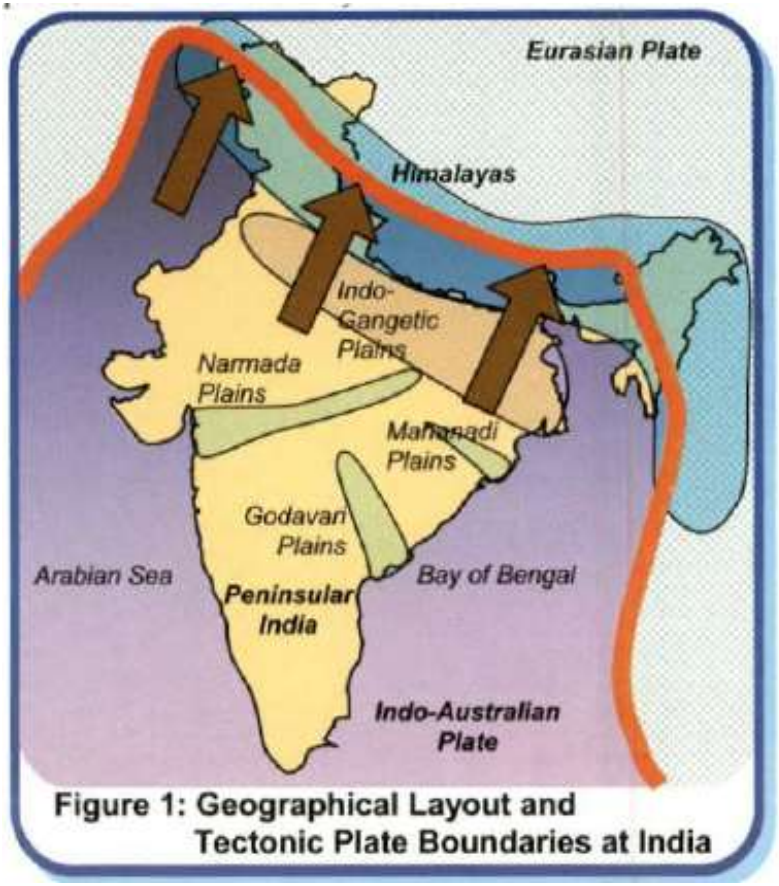


Figure 1: Geographical Layout and Tectonic Plate Boundaries at India

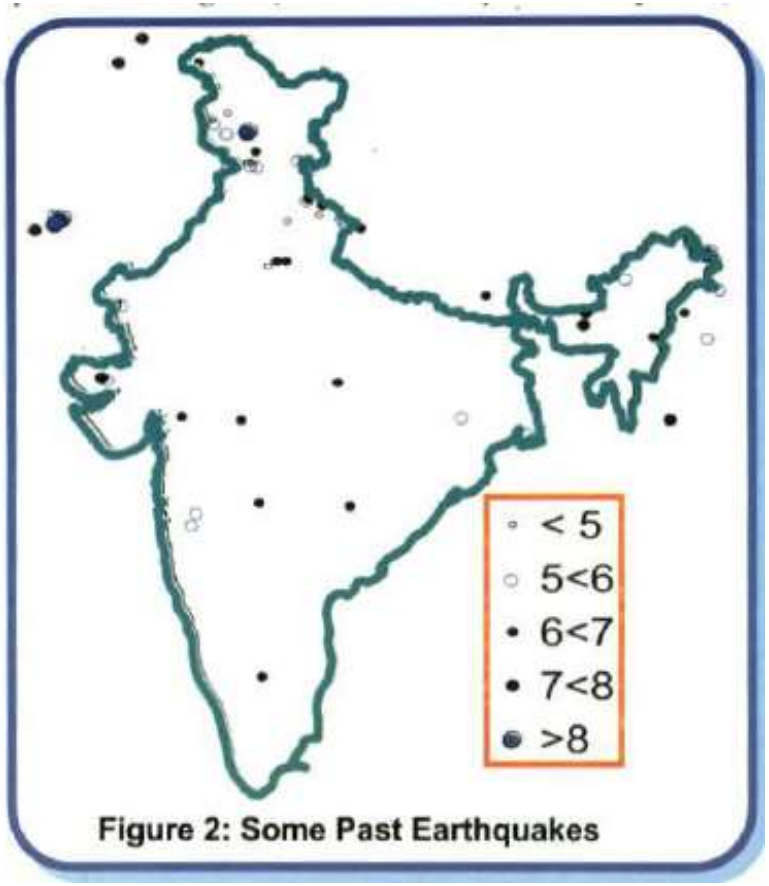


Figure 2: Some Past Earthquakes

Requirement for structural Drawing

- **Magnitude of an earthquake is a measure of its size.**

- **Intensity is an indicator of the severity of shaking generated at a given location**

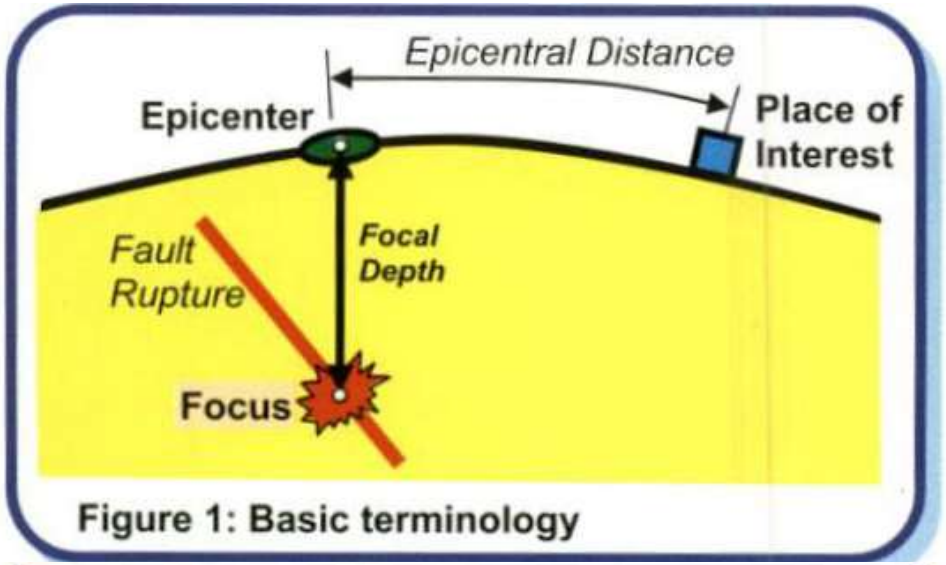


Figure 1: Basic terminology

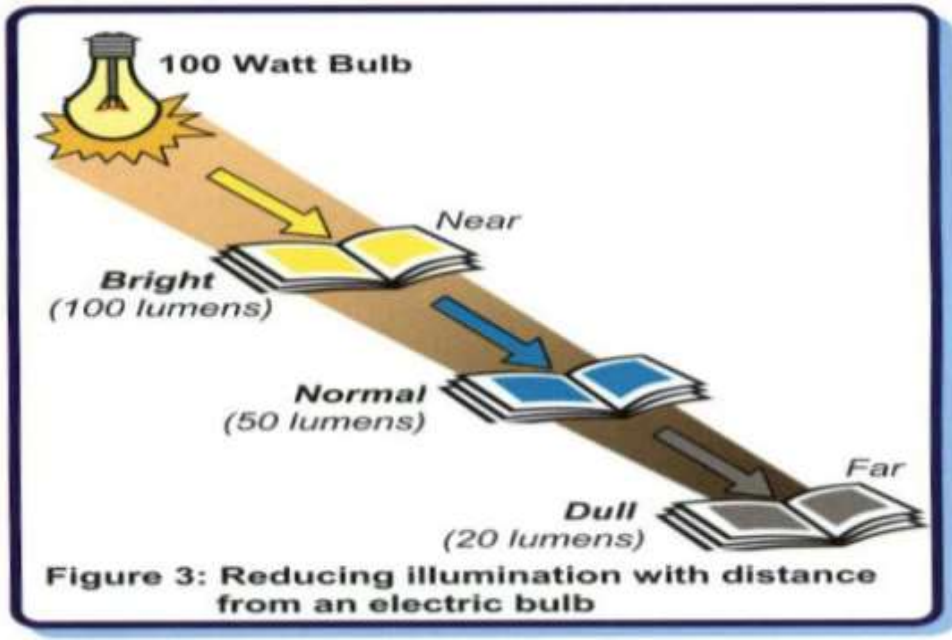


Figure 3: Reducing illumination with distance from an electric bulb

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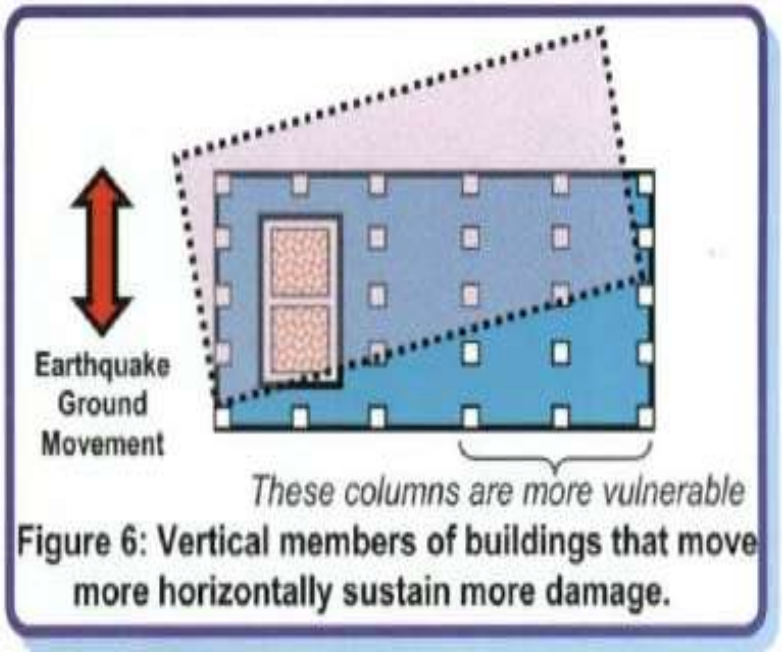


Figure 6: Vertical members of buildings that move more horizontally sustain more damage.

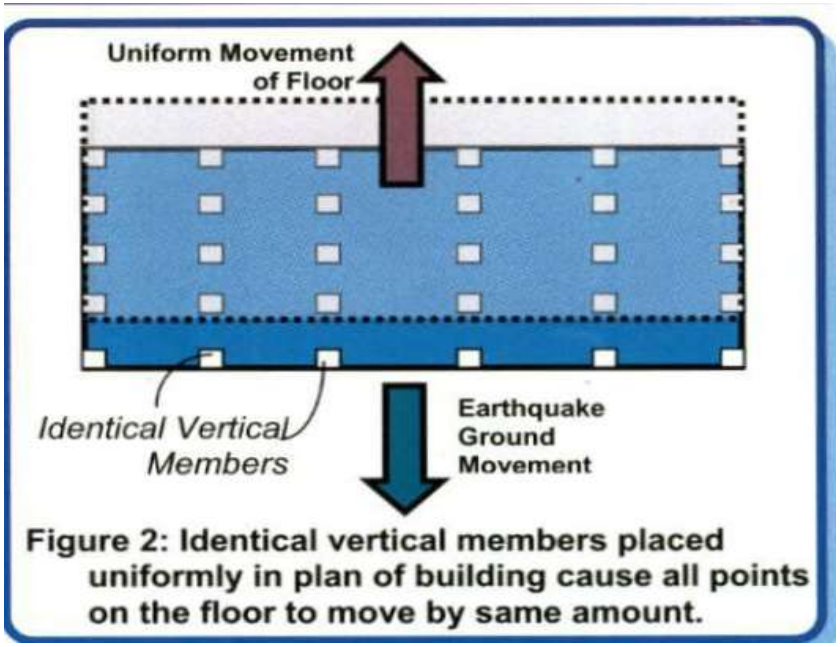


Figure 2: Identical vertical members placed uniformly in plan of building cause all points on the floor to move by same amount.

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- **Structural configurations (BNBC 2015, Ch-1, page 6-9)**
  - **Regular structure**
  - **Irregular structure**
    - **Vertical**
    - **Plan**

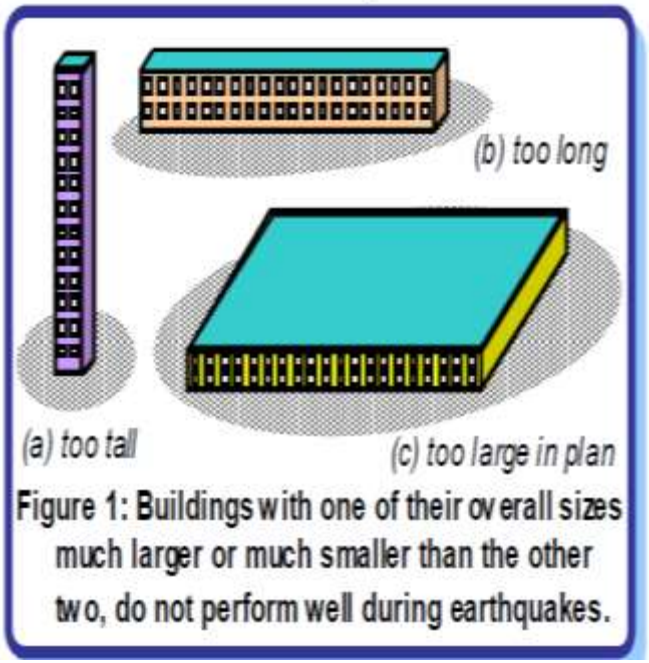


Figure 1: Buildings with one of their overall sizes much larger or much smaller than the other two, do not perform well during earthquakes.

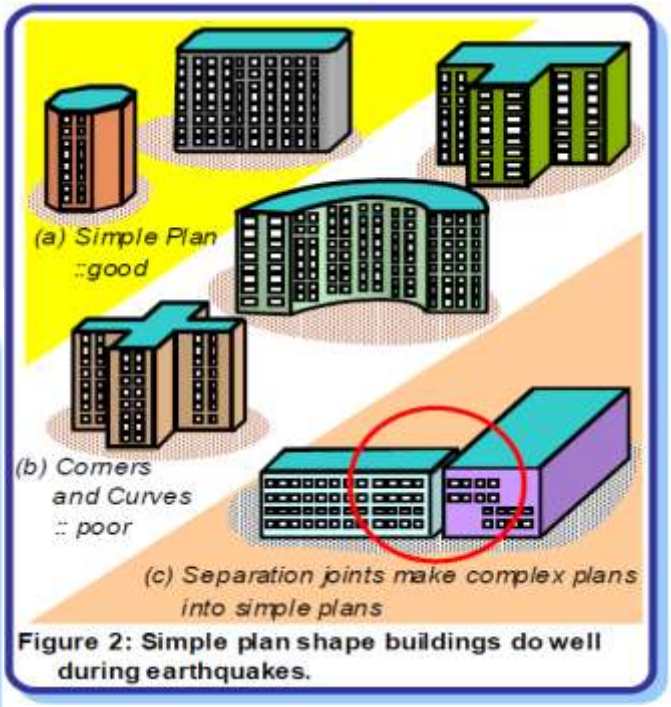
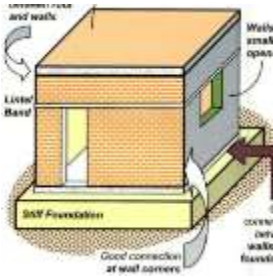


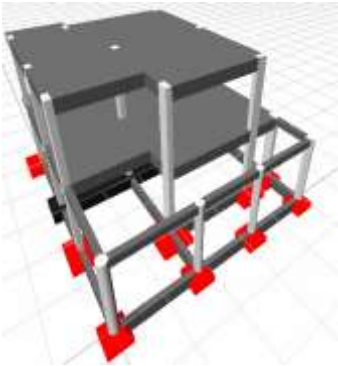
Figure 2: Simple plan shape buildings do well during earthquakes.

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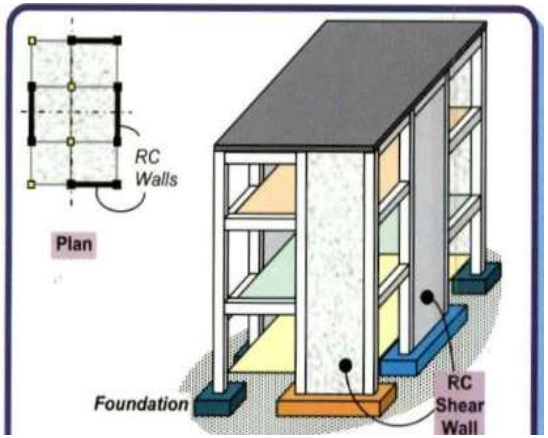
➢ Structural analysis



- Select structural system (BNBC-2015,ch-1, page 6-7)
  - Bearing wall
  - Building frame
  - Moment resisting frame (no shear wall)
  - Dual system



- Moment resisting frame
  - SMRF, IMRF, OMRF



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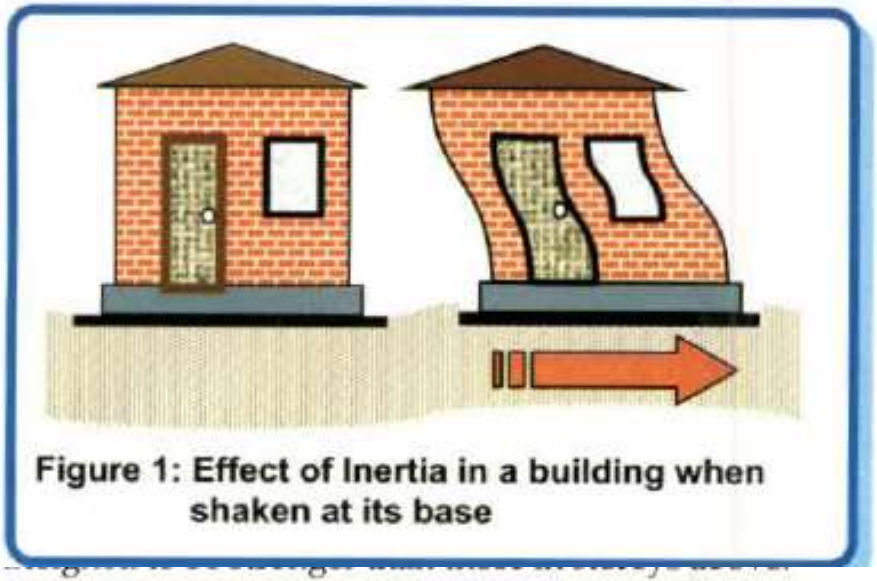
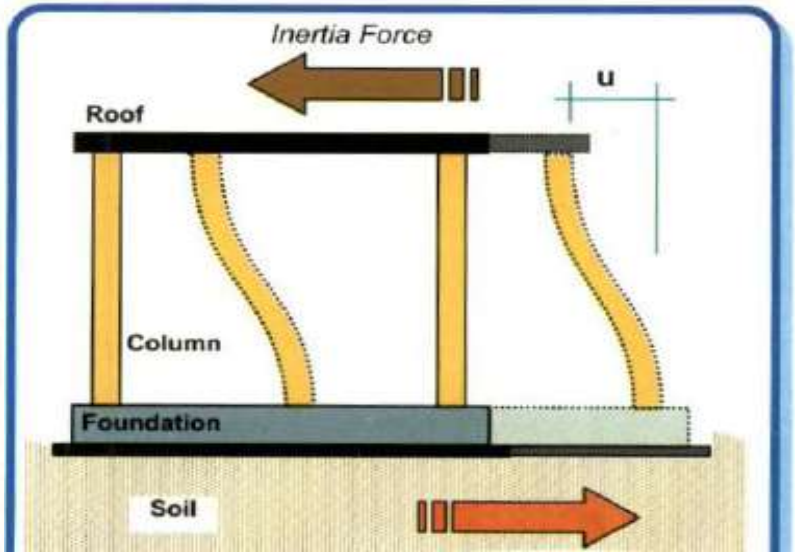


Figure 1: Effect of Inertia in a building when shaken at its base



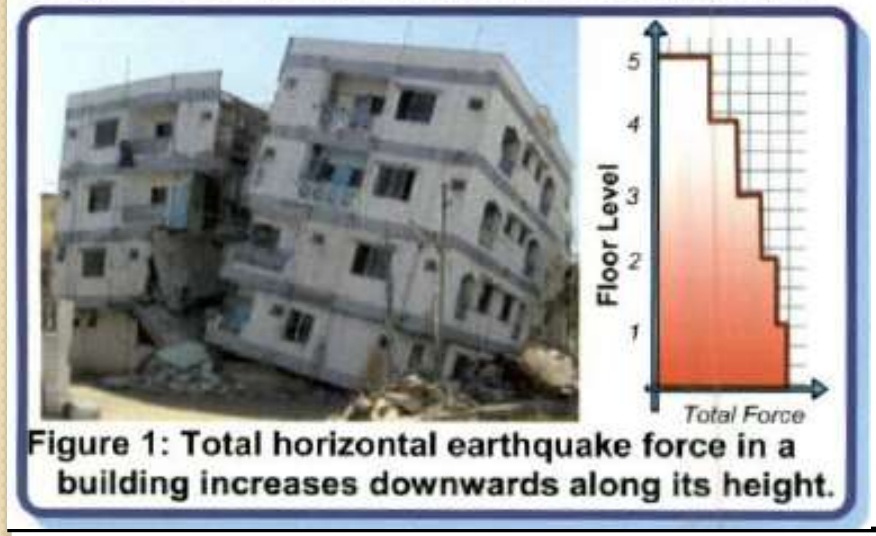


Figure 1: Total horizontal earthquake force in a building increases downwards along its height.

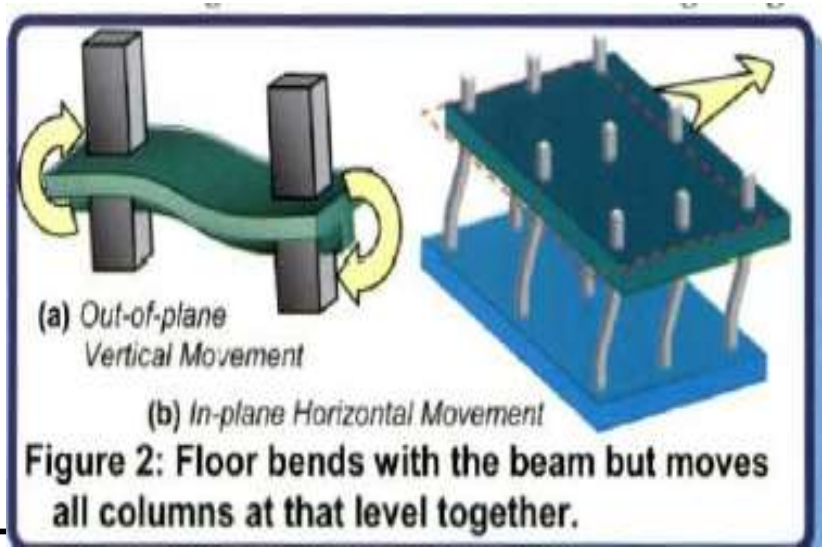
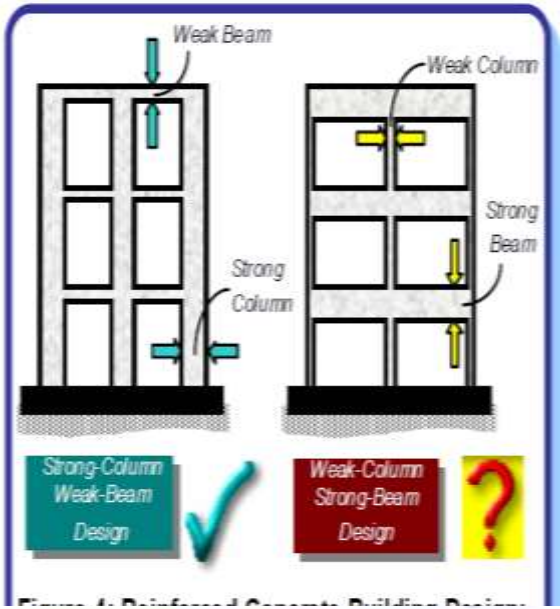


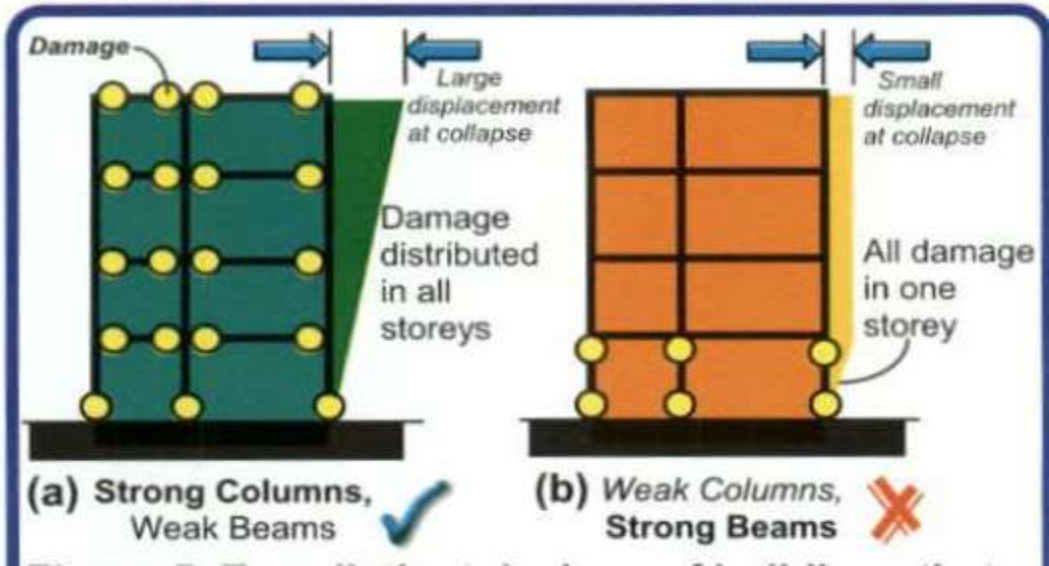
Figure 2: Floor bends with the beam but moves all columns at that level together.

Structural Analysis & Design I

- **Design Philosophy**
  - **Strong Columns week beam**

- **Earthquake Philosophy**
  - **Earthquake proof buildings**
  - **Earthquake resistance**





Structural Analysis & Design I

Seismic Design Methods:

- **Equivalent static force method**
- **Dynamic response method**
  - **Ground motion method**
  - **Response spectrum method**
  - **Time history analysis**