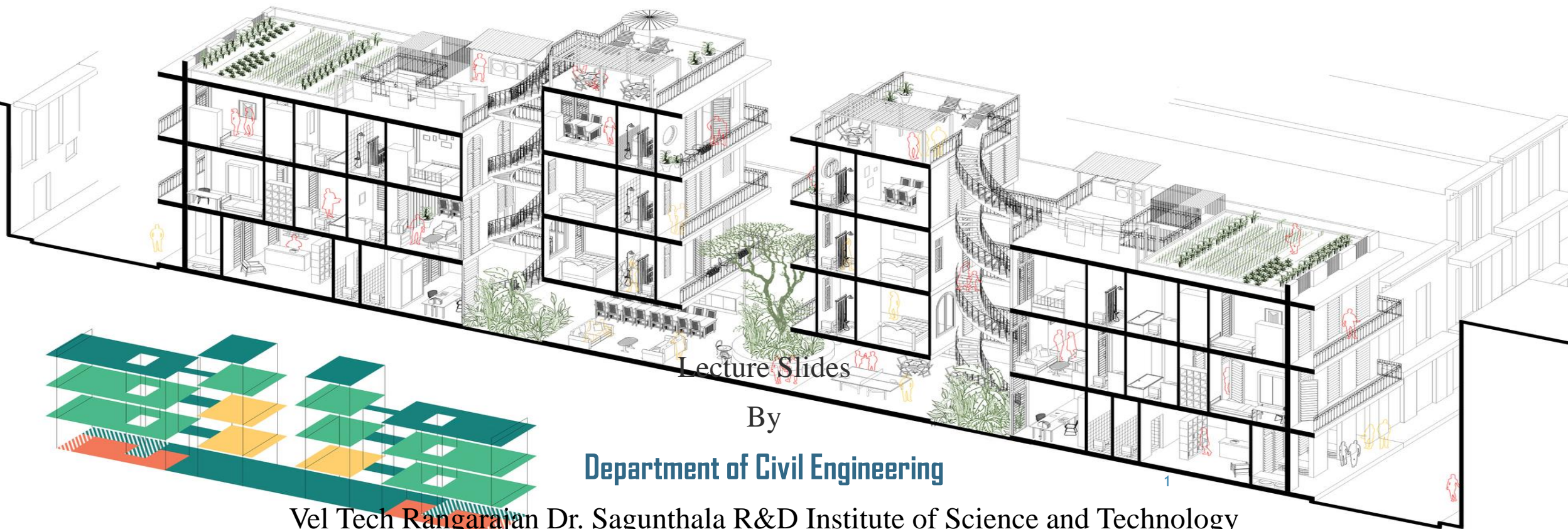




Basic Civil Engineering

(Subject Code: 1150CE101)



Lecture Slides

By

Department of Civil Engineering

Syllabus

UNIT I: Building Materials

Introduction – Civil Engineering – Materials – Bricks – Composition – Classifications – Properties – Uses – Stone – Classification of Rocks – Quarrying – Dressing – Properties – Uses – Timber – Properties – Uses – Plywood – Cement – Grades – Types – Properties – Uses – Steel – Types – Mild Steel – Medium Steel – Hard Steel – Properties – Uses – Market Forms – Concrete – Grade designation – Properties – Uses – Advancements in Concrete – Pre-stressed Concrete – Pre fabricated concrete.

UNIT II: Building Components

Building – Selection of site – Classification – Components – Foundations – Functions – Classifications – Bearing Capacity – Flooring – Requirements – Selection – Types – Cement concrete marble – Terrazzo floorings – Roof – Types and requirements.

UNIT III: Planning Aspects and Regulations

Building types and design criteria – Space standards for residential, commercial and institutional categories – Building by-laws applicable for approval by the local governing body – Development control rules for Chennai Metropolitan Area. Basic guidelines for earthquake resistant structures.

UNIT IV: Water Supply and Sanitary Systems

Water supply – Objectives – Quantity/Quality of water – Sources – Standards of drinking water – Distribution system – Sewage – Classification – Technical terms – Septic tank – Components and functions – layout of external services – water supply – Sewage disposal – water supply and plumbing layout for a residential building.

UNIT V: Surveying and Transportation

Surveying – Objectives – Classification – Principles of Survey – Transportation – Classification – Cross section and components of road – Classification of roads – Railway – Cross section and components of permanent way – Functions – Water way – Docks and Harbors – Classification - Components – Bridges – Components of bridges.

Unit III: Planning Aspects and Regulations

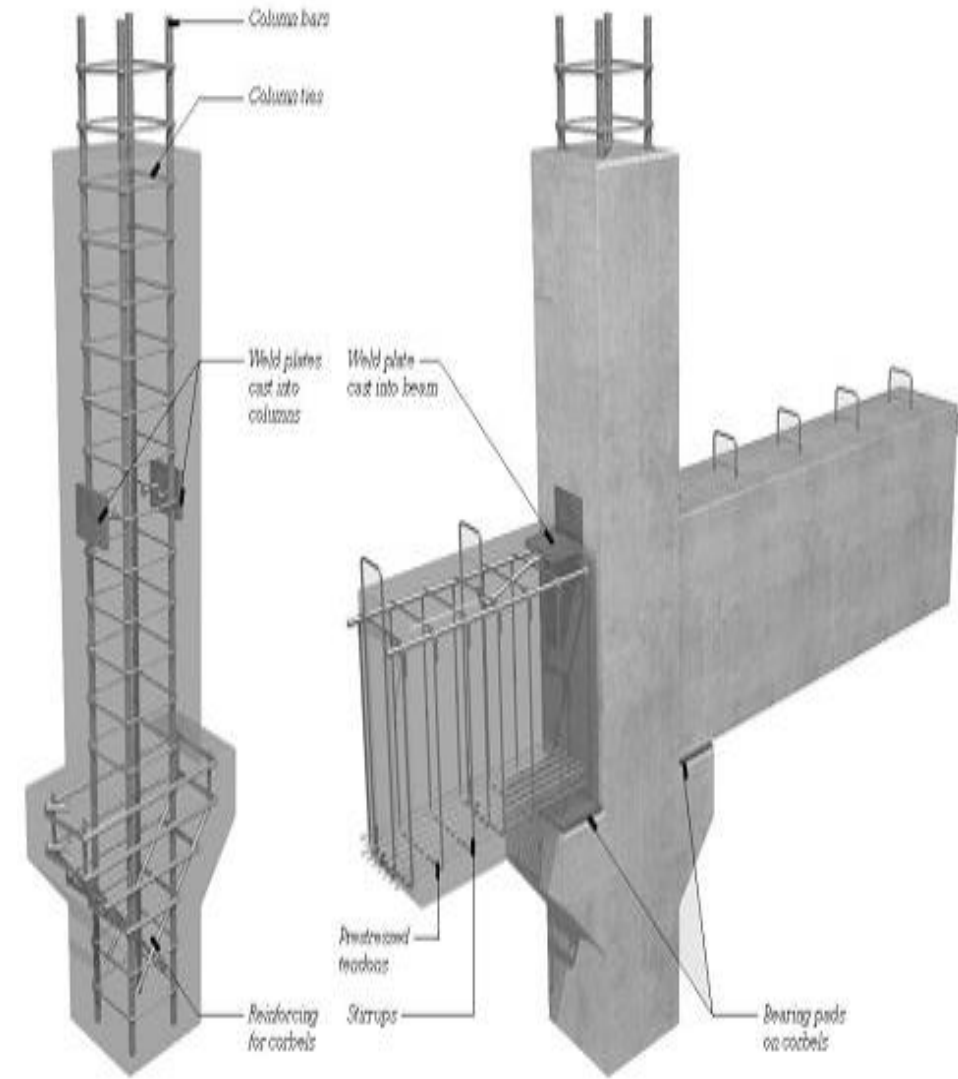
Building types and design criteria – Space standards for residential, commercial and institutional categories – Building by-laws applicable for approval by the local governing body – Development control rules for Chennai Metropolitan Area. Basic guidelines for earthquake resistant structures.

Building Types



Based on the material of the construction, types of the building are:

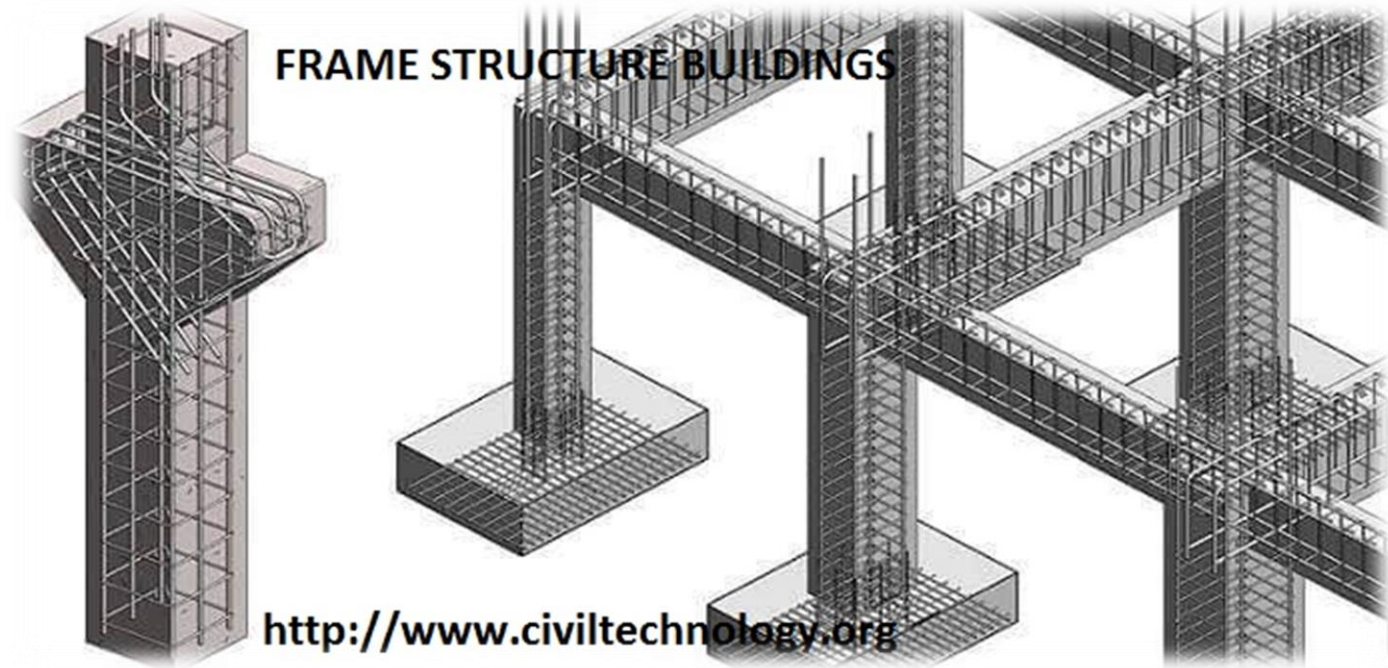
- (i) Reinforced Cement Concrete structure
- (ii) Steel Structure
- (iii) Composite Structure



Building Types

RCC Structure:

- Made up of Reinforced Cement Concrete structure. And at some places PCC (Plain Cement Concrete) also used to build up the components
- RCC is being the most preferred type for the construction of residential, commercial and industrial buildings.
- IS 456: 2000 is referred for the design of RCC structure.



Building Types

Steel Structure:

- Made up of steel sections. Preferably with I, T and Channel sections.
- Joints would be made with Bolt & Nut connections (or) with welded connections.
- IS 800 – 2007 is referred for the design of steel structures.



Building Types

Composite Structure:

- Made up of both RCC components along with steel sections.
- Preferably chosen for high rise buildings for lateral stability.
- IS 11384 – 1985 is referred for the design of composite structures.



Design Criteria

Design Criteria:

Design criteria of a building is meant by the structural requirements of various building components (Columns, Beams, Slabs, etc.) regarding various parameters such as loading, load transfer, failure and durability.

Design criteria are usually provided by IS Codes for various structural related design process.

Design of Buildings:

It is defined as the process of working out the required dimensions and specifications of any building component based on the design criteria.

Design Criteria

Significances / Importance / Necessity of Design Criteria:

- (i) All possible loads coming on to a building have to be identified so that to design a required adequate building components
- (ii) Based on the load transferring mechanism, components such as columns, beams, slabs have to be designed accordingly.
- (iii) By having checks at various stages of design process, we can adequately reduce the failure possibilities of building components.

Space Standards for Buildings

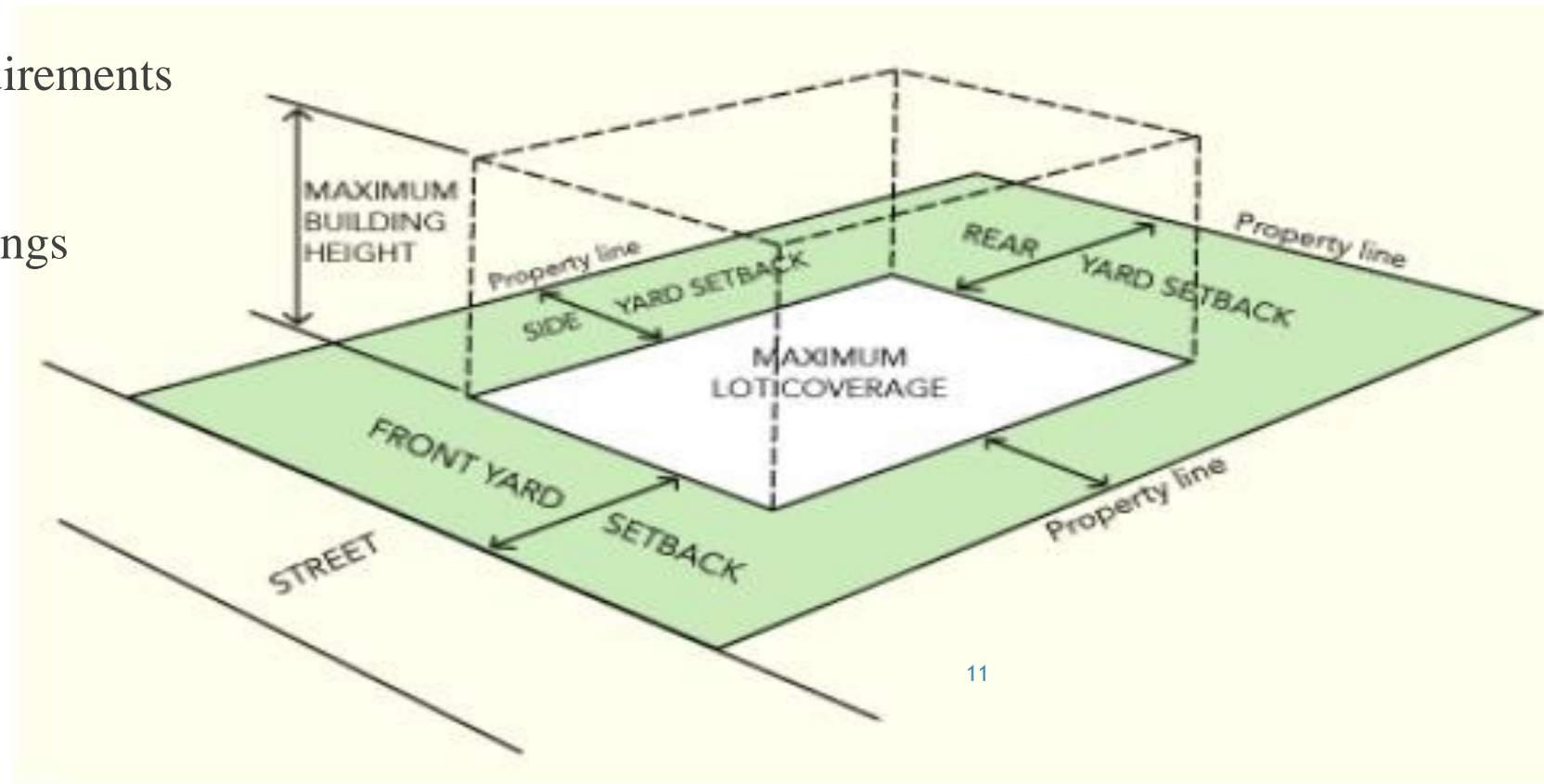
Important Terminologies:

- (i) Building Line: This is the line up to which the plinth of a building may lawfully extend within the plot on a street. No overhead projections are allowed beyond the building line.
- (ii) Building Setback: Minimum distance between any building or any structure from the boundary line of the plot.
- (iii) Frontage: Frontage means the width of the site abutting the access road.
- (iv) Height of building: It means the vertical distance measured from the average level of the surround ground to the highest point of the building. In case of flat roof.
- (v) High Rise Building: It means a building, which has a height of **24m** or more above the average ground level.
- (vi) Floor Area Ratio: It is the ratio of a building's total floor area to the size of the plot on which it is built.
- (vii) Carpet Area: It is the area enclosed within the walls, actual area to lay the carpet. This area does not include the thickness of the inner walls.
- (viii) Plinth Area (Built up area): It is the carpet area plus the thickness of outer walls and the balcony.

Space Standards for Buildings

Space standards for a building consists of following sub categories:

- (i) Common Plot Area
- (ii) Frontage
- (iii) Side & Rear open spaces
- (iv) Interior minimum space requirements
- (v) Parking spaces
- (vi) Lighting & Ventilation openings



Space Standards - Common Plot Area

Common Plot Area for Residential / Commercial / Institutional buildings:

- Open space or the purpose of entertainment shall have to be kept when the area of layout exceeds 0.3 hectors.
- Minimum area should not be less than:
 - 15% of the area of the layout
 - 0.3 to 0.4 hectare per 1000 persons
 - 0.3 hectare per 1000 persons for low income group housing

Common Plot Area for Industrial buildings:

- For industrial units having area more than 0.8 hectares, 5% area shall be reserved for amenities.
- For industries having area $> 1000 \text{ m}^2$, 10% area shall be reserved for amenities.

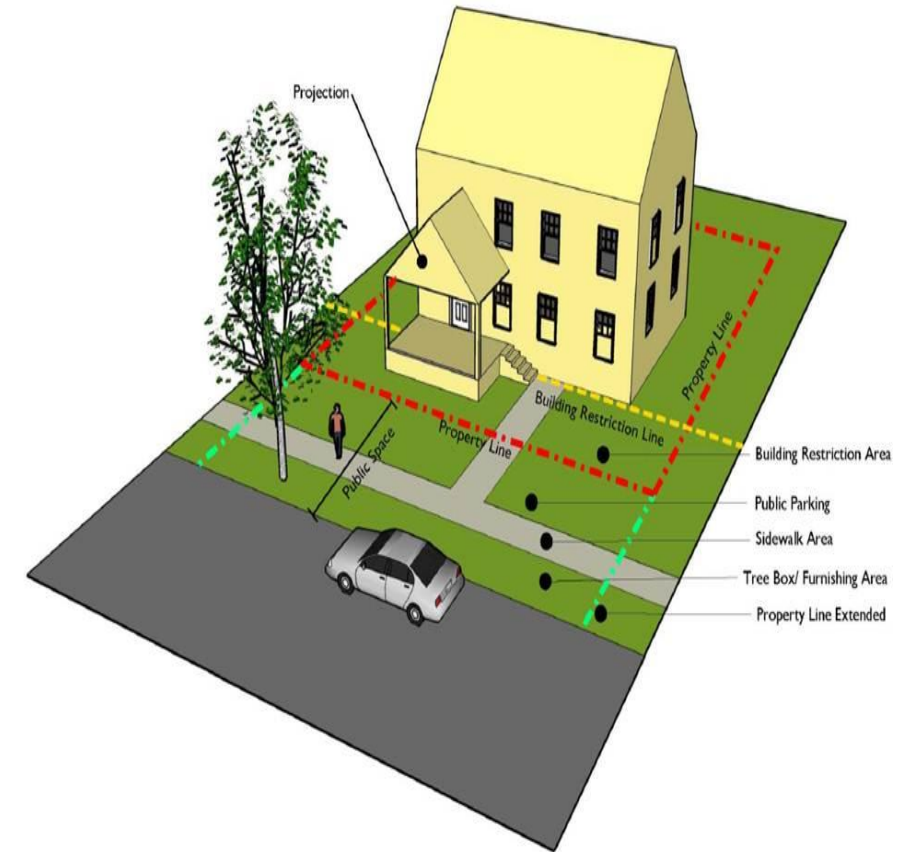
Space Standards - Frontage

For Residential Buildings:

Type of Residential Building	Plot Size (m ²)	Frontage (m)
Detached Building	Above 250	Above 12
Semi-Detached Building	125 – 250	8 – 12
Row type Building	50 - 125	4.5 - 8

For Institutional & Industrial Buildings:

Width of Proposed Road (m)	Frontage (m)
9m or less	3
9 – 12m	4.5
12 – 18m	6
18 – 30m	7.5
30 – 60m	9
More than 60m	12



Space Standards – Open Spaces

For Residential Buildings:

Height of the Building (m)	Left around building (m)
10	3
15	5
18	6
21	7
24	8
30	10
40	12
50	14
53 and Above	16

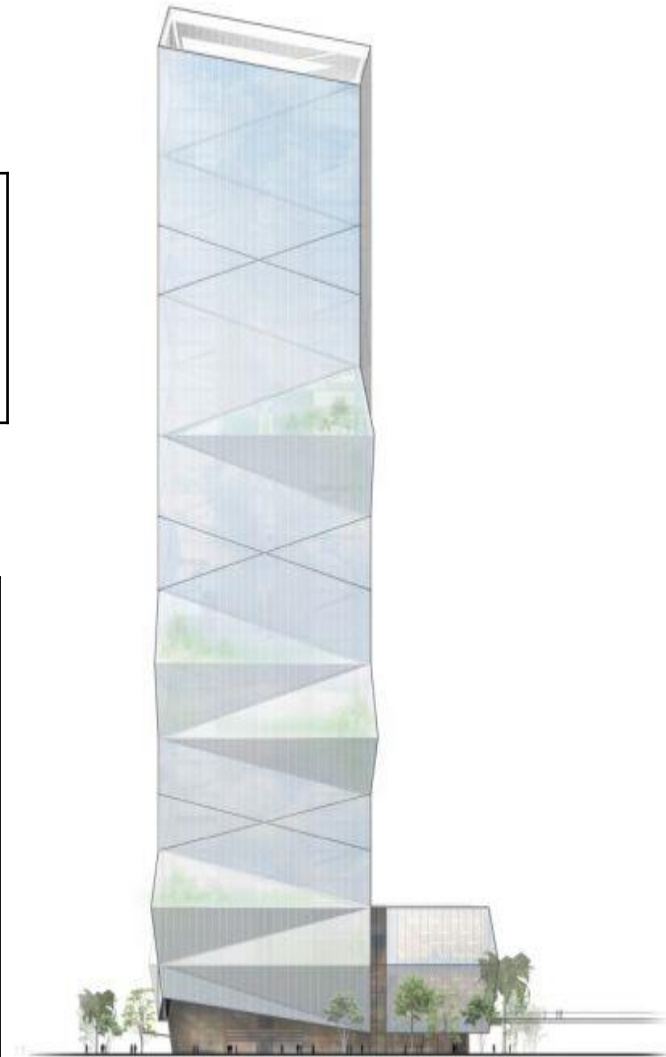
For Institutional & Industrial Buildings:

Maximum Side open space along perimeter of the plot:

- (i) For area up to 1000 m² --→ 6m
- (ii) For area > 1000 m² --→ 4.5m

For High Rise Buildings:

- (i) High rise building shall be permitted on roads having more than 12m width.
- (ii) Side Open space should be 6m (or) 0.2 x H of building, whichever is more.
- (iii) Road Side Open space should be 9m (or) 0.3 x H of building, whichever is more.



Space Standards – Interior Space Requirements

For Residential Buildings:

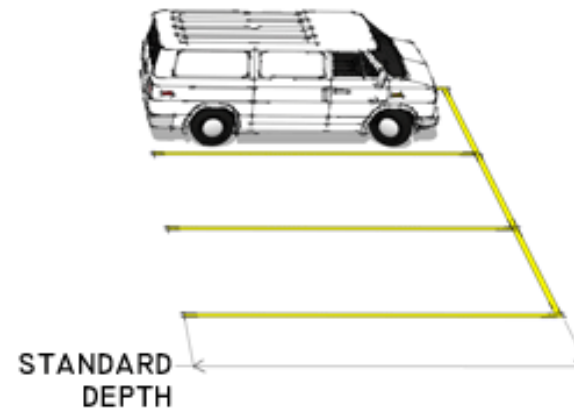
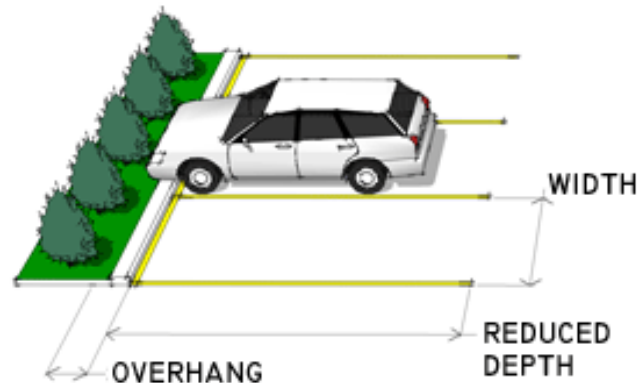
S.No	Name of Room	Minimum Size (m ²)
1	Habitable Room	9.5
2	Kitchen	5
3	Bath / Water Closets	1.8 / 1.1
4	Store Room	3
5	Garage	12.5
6	Staircase	15

For Institutional & Industrial Buildings:

S.No	Name of Building	Minimum Size (m ²)
1	Primary & High School	1000
2	Educational Institutions, Community hall, Marriage hall, Assembly hall, Cinema theatre	2000
3	Petrol Pump without service station	1000
4	Petrol Pump with service station	2000
5	Religious Places	500 (Built up area < 20% of plot area)
6	Industries ¹⁵	More than 300 (Width > 15m)

Space Standards – Parking Space

S.No	Building Type	Suggested Parking Area
1	Residential	15% of total built up area of all floor
2	Cinema & Assembly hall	1m ² per seat
3	Shops, Offices, Institutes, Hospitals	30% of total built up area of all floor
4	Community hall, recreation club, party plot	50% of area
5	Colleges	70m ² per 100 students
	Secondary & Higher secondary schools	50m ² per 100 students
	Primary Schools	20m ² per 100 students
6	Grain, Timber, Agriculture, whole sale markets	30% of total built up area of all floor



Space Standards – Lighting & Ventilation

Door Openings are not counted in the lighting and ventilation of a building. Hence, the minimum area for opening shall not be less than:

- (i) $1/10^{\text{th}}$ of the floor area for dry hot climate
- (ii) $1/6^{\text{th}}$ of the floor area for wet hot climate
- (iii) $1/8^{\text{th}}$ of the floor area for intermediate climate
- (iv) $1/12^{\text{th}}$ of the floor area for cold climate
- (v) For stair rooms, the ventilation per floor shall not be less than 1m^2

Building By-Laws

Definition of Building By-Laws:

Building by-laws are the set of “*minimum provisions designed from National Building Code (NBC) by town planning authority to protect the safety of public with regarding to structural sufficiency, fire hazards and health aspects*”

If everyone constructs the building without obeying the prescribed rules, then there will be problems of:

- Irregular and narrow roads
- Frequent Traffic
- Problem of parking
- Health problems due to pollution
- Poor light and ventilation
- No proper planning of gardens, play ground, etc.

Building By-Laws

Purposes of Building By-Laws:

- Provides suitable areas for selected activities
- Avoids problem of traffic
- Develops town in systematic manner
- Provides well lightened and ventilated buildings
- Assures basic services like water supply, drainage, electricity, gas, telephone lines, etc.

Creators of Building By-Laws:

By considering the local situations and the actual requirements of the people, the *Local Governing Body* prepares certain rules and norms for the buildings, and for the development of the town.

These rules are submitted to the government for the approval. After getting the approval of the government, these rules becomes by laws.

Building By-Laws for the approval by Local Governing Body

For any building to get constructed, the builder will need to have a set of approvals as well as sanctions from all the authorities concerned. Any building that comes up without these approvals will invite penalty in the form of fines and even prosecution.

Here is a detailed procedure required to get approvals and sanctions for building construction:

- (i) Land Title
- (ii) Land Clearance
- (iii) Zonal Clearance
- (iv) Building Approval
- (v) Completion Certificate
- (vi) Services & Utilities Installation
- (vii) Occupancy Certificate

BUILDING CLEARANCE PROCESS



DEVELOPER

The legal procedure to get approval for a building proposal

A  **Land Title**

1 Revenue department (tehsildar) → Ownership Certificate

2 State town planning urban local body (planning dept) → Non-Encumbrance certificate

B  **Land Clearance**

3 State town planning body → Conversion of land

4 Urban local body (planning dept) → Conversion of land use

C  **Zonal Clearance**

5 Revenue department (tehsildar) → Ownership Certificate

6 State town planning body → Checks compliance with the city's development plan

7 Applicant gets zoning approval 

D  **Building Approval**


8 Urban local body (building dept)

9 Applicant submits application for plan approval → Compliance with by-laws checked

10 Applicant submits application for plot demarcation → Plot dimensions checked

11 Applicant submits all NOCs to the urban local body (see NOCs required)

12 Applicant gets building approval

13 Construction begins 

14 Construction ends 

E  **Completion Certificate**

15 Urban local body → Gives completion certificate after inspection

F  **Service & Utilities Installation**

16 State water board → Water connection

17 Urban local body (sewerage dept) → Sewerage connection

18 Public/private company → Gas connection

19 Public/private company → Electricity connection

20 Operator → Phone connection

21 Urban local body → submit all connection receipts

G  **Occupancy Certificate**

Building By-Laws for the approval by Local Governing Body

(i) Land Title:

- First and foremost, the builder has to get clear title for the land or plot.
- Clear title ensures that the property is clear, marketable and it traces any charges or encumbrances created on the property and its present status.

(ii) Land Clearance:

- On account of urbanization agricultural land is sometimes converted into Non – Agricultural land which can further be used for constructing building for residential or commercial purpose.
- In such cases a developer needs to get approval from concerned authority to convert agricultural land to non-agricultural (NA) purpose.
- Approval for change in land use of the plot is required from local body and the State Ministry of urban Development (UD)

Building By-Laws for the approval by Local Governing Body

(iii) Zonal Clearance:

- After the land title & clearance, builder is required to take zoning approval from the local body / authority.
- The revenue department provides the ownership certificate for building permit under the provisions of Local Body Acts.
- The state town planning checks regarding city development with the planning board and forwards the proposals to the various other concerned authorities in the city as required for issue of case specific approvals/ NOC before granting zoning approval.

(iv) Building Approval:

The next step requires an approval from authority for sanction of building plans/ building permit under the provisions of Building Byelaws, Master plan and Local Body Acts.

The Building approval comprises of the building plan and the layout approval for the construction of the building.

Building By-Laws for the approval by Local Governing Body

(a) Building Plan:

- A builder should submit building plan before starting the construction activities. Building plans are a graphical representation of what a building will look like after construction.
- Building plan ensures that building complies with building laws.
- Once the building plan is approved, the builder should commence construction work within two years and there should be no deviation from the sanctioned plan.

(b) Layout Approval:

- The builder has to get approval of layout plan from concerned authorities before starting construction of residential or commercial building.
- Approved Layout Plan is as per approved FAR (Floor Area Ratio) or FSI (Floor Space Index).
- Constructing building on unapproved layout will not be given permission to be occupied or such layout plots will be treated as unlawful and exemplary penalties will be levied as per Municipal Laws.
- No facilities such as roads, drainage, street lighting will be extended in such areas.

Building By-Laws for the approval by Local Governing Body

(v) Completion Certificate:

- After the construction is completed, Completion certificate is mandatory for building constructed before selling the building.
- The completion certificate is issued after the inspection process. Issuing of Completion Certificate will ensure that the builder or owner has constructed the building as per approved plan.

(vi) Services & Utility Installation:

- The builder should get approval from concerned authorities for electricity, gas and water for potable and non-potable use.
- The building should comply with building laws for sanction or approval of basic amenities.
- The builder has to get NOC from pollution board on the project.
- Builder has to get NOC from municipality or respective authority for digging bore well.
- It is essential for the approval for sewer or water supply.

Building By-Laws for the approval by Local Governing Body

(vii) Occupancy Certificate:

- Lastly, an occupancy Certificate is required from local body/ authority before occupation of a building or part of a building for any purpose.
- The local body forwards the proposals to the various other concerned authorities in the city as required for issue of case specific approvals/ NOC before granting Completion-cum-Occupancy Certificate.

Development Control Rules for Chennai Metropolitan Area

For the approval of large scale projects in Chennai as per CMDA, the by laws are given below:

STAGE I: Project Feasibility / Pre Sanction Stage

STAGE II: Sanction Stage (*For multi building large scale proposals*)

STAGE III: Sanction / Building Permit Stage

STAGE IV: Construction Stage

STAGE V: Completion Cum Occupancy Certificate Stage

Development Control Rules for Chennai Metropolitan Area

STAGE I: Project Feasibility / Pre Sanction Stage

(i) Approvals from Local Body:

- Land Use Plan Approval
- Approval for change in land use
- NOC for construction
- Approval for demolition of any existing structure

(ii) Approval from Airport Authority of India:

- NOC for height clearance when the project lies within 20kms radius.

(iii) Approval from Coastal Regulation Zone:

- NOC for construction for projects within 500m from high tide line

Development Control Rules for Chennai Metropolitan Area

STAGE II: Sanction Stage *(for large scale projects)*

(i) Approval from Local Bodies

(ii) Approval from National Monument Authority (for 300 m radius)

(iii) Approval from Forest Department

(iv) Approval from Heritage Conservation Authority

(v) Approval from Railway Authority/ Port Trust/ Defense

(vi) Approval from Road Owning Agency

(vii) Approval from Chief Fire Officer

(viii) Approval from Chief Controller for Explosives

(ix) Approval from Chief Inspector of Factories

(x) Approval from Ministry of Environment and Forest for Environmental Clearance

Development Control Rules for Chennai Metropolitan Area

STAGE III: Sanction / Building Permit Stage

- (i) Approval from local body*
- (ii) Approval from Power Distributing Agency*
- (iii) Approval from Water Supply Agency*

STAGE IV: Construction Stage

- (i) Approval from Central Groundwater Authority*
- (ii) Intimation to Local Authority (CMDA)*

STAGE V: Completion Cum Occupancy Stage

- (i) Completion cum Occupancy Certificate from CMDA*
- (ii) Approval from the Lift Inspector*

Introduction to Earthquake Concepts

Causes of Earthquake:

- (i) Earth and its Interior
- (ii) Circulation between earth masses
- (iii) Plate Tectonics

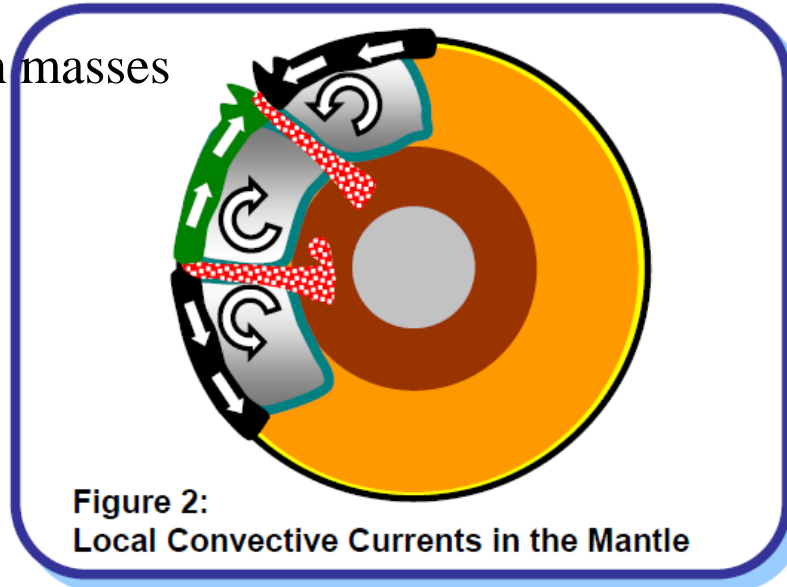


Figure 2:
Local Convective Currents in the Mantle

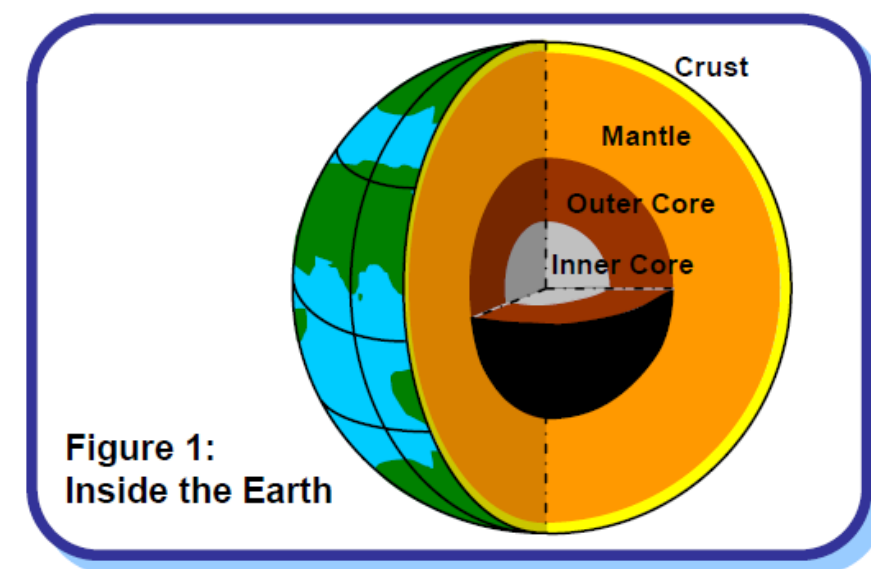


Figure 1:
Inside the Earth

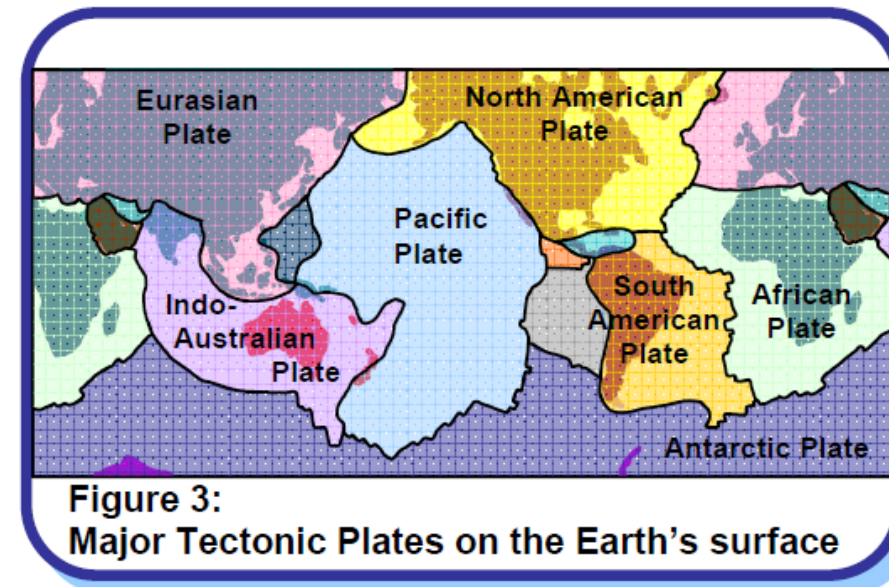


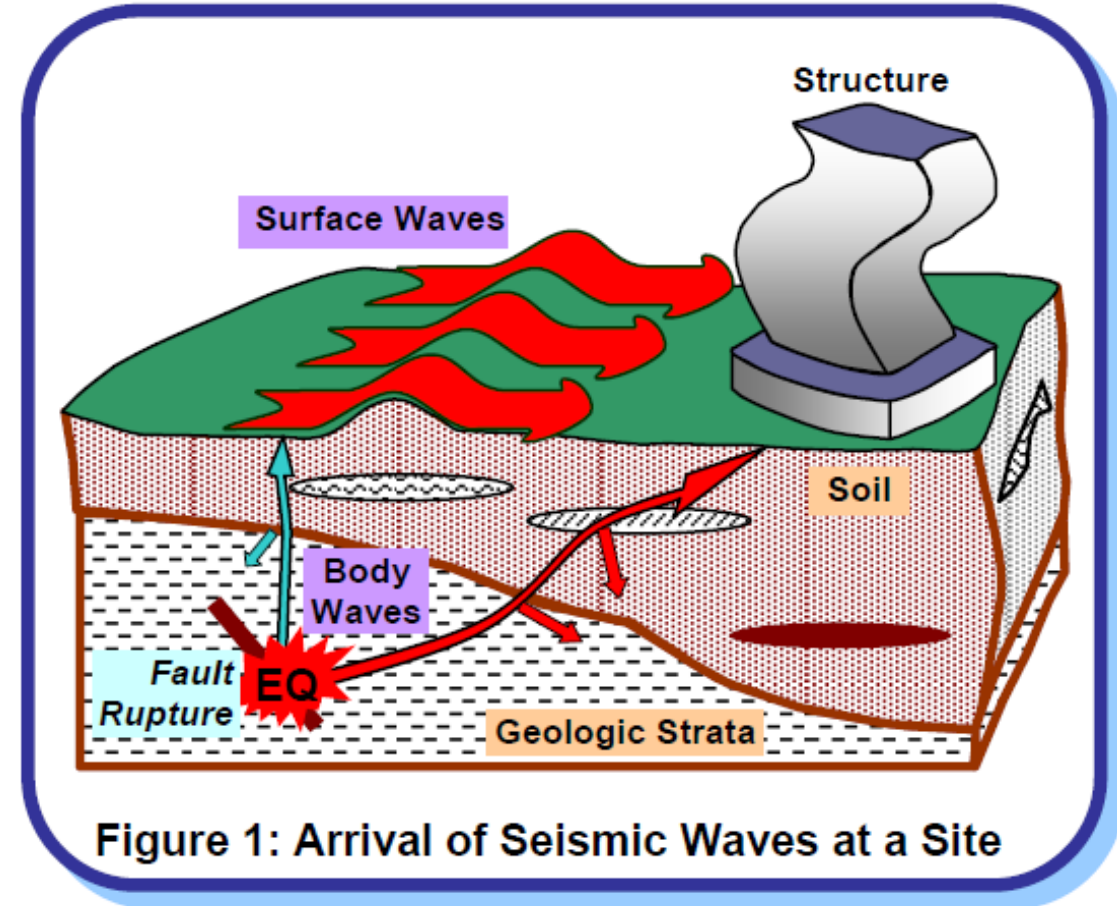
Figure 3:
Major Tectonic Plates on the Earth's surface

Introduction to Earthquake Concepts

How the ground shakes?:

Large strain energy released during an earthquake travels as seismic waves in all directions through the Earth's layers, reflecting and refracting at each interface. These waves are of two types - *body waves* and *surface waves*.

Thus the ground shakes due to the spreading of seismic waves.



Introduction to Earthquake Concepts

Seismic Zones of India:

Seismic zones are meant for understanding the chances for occurrence of earthquake based on the geographical location with respect to the nearby tectonic plates.

As per 2002, Seismic Zone Map, India has **4 Seismic Zones (II, III, IV and V)**

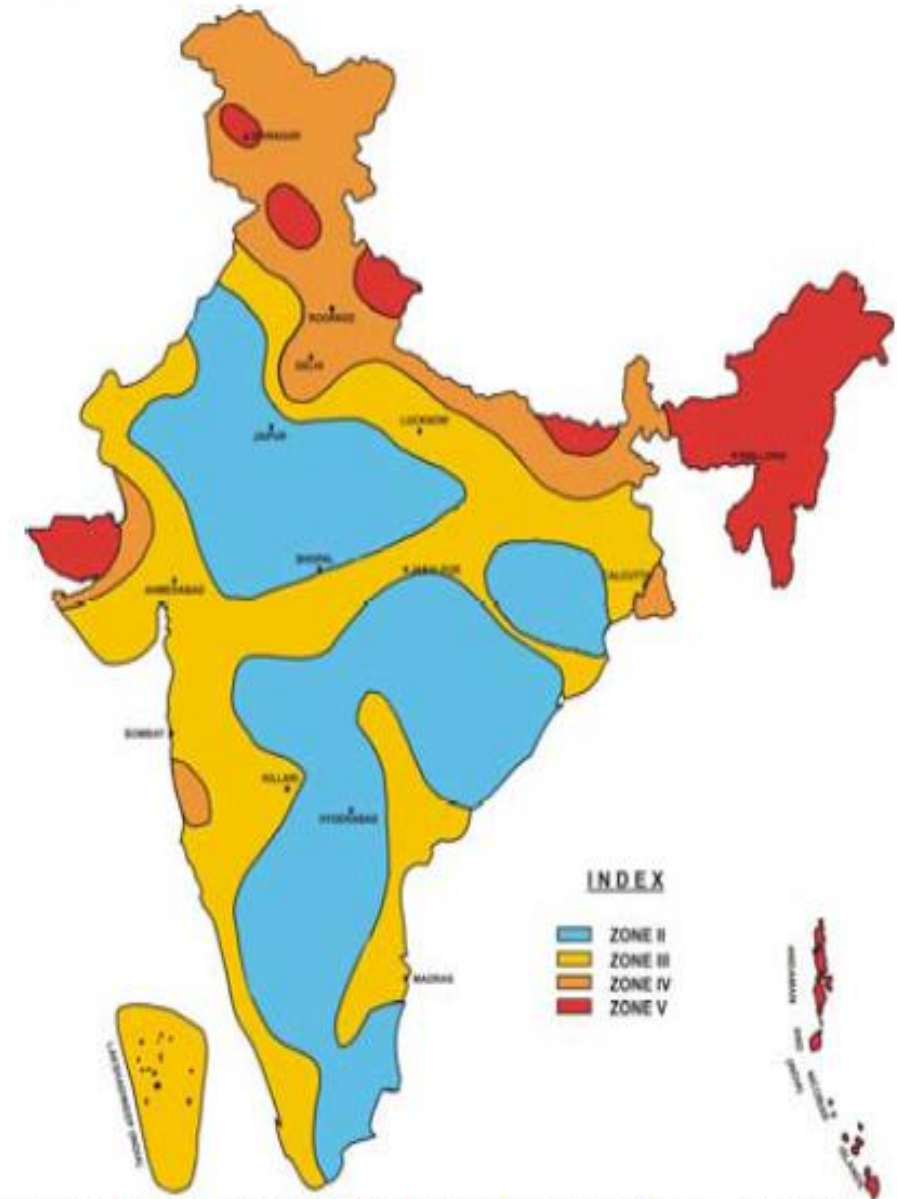
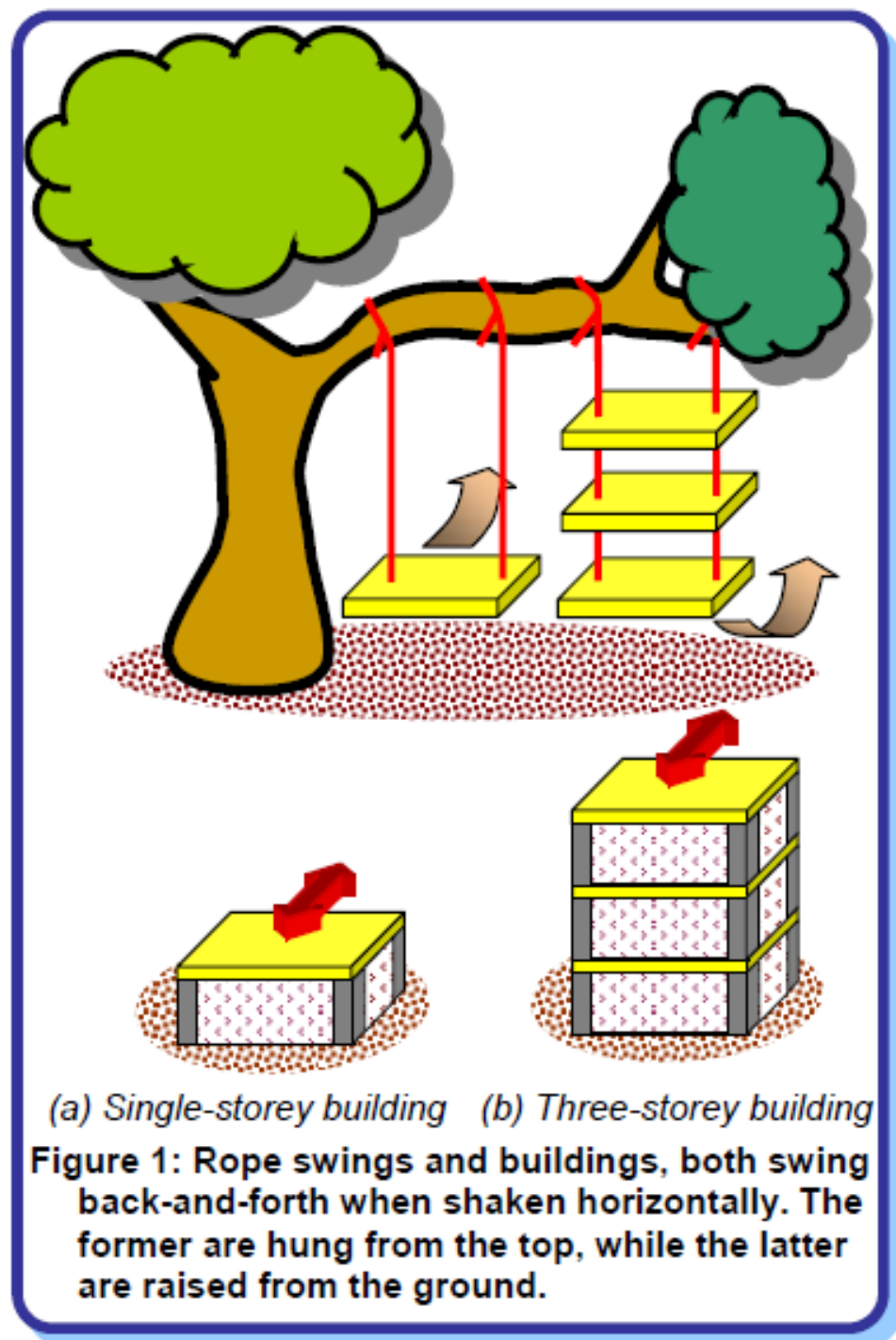


Figure 4: Indian Seismic Zone Map as per IS:1893 (Part 1)-2002

Introduction to Earthquake Concepts

Behavior of buildings to earthquake:

- (i) The *bottom floors* of a building will experience *more stress* during the earthquake, since it is present very close to the foundation level.
- (ii) Even though, the *top floors* are present adequately away from the foundation level, will experience *more shaking (vibration)* during the earthquake.



Introduction to Earthquake Concepts

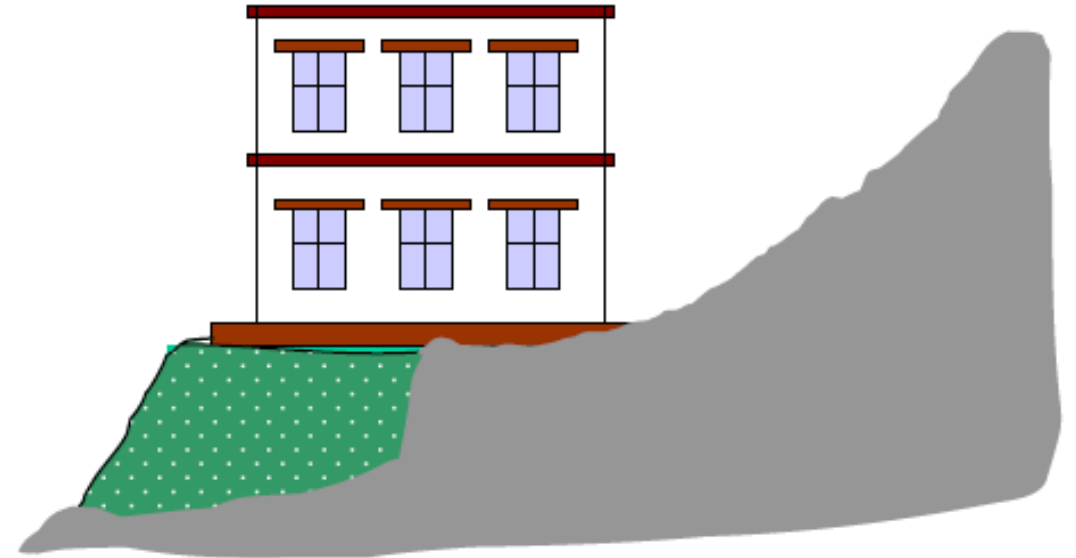
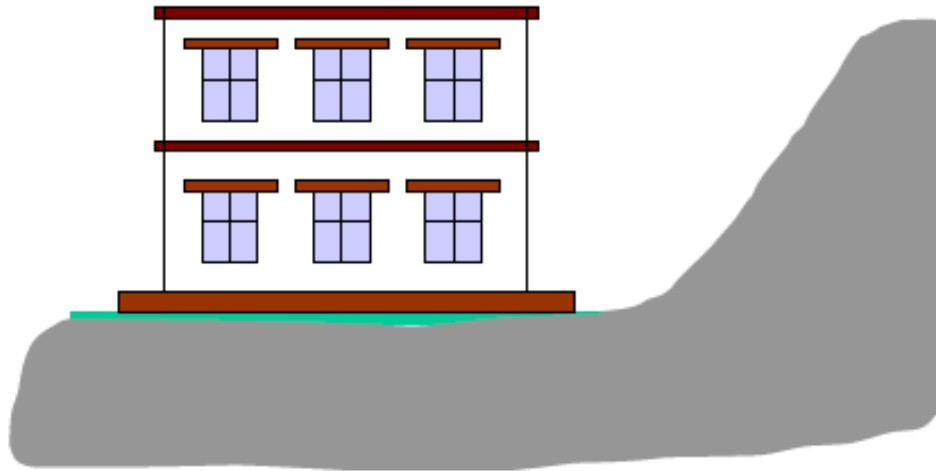
Earthquake Resistant Design Philosophy:

- (i) Base Isolation
- (ii) Damping
- (iii) Ductility Achievement

Basic Guidelines for Earthquake Resistant Design of Structures:

I. Site Selection:

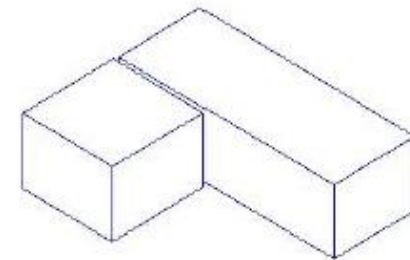
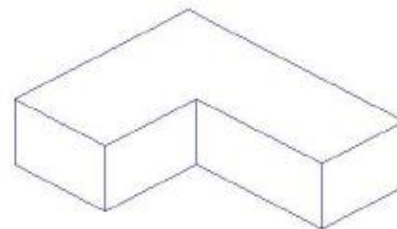
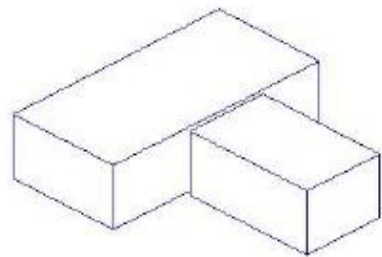
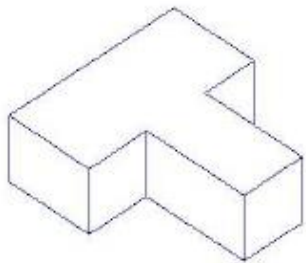
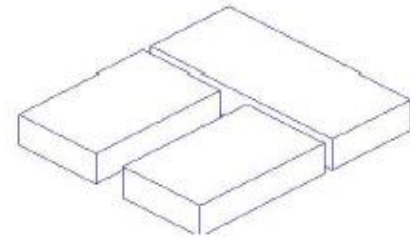
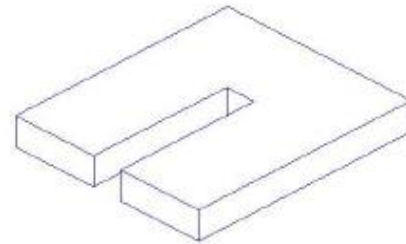
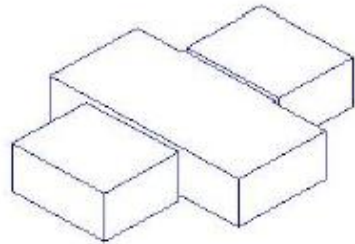
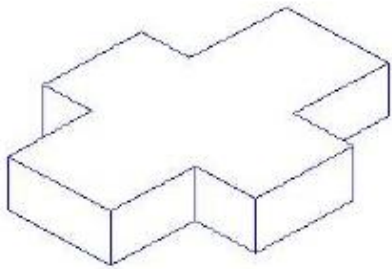
- (i) Building should be placed sufficiently away from steep slopes.
- (ii) Building should not be built on filled-up soil.



Basic Guidelines for Earthquake Resistant Design of Structures:

II. Plan of Building:

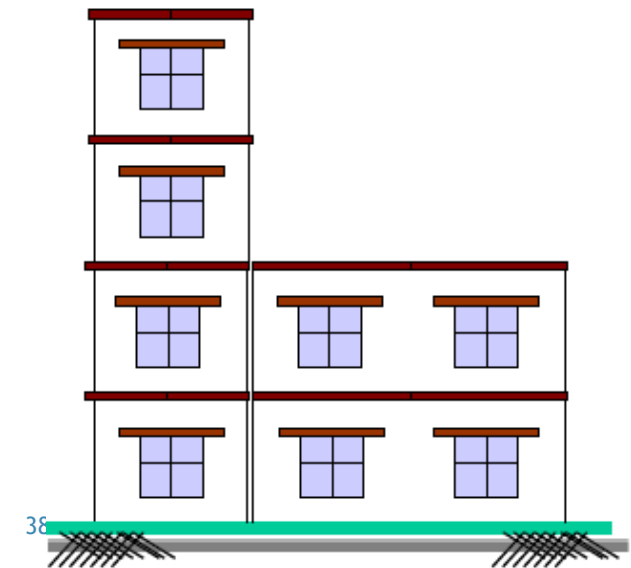
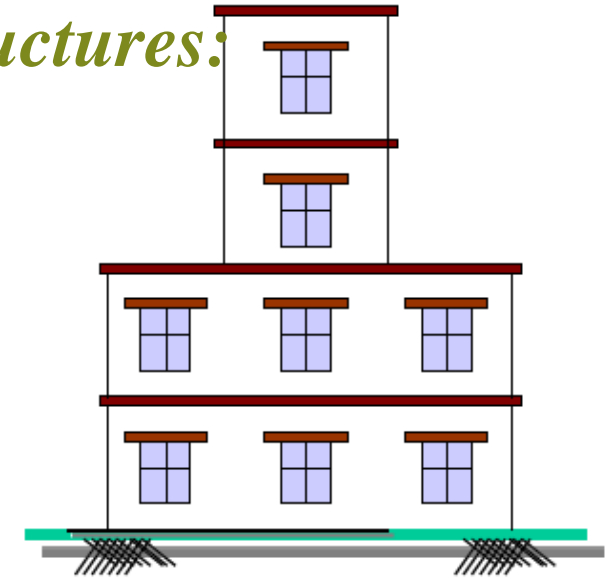
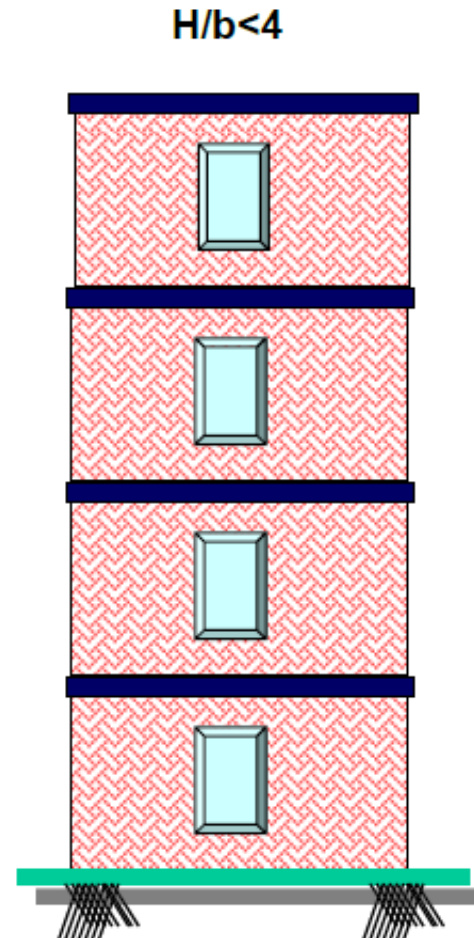
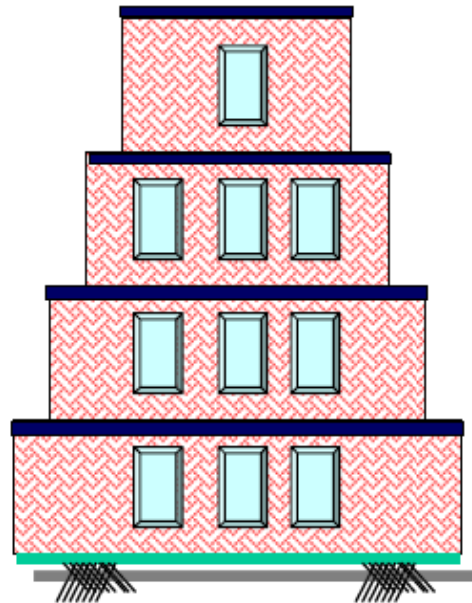
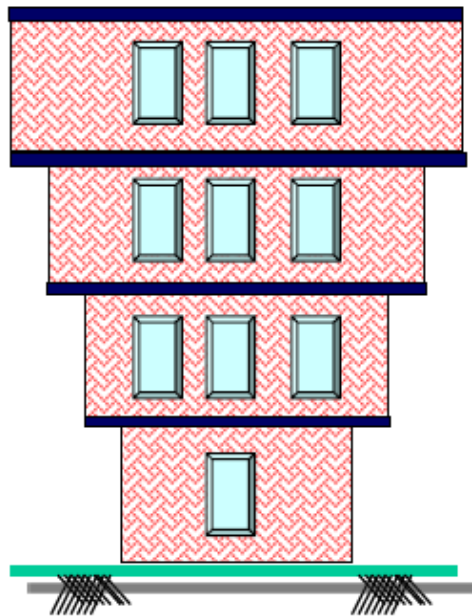
Asymmetry of building should be avoided. Because, asymmetric buildings undergo torsion and extreme corners are subjected to large earthquake forces.



Basic Guidelines for Earthquake Resistant Design of Structures:

III. Shape of Building:

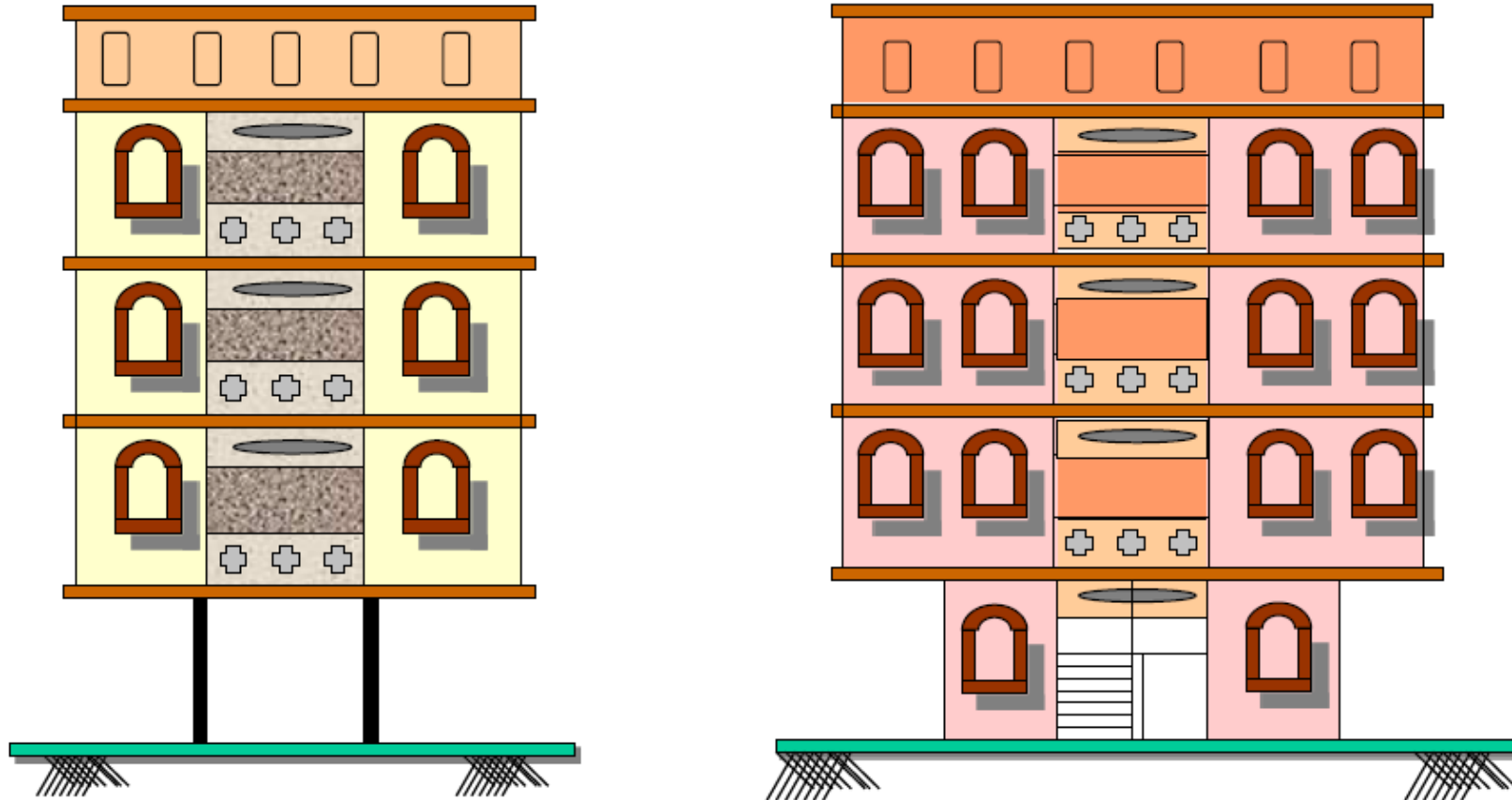
- (i) Very slender buildings should be avoided.
- (ii) Inverted pendulum buildings are unstable.
- (iii) Sudden change of lateral stiffness should be avoided.



Basic Guidelines for Earthquake Resistant Design of Structures:

IV. Projections and Overhangs:

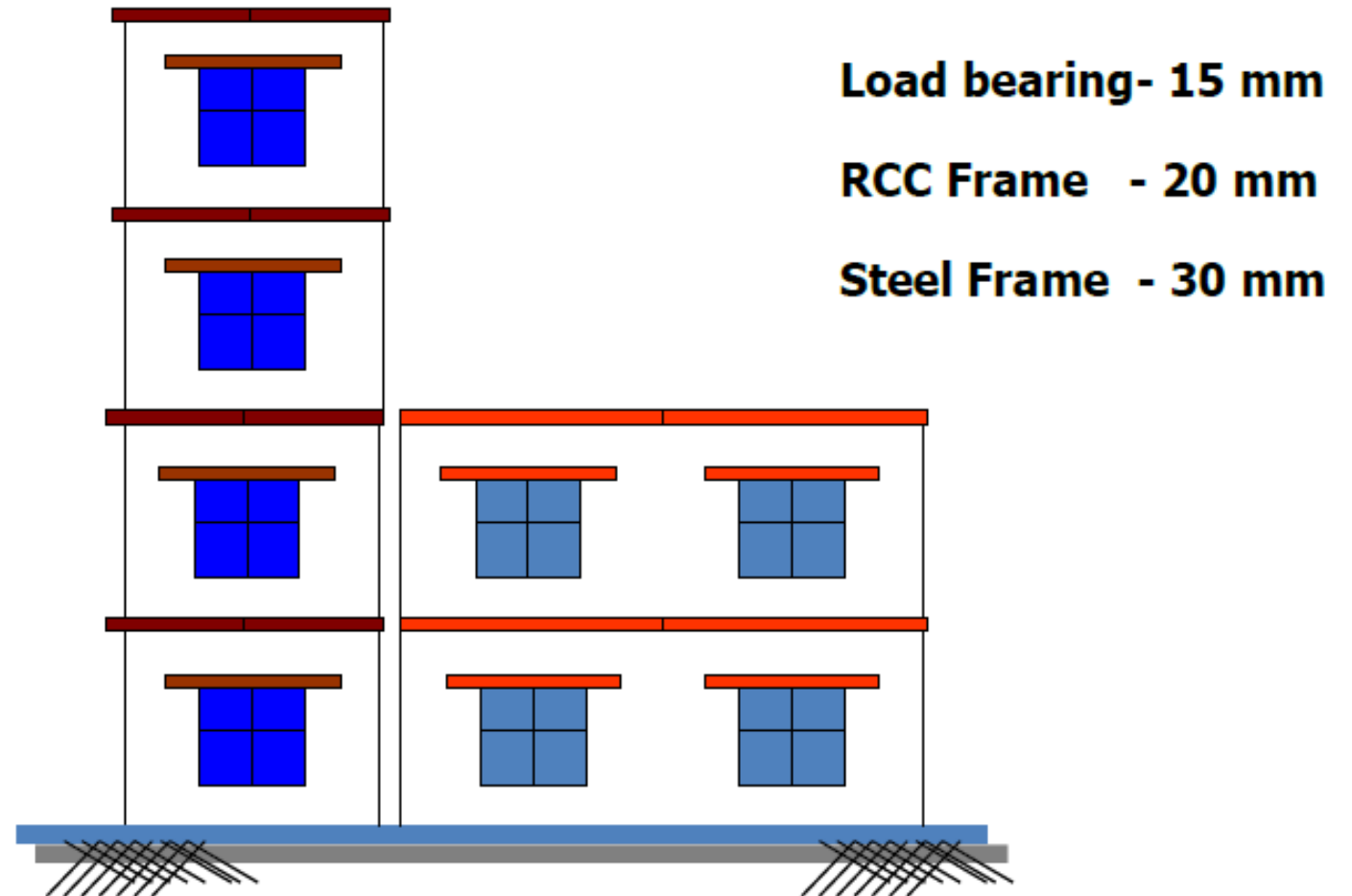
Large overhangs and projects attracts large earthquake forces.



Basic Guidelines for Earthquake Resistant Design of Structures:

V. Separation of Dissimilar Buildings:

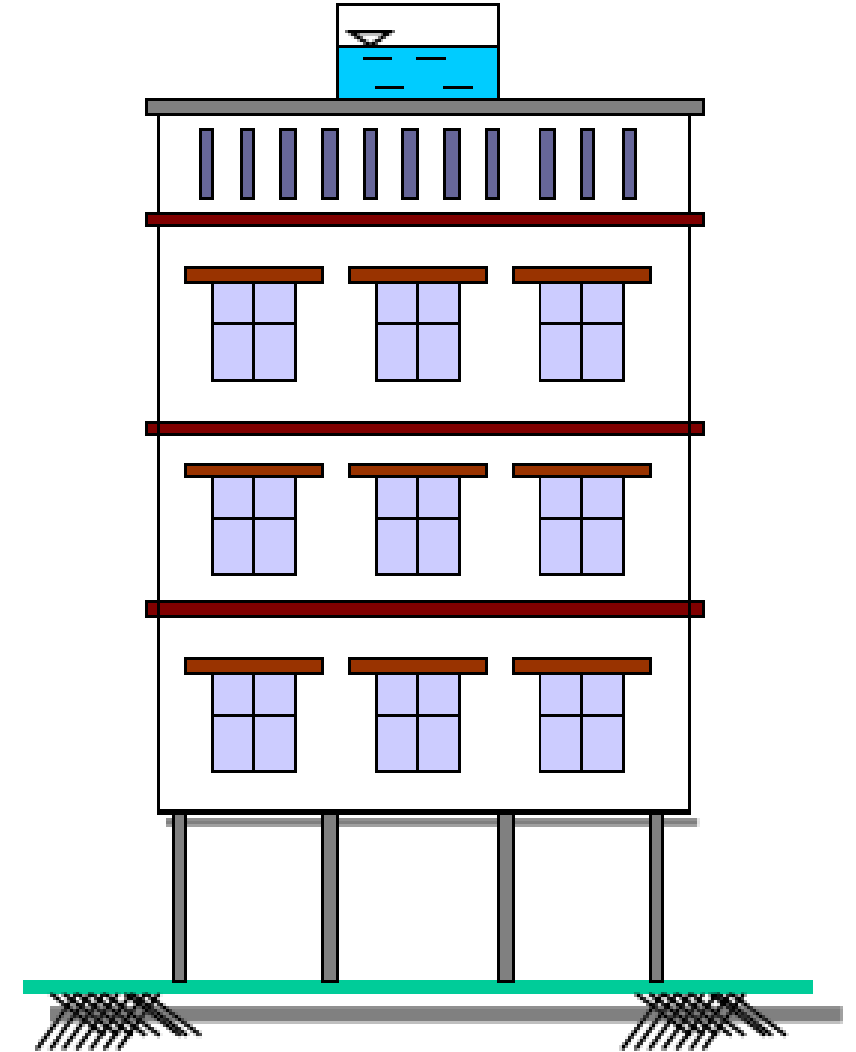
- (i) To avoid collision, adjacent building should be separated by a minimum gap.
- (ii) For Load Bearing structure = 15mm
- (iii) For RCC Frame structure = 20mm
- (iv) For Steel Frame structure = 30mm



Basic Guidelines for Earthquake Resistant Design of Structures:

VI. Avoid Heavy Mass at the top:

- (i) Large water tanks at the top should be avoided.
- (ii) Small tanks if provided, should be connected properly with the frame system.



Basic Guidelines for Earthquake Resistant Design of Structures:

VII. Open Ground Storey:

- (i) Open ground storeys should be avoided.
- (ii) In unavoidable conditions, in-filled walls should be placed

