SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – I – Tall Buildings – SCI1618

I. Design Criteria

Syllabus

Design philosophy, loading, sequential loading, materials, high performance concrete - Fiber reinforced concrete - High strength concrete - Lightweight concrete - design mixes

Heavy Density Concrete

« Heavy-density concrete has a density of up to about 6400kg/m3.

« Heavyweight concrete used for radiation shielding as a shielding material, heavyweight concrete protects against the harmful effects of X-rays, gamma rays, and neutron radiation.

Heavy-density concrete to protect & shield places with greater risk of Radiation.

« Selection of concrete for radiation shielding is based on space requirements and on the type and intensity of radiation.

« Where space requirements are not important, normalweight concrete will generally produce the most economical shield.

« Where space is limited, heavyweight concrete will allow for reductions in shield thickness without sacrificing shielding effectiveness.

Properties of Heavy Density Concrete

« Both the freshly mixed and hardened states can meet job conditions and shielding requirements by proper selection of materials and mixture proportions.

« Except density, the physical properties are similar to normalweight concrete.

« Strength is a function of water-cement ratio; thus, for any particular set of materials, strengths comparable to those of normal-weight concretes can be achieved.

« Radiation shield has special requirements, trial mixtures should be made with job materials and under job conditions to determine suitable mixture proportions.

Lightweight Concrete

Structural Lightweight Concrete

Structural lightweight concrete is similar to normal- weight concrete except that it has a lower density.

it is made with lightweight aggregates or

it is made with a combination of lightweight and normal- weight aggregates.

 The term "lightweight“ - made with coarse lightweight aggregate and natural sand.

 Structural lightweight concrete has -air-dry density in the range of 1350 to 1850 kg/m3

 28-day compressive strength in excess of 17 Mpa.

 A Concrete which is light in weight and sufficiently strong to be used in conjunction with steel reinforcement will be a material which is more economical than conventional Concrete.

Lightweight Concrete Mix design

Mix Design Procedure

• Stage 1 deals with strength leading to the free water/cement ratio

• Stage 2 deals with workability leading to the free water

• Stage 3 combines the results of Stages 1 and 2 to give the cement content

• Stage 4 deals with the determination of the total aggregate content

• Stage 5 deals with the selection of the fine and coarse aggregate contents

Some Points about Water, Cement, & Aggregate

1. As the water to cement ratio increases, the strength of a concrete mix decreases.

2. For a given water / cement ratio, the strength of a concrete remains the same regardless of the amount of aggregate added to the mix, so long as there is sufficient cement paste to coat all of the aggregate particles.

3. For a given set of aggregates -aggregate volume, and concrete consistency, the water requirement of the concrete mix is inversely proportional to the size of the aggregate.

4. As the surface area of the aggregate increases (i.e., due to a coarser surface texture or particle shape) the more water will be neededto maintain a given slump.

5. As the air content of a mix increases, less water is needed to maintain a constant consistency.

6. For a given concrete mix of given consistency, the strength of the mix will decrease as the air increases*. As the cement content of the mix increases, the rate at which this will occur increases.

Terminology - Specific Gravity

1.The relative density of a material compared to water

2.The ratio of a material's weight to the weight of an equal volume of water

Bulk specific gravity (SSD):

1.Used to determine the "solid volume"(absolute volume) of a material going into concrete

2.It is determined by submerging the material in water for 24 hours in order to fill any permeable voids.

Data required for mix design:

• Characteristic compressive strength at 28 days

• Degree of workability desired

• Limitations on water – cement ratio

• Type & maximum size of aggregates

• Standard Deviation

Concrete Mix Design –Special Requirements

• Architectural concrete

• Flexural strength

• Impact strength

• Abrasion resistance

• High density

• Light weight

• Radiation shielding

The mix proportion of M20 grade concrete is designed as per IS: 10262-2009 and is given below:

A.1Design Stipulation

- Characteristic compressive strength at 28 days : 20N/mm2
- Maximum size of aggregate : 20mm
- Workability, slump : as per is 456 table.7.1
- Degree of quality control : Good
- Type of exposure : Moderate

A.1.1 Source of Materials:

- Cement : OPC
- Fine aggregate : Cuddalore
- Coarse aggregate 20mm : Chidambaram
- Coarse aggregate 12mm : Chidambaram
- Admixture : SNF/PCE based super-plasticizer

A.2Test Data of Materials:

- Type of cement and grade : OPC 53grade
- Specific gravity of cement : 3.15
- Specific gravity of admixture : 1.20
- Specific gravity of 20mm : 2.70
- Specific gravity of 12mm : 2.70
- Specific gravity of river sand : 2.60
- Water absorption of 20mm : 0.6%
- Water absorption of 12mm : 0.74%
- Water absorption of river sand : 2%

A.3 Mix Design

A.3.1 Target Mean Strength:

- ft = fck + k.s

• Where

ft = target mean strength @ 28 days

• fck = characteristic compressive strength @ 28 days

• s = standard deviation from table-1(IS 10262-2009)

• k = Himsworth constant. According to IS, the characteristic strength is defined as that

• Value below which not more than 5% (1 in 20) results are expected to fall. (IS 10262-pg.6)

• Ft = 20 + 1.65 *4.6 = 27.59 MPa

A.3.2 Selection of free w/c ratio:

• From IS 456, table-5, max w/c ratio = 0.55.

A.3.3 Selection of Water Content:

• For grade up to M 20 as per SP 23:1982, Table -42

• Estimated water content = 186 litres.

• As super plasticizer is used, water content can be reduced up to 20 %.

(IS 9103 table 1a)

• Based on trial mixes with super plasticizer, a reduction of 15% of water content has been achieved.

• Arrived water content = 186*0.15 = 27.9 litres = 186-27.9 = 158.1 litres

A.3.4 Selection of Cement Content:

• W/c ratio = 0.55

• Cement content = 158.1/0.55 = 287.45 kg

• Check for exposure condition from is 456 table-5

• Min. cement content = 300 kgs ≥287.45 kg

• Hence 300kgs of cement is taken.

A.3.5 Calculation of Aggregate Content:

• Volume of concrete, a = 1 cum

• Volume of cement,

b = mass of cement/sp.gr. of cement *1/1000 = 300/3.15 *1/1000 = 0.0952 cum

• Volume of water, c = 158/1*1/1000 = 0.158 cum

• Volume of admixture, d = 2.4/1.2*1/1000 = 0.002 cum (300*0.8%   = 2.4 kg by weight of Cement)

• Volume of all aggregate, e = a - (b + c + d) = 1-(0.0952+0.158+0.002) = 0.7448 cum.

• Mass of coarse aggregate, 20mm = 0.7448*0.6*0.60*2.70*1000 = 724 kg.

• Mass of coarse aggregate, 12mm = 0.7448*0.6*0.40*2.70*1000 = 482.6 kg.

• Mass of fine aggregate,   = 0.7448*0.4**2.60 *1000 = 774.6 kg.

Cement 300 kg

coarse aggregate 20mm 724 kg

coarse aggregate 12 mm 482.60 kg

fine aggregate 774.60 kg

water 158 litres

Admixture: super-plasticizer 2.4 kg

A.4.Mix Proportions Before Corrections:

Design Ratio of Materials

Cement Fine Aggregate Coarse Aggregate

300 758.42 1185

1 2.53 3.95

A.8.Proportions of Materials for Different Grades of Portland Cement Concrete

SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – II – Tall Buildings – SCI1618

I. Loading and Movement

Syllabus

Gravity Loading: Dead and Live load, Methods of Live load reduction - impact, Gravity loading, Construction loads.

Wind Loading - Static and dynamic approach -Earth quake loading - Equivalent lateral force - Introduction to working stress design - limit state design, plastic design.

UNIT 2 - Loading and movement

- Gravity Loading: Dead and Live load,
- Methods of Live load reduction and its impact,
- Construction loads.
- Wind Loading - Static and dynamic approach –
- Earth quake loading –
- Equivalent lateral force –
- Introduction to working stress design –
- limit state design,
- plastic design

Loading and Movement

- The structure must designed to resist the gravitational and lateral forces of both permanent and transient.
- it will sustain during its construction and subsequent service life.
- These forces will depend on the size and shape of the building as well as on its geographic location.

The maximum probable values must be established before the design can proceed

The probable accuracy of estimating the dead and live loads And the probability of the Simultaneous occurrence of different combinations of gravity loading such as dead and live load with either wind or earthquake forces.

It is included in limit States design through the use of prescribed factors.

GRAVITY LOADING D/L and L/L

• Gravity loads D/L-Permanent loads

• Self weight of all structural members such as

• Slabs,beams,columns,shear walls,

• brick walls,facades,bracinings,false ceilings,

• footings and pile caps .etc.,

• Self weight= c/s area x length or height x density of concrete

25kn/cu.m 100 Kg/cu.m=1kn/cum

S.No.	*Material*	*Weight (kg/m^3)*
1.	Steel	7850
2.	Reinforced concrete	2500
3.	Plain concrete	2400
4.	Cement	3150
5.	Brick	1920
6.	Granite	2640
7.	Marble	2720
8.	Earth, wet loose sand and gravel	2000
9.	Water	1000
10.	Aluminium	2720
11.	Lumber	560

schedule of unit weights of building materials is given in IS:1911. Typ

Where L/L does not exceed 500kg/sq.m red.is applicable for cols and footings only

Floor Live Loads

IS:875-1964 provides values of live loads for various categories of application. ...3 presents typical values of live loads for guidance. They are considered mostly in ... equivalent uniformly distributed loads on floor area.

Floor live loads as per IS:875-1964

Floor types in different structures	Minimum live load (kg/m^2)
Dwelling houses, tenements, hospital wards, bed rooms and private sitting rooms in hostels and dormitories	200
Office floors other than entrance halls, floors of light work rooms	250 - 400
Floors of banking halls, office entrance halls and reading rooms	300
Shop floors used for the display and sale of merchandise; floors of work rooms generally; floors or places of assembly with fixed seating, restaurants; circulation space in machinery halls, power stations, etc., where not occupied by plant or equipment.	400

Simple percentages may be specified for the reductions and for the limiting amount.

For example, the Supporting members may be designed for 100% of the live load on the roof. 85% of that on the top floor. And further reductions of 5% for each successive floor and down to a minimum of 50 % of the live load, A tributary area formula may be given.

Allowing a more refined definition of reduction. With the limit built into the formula, For example, the supporting members may be designed for a live load equal to the basic live multiplied by a factor

L/L * 0.3 +(10 / √(A))

where A is the accumulated area in Square feet.

An even more sophisticated formula type method may define the maximum reduction in terms of the dead-to-live load ratio.

For example, it may be specified that the maximum percentage reduction shall not exceed:

100 x[(D + L) /4. 33L], in which D and L are the intensities of dead and live loading respectively,

This particular limit is intended to ensure that if the full live load should occur over the full tributary area,

mber of floor carried by member under consideration	Percentage reduction of total live load on all floors above the member under consideration
1	0
2	10
3	20
4	30
5 to more	40

Where L/L does not exceed 500kg/sq.m red.is applicable for cols and footings only

THE ELEMENT WOULD NOT BE STRESSED TO THE YIELD POINT

IMPACT LOADS

Impact Gravity Loading

Impact loading occurs as a gravity live load in the case of an elevator being accelerated upward brought to a rest On its way down.

An increase of the static elevator load has usually used to give a satisfactory performance of the supporting structure

INCREASE IN L/L FOR IMPACT AND VIBRATION

INCREASE IN L/L FOR IMPACT AND VIBRATION

S.No.	Structure	Impact factor (%
1.	Frames supporting lifts and hoist	100
2.	Foundations, footings and piers supporting lifts and hoisting apparatus	40
3.	Light machinery, shaft or motor units	20 (min.)
4.	Reciprocating machinery or power units	50 (min.)

S.No.	Type of load	Impact factor (%)
1.	Vertical loads for electric overhead travelling (EOT) cranes	20 (of maximum static wheel loa
2.	Vertical loads for hand-operated travelling (HOT) cranes	10 (of maximum wheel load)
3.	Horizontal force transverse to the rails:	
	a) For EOT cranes	10 (of weight of the crab and the weight lifted)
	b) For HOT cranes	5 (of weight of the crab and the weight lifted)
4.	Horizontal forces along the rails	5 (of static wheel loads)

CONSTRUCTION LOADS

• Construction loads are often claimed to be the most severe loads that a building has to withstand.

• Many more failures occur in buildings under construction than in the buildings that have been completed.

• But it is rare for special provision to be made for construction loads in building design.

• If, however, in a building with an Unusual Structure,

A lack of consideration for construction loading could increase the total of the project at the later stage when the actual work is carried out. An early discussions between the designer and contractor On making some provision would obviously desirable to avoid failures and over cost.

CONSTRUCTION LOADS

• Equipment loads

• Materials stock pile

• Weight of Derrick

• Weight of Crane

• Wind forces from climbing tower crane

• Weight of form work

• Shoring to transfer vertical loads form upper slab

• Two shore and 1 re shore are required for tall buildings with1 week cycle for floor

• Lifting points in different floors

• addl. Stresses due to Accidental, impact and vibration during transportation

Typically, these loads to be supported. The weight of the floor forms and a newly placed

Slab in total, it may be equal to twice the floor dead load. This load is supported by props that transfer it to the three or more previously constructed floors below

The climbing crane is another common construction load.

This is usually supported by connecting it go a number of floors below possibly with additional shoring in stories further below

WIND LOADING

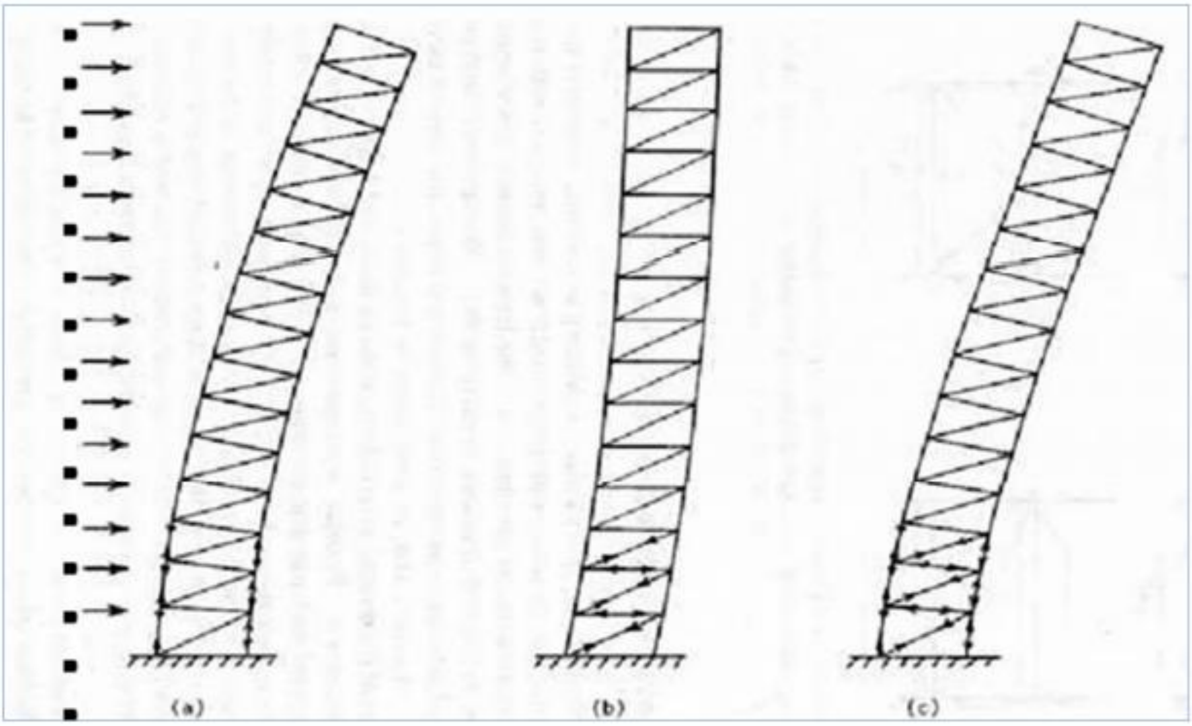
The lateral loading due to wind or earthquake is the major factor that causes the design of high-rise buildings to differ from medium-rise buildings, Buildings of up to 10 Stories and of typical proportions, the design is rarely affected by Wind loads, Above this height, due to the increase in size of the structural members and the possible rearrangement of the structure to account for wind loading, It incurs additional cost that increases progressively with height.

With innovations in architectural treatment, Increases in the Strengths of materials, And advances in the methods of analysis, Tall building structures have become more efficient and lighter.

Consequently, more prone to deflect and even to Sway to wind loading.

This served as a spur to research. This has produced significant advances in understanding the nature of wind loading and in developing methods for its estimation.

In wind loading due to gusting and the dynamic interaction of structures with gust forces



Simple Static Approach

The modem static methods of estimating wind loading accounts for the effects of gusting and for local extreme pressures on the faces of the building Also accounts for local differences on exposure between the open countryside and a city center.

The Vital facilities such as hospitals, fire stations and police stations, whose safety must be ensured for use after the extreme windstorm.

The design wind pressure is obtained from the formula as per IS 875 part 3

5.4. IS 875 PART 3- 1987 Design Wind Pressure –

The design wind pressure at any height above mean ground level shall be obtained by the following relationship between wind pressure and wind velocity:

pz = 0.6 Vz

Where

pz = design wind pressure in N/m2 at height z, and

vz, - design wind velocity in m/s at height z.

NOTE - The coefficient 0.6 (in SI units) based on atmospheric pressure and air temperature

.

5.2 Basic Wind Speed — Figure 1 gives basic wind speed map of India, as applicable to 10 m height above mean ground level for different zones of the country. Basic wind speed is based on peak gust velocity averaged over a short time interval of about 3 seconds and corresponds to mean heights above ground level in an open terrain (Category 2). Basic wind speeds presented in Fig. 1 have been worked out for a 50 year return period. Basic wind speed for some important cities/towns is also given in Appendix A.

5.3 Design Wind Speed (V_z) — The basic wind speed (V_b) for any site shall be obtained from Fig. 1 and shall be modified to include the following effects to get design wind velocity at any height (V_z) for the chosen structure:

a) Risk level;

b) Terrain roughness, height and size of structure; and

c) Local topography.

It can be mathematically expressed as follows:

$$V_z = V_b \, k_1 \, k_2 \, k_3$$

where

V_z = design wind speed at any height z in m/s;

k_1 = probability factor (risk coefficient) (*see* **5.3.1**);

k_2 = terrain, height and structure size factor (*see* **5.3.2**); and

k_3 = topography factor (*see* **5.3.3**).

NOTE — Design wind speep up to 10 m height from mean ground level shall be considered constant.

5.3.1 *Risk Coefficient* (*k_1 Factor*) — Figure 1 gives basic wind speeds for terrain Category 2 as applicable at 10 m above ground level based on 50 years mean return period. The suggested life period to be assumed in design and the corresponding k_1 factors for different class of structures for the purpose of design is given in Table 1. In the design of all buildings and structures, a regional basic wind speed having a mean return period of 50 years shall be used except as specified in the note of Table 1.

Terrain in which a specific structure stands shall be assessed as being one of the following terrain categories:

a) *Category* 1 — Exposed open terrain with few or no obstructions and in which the average height of any object surrounding the structure is less than 1·5 m.

NOTE — This category includes open sea-coasts and flat treeless plains.

b) *Category* 2 — Open terrain with well scattered obstructions having heights generally between 1·5 to 10 m.

NOTE — This is the criterion for measurement of regional basic wind speeds and includes airfields, open parklands and undeveloped sparsely built-up outskirts of towns and suburbs. Open land adjacent to sea coast may also be classified as Category 2 due to roughness of large sea waves at high winds.

c) *Category* 3 — Terrain with numerous closely spaced obstructions having the size of building-structures up to 10 m in height with or without a few isolated tall structures.

NOTE 1 — This category includes well wooded areas, and shrubs, towns and industrial areas full or partially developed.

NOTE 2 — It is likely that the next higher category than this will not exist in most design situations and that selection of a more severe category will be deliberate.

NOTE 3 — Particular attention must be given to performance of obstructions in areas affected by fully developed tropical cyclones. Vegetation which is likely to be blown down or defoliated cannot be relied upon to maintain Category 3 conditions. Where such situation may exist, either an intermediate category with velocity multipliers midway between the values for Category 2 and 3 given in Table 2, or Category 2 should be selected having due regard to local conditions.

d) *Category* 4 — Terrain with numerous large high closely spaced obstructions.

The buildings/structures are classified into the following three different classes depending upon their size:

Class A — Structures and/or their components such as cladding, glazing, roofing, etc, having maximum dimension (greatest horizontal or vertical dimension) less than 20 m.

Class B — Structures and/or their components such as cladding, glazing, roofing, etc, having maximum dimension* (greatest horizontal or vertical dimension) between 20 and 50 m.

Class C — Structures and/or their components such as cladding, glazing, roofing, etc, having maximum dimension (greatest horizontal or vertical dimension) greater than 50 m.

TABLE 1 RISK COEFFICIENTS FOR DIFFERENT CLASSES OF STRUCTURES IN DIFFERENT WIND SPEED ZONES

(*Clause* 5.3.1)

Class of Structure	Mean Probable Design Life of Structure in Years	k_1 Factor for Basic Wind Speed (m/s) of					
		33	39	44	47	50	55
All general buildings and structures	50	1·0	1·0	1·0	1·0	1·0	1·0
Temporary sheds, structures such as those used during construction operations (for example, formwork and falsework), structures during construction stages and boundary walls	5	0·82	0·76	0·73	0·71	0·70	0·67
Buildings and structures presenting a low degree of hazard to life and property in the event of failure, such as isolated towers in wooded areas, farm buildings other than residential buildings	25	0·94	0·92	0·91	0·90	0·90	0·89
Important buildings and structures such as hospitals communication buildings / towers, power plant structures	100	1·05	1·06	1·07	1·07	1·08	1·08

TABLE 2 k_2 FACTORS TO OBTAIN DESIGN WIND SPEED VARIATION WITH HEIGHT IN DIFFERENT TERRAINS FOR DIFFERENT CLASSES OF BUILDINGS/STRUCTURES

(*Clause* 5.3.2.2)

HEIGHT	TERRAIN CATEGORY 1 CLASS			TERRAIN CATEGORY 2 CLASS			TERRAIN CATEGORY 3 CLASS			TERRAIN CATEGORY 4 CLASS		
m	*A*	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*	*A*	*B*	*C*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
10	1·05	1·03	0·99	1·00	0·98	0·93	0·91	0·88	0·82	0·80	0·76	0·67
15	1·09	1·07	1·03	1·05	1·02	0·97	0·97	0·94	0·87	0·80	0·76	0·67
20	1·12	1·10	1·06	1·07	1·05	1·00	1·01	0·98	0·91	0·80	0·76	0·67
30	1·15	1·13	1·09	1·12	1·10	1·04	1·06	1·03	0·96	0·97	0·93	0·83
50	1·20	1·18	1·14	1·17	1·15	1·10	1·12	1·09	1·02	1·10	1·05	0·95
100	1·26	1·24	1·20	1·24	1·22	1·17	1·20	1·17	1·10	1·20	1·15	1·05
150	1·30	1·28	1·24	1·28	1·25	1·21	1·24	1·21	1·15	1·24	1·20	1·10
200	1·32	1·30	1·26	1·30	1·28	1·24	1·27	1·24	1·18	1·27	1·22	1·13
250	1·34	1·32	1·28	1·32	1·31	1·26	1·29	1·26	1·20	1·28	1·24	1·16
300	1·35	1·34	1·30	1·34	1·32	1·28	1·31	1·28	1·22	1·30	1·26	1·17
350	1·37	1·35	1·31	1·36	1·34	1·29	1·32	1·30	1·24	1·31	1·27	1·19
400	1·38	1·36	1·32	1·37	1·35	1·30	1·34	1·31	1·25	1·32	1·28	1·20
450	1·39	1·37	1·33	1·38	1·36	1·31	1·35	1·32	1·26	1·33	1·29	1·21
500	1·40	1·38	1·34	1·39	1·37	1·32	1·36	1·33	1·28	1·34	1·30	1·22

NOTE 1 — *See* **5.3.2.2** for definitions of Class A, Class B and Class C structures.

NOTE 2 — Intermediate values may be obtained by linear interpolation, if desired. It is permissible to assume constant wind speed between 2 heights for simplicity.

5.3.3 *Topography* (k_3 *Factor*) — The basic wind speed V_b given in Fig. 1 takes account of the general level of site above sea level. This does not allow for local topographic features such as hills, valleys, cliffs, escarpments, or ridges which can significantly affect wind speed in their vicinity. The effect of topography is to accelerate wind near the summits of hills or crests of cliffs, escarpments or ridges and decelerate the wind in valleys or near the foot of cliffs, steep escarpments, or

5.3.3.1 The effect of topography will be significant at a site when the upwind slope (θ) is greater than about 3°, and below that, the value of k_3 may be taken to be equal to 1·0. The value of k_3 is confined in the range of 1·0 to 1·36 for slopes greater than 3°. A method of evaluating the value of k_3 for values greater than 1·0 is given in Appendix C. It may be noted that the value of k_3 varies with height above ground level, at a maximum near the ground, and reducing to 1·0 at higher levels.

DYNAMIC APPROACH

The dynamic methods are for exceptionally tall buildings, highly slender. or susceptible for more vibration-prone buildings.

Alternatively, such exceptional buildings may be defined In a more rigorous way according to the natural frequency and damping of the structure, as well as to its proportions and height

Effective wind loading in the building may be increased by dynamic interaction between the motion of the building and the gusting of the Wind.

The best method of assessing such dynamic effects is by wind tunnel tests in Which the relevant properties of the building and the surrounding countryside are modeled.

Alternative dynamic methods estimating the wind loading by calculation have been developed.

The wind tunnel experimental method

The dynamic calculation methods.

Wind tunnel Experimental Method.

To determine the loading quasi steady for determining the static pressure distribution or force on a building. The pressure or force coefficients so developed are then used in calculating full-scale loading through one of the described simple methods.

This approach is satisfactory for buildings whose motion is negligible and therefore has little effect on the wind loading.

If the building slenderness or flexibility is such that its response to excitation by the energy of the gusts may significantly influence the effective wind loading.

(The elastic structrural properties and the mass distribution of the building as well as the relevant characteristics of the Wind should be modeled „

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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – III – Tall Buildings – SCI1618

I. BEHAVIOR OF VARIOUS STRUCTURAL SYSTEMS

Syllabus

Factors affecting growth, Height and structural form - High rise behavior, rigid frames - braced forms - infilled frames, shear walls, coupled shear walls, wall frames, tubular, cores, futriger - braced and hybrid mega systems.

UNIT 3

BEHAVIOR OF VARIOUS STRUCTURAL SYSTEMS .

• Factors affecting growth, Height and structural form

• - High rise behavior, rigid frames - braced forms - infilled frames,

• shear walls, coupled shear walls, wall frames, tubular, cores, outrigger - braced and hybrid mega systems.

FACTORS AFFECTING GROWTH, HEIGHT, AND STRUCTURAL FORM

• The feasibility and desirability Of high-rise Structures have always depended on

• the available materials,

• the level of construction technology.

• the state of development of the services necessary for the use of the building

• The new materials allowed the development of lightweight skeletal structures.

• permitting buildings of greater height.

• And With larger interior open spaces and Windows.

• The inherent advantages of the composite material which could be readily used to imultaneously satisfy both aesthetic and load-carrying requirements.

Other architectural features of commercial buildings that have influenced structural form are:

• The large entrances and open lobby areas at ground level.

• The multistory atriums.

• And the high-level restaurants

• Viewing galleries may require more extensive elevator systems and associated Sky lobbies.

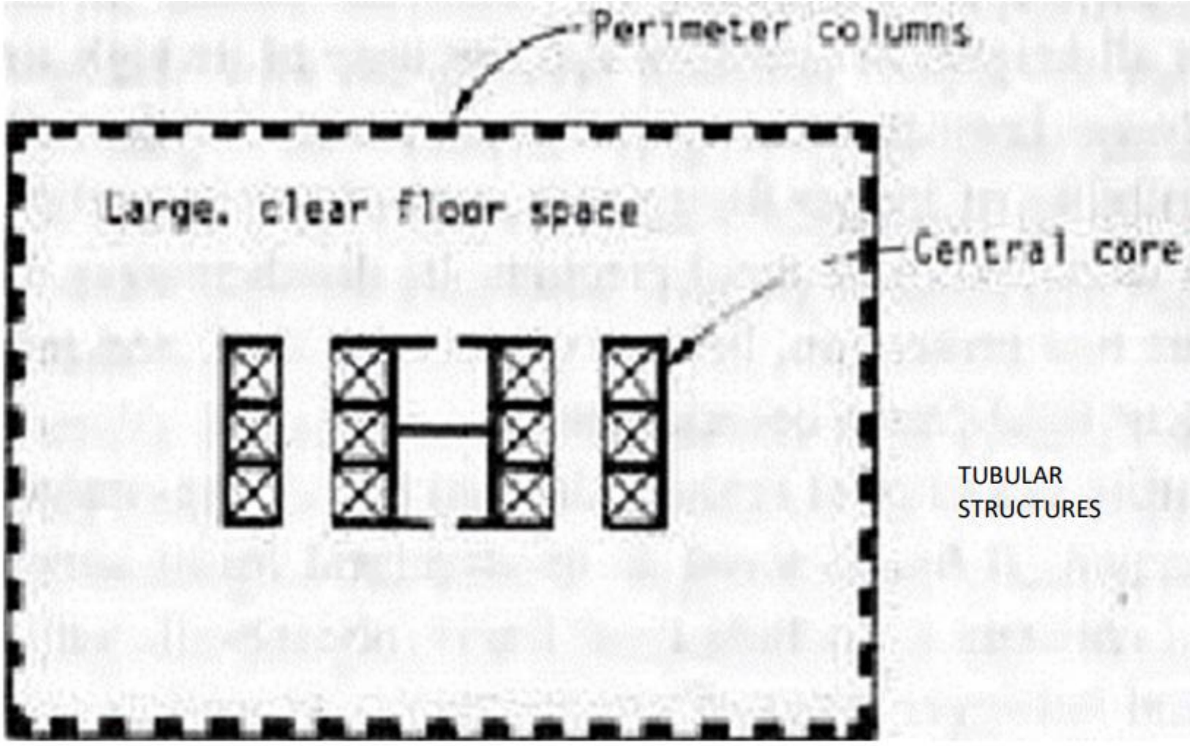
• A residential building's basic functional requirement is the provision of self contained individual dwelling units.

• separated by substantial partitions that provide adequate fire and acoustic insulation.

• Because the partitions are repeated from story to story, modern designs have utilized them in a capacity.

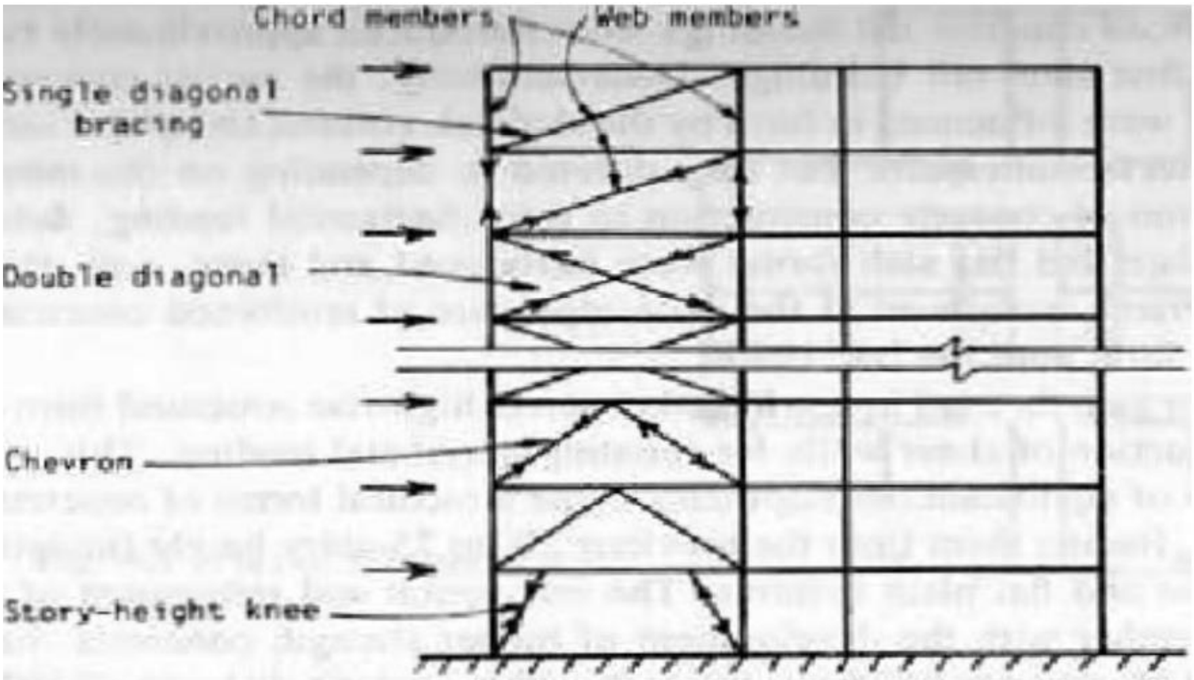
• leading to the shear wall construction.

TUBULAR STRUCTURES



TUBULAR STRUCTURES

Braced frame



Braced frame

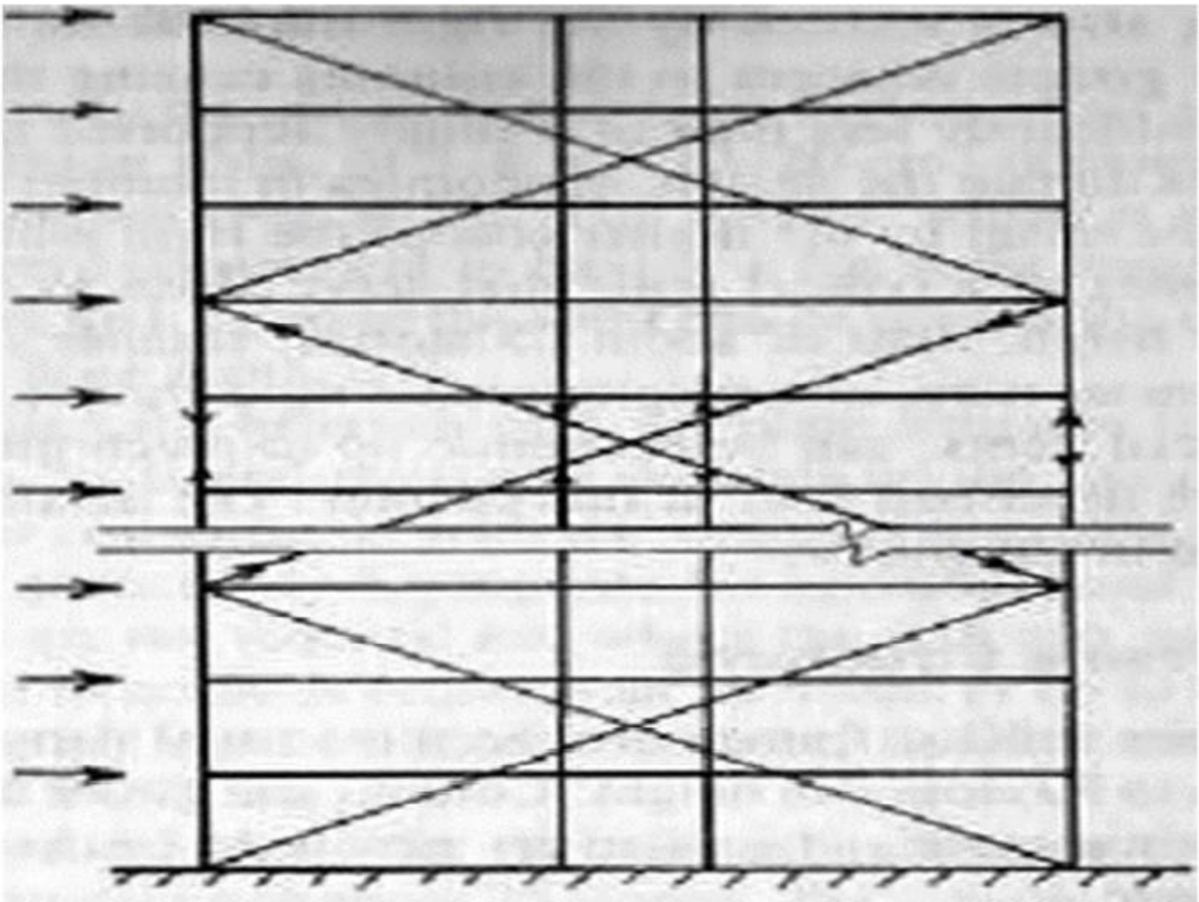


Fig. 4.5 Large-scale braced frame.

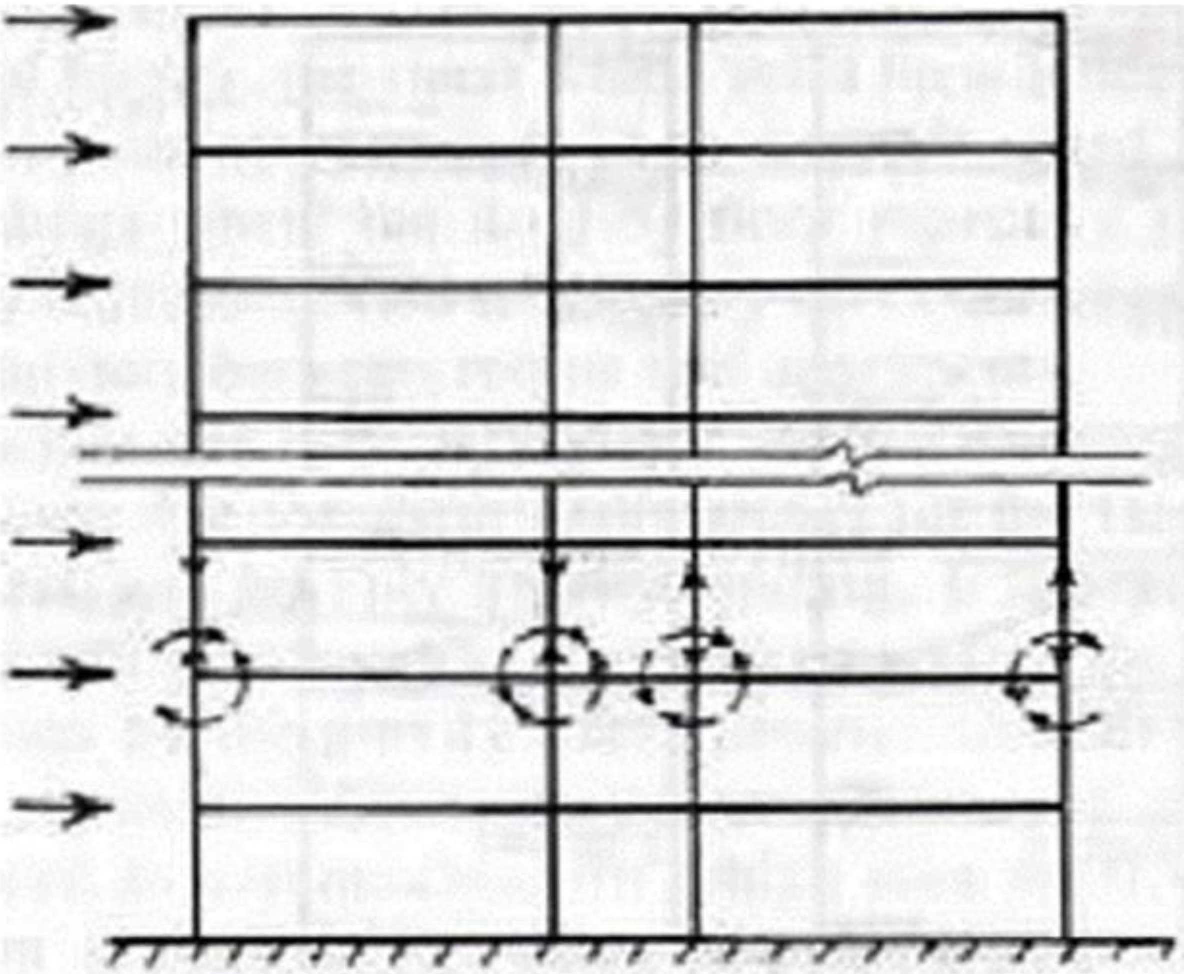


Fig. 4.6 Rigid frame.

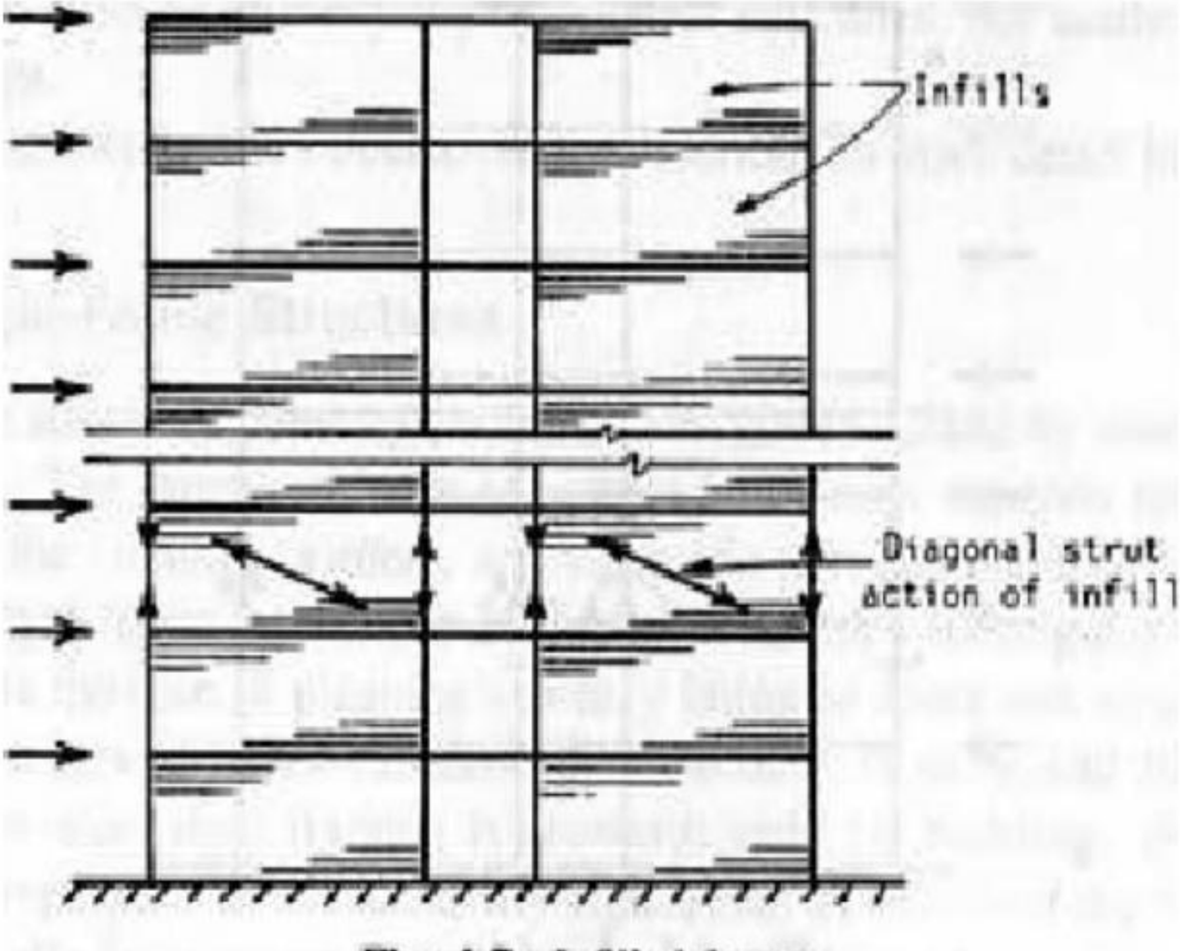


Fig. 4.7 Infilled frame.

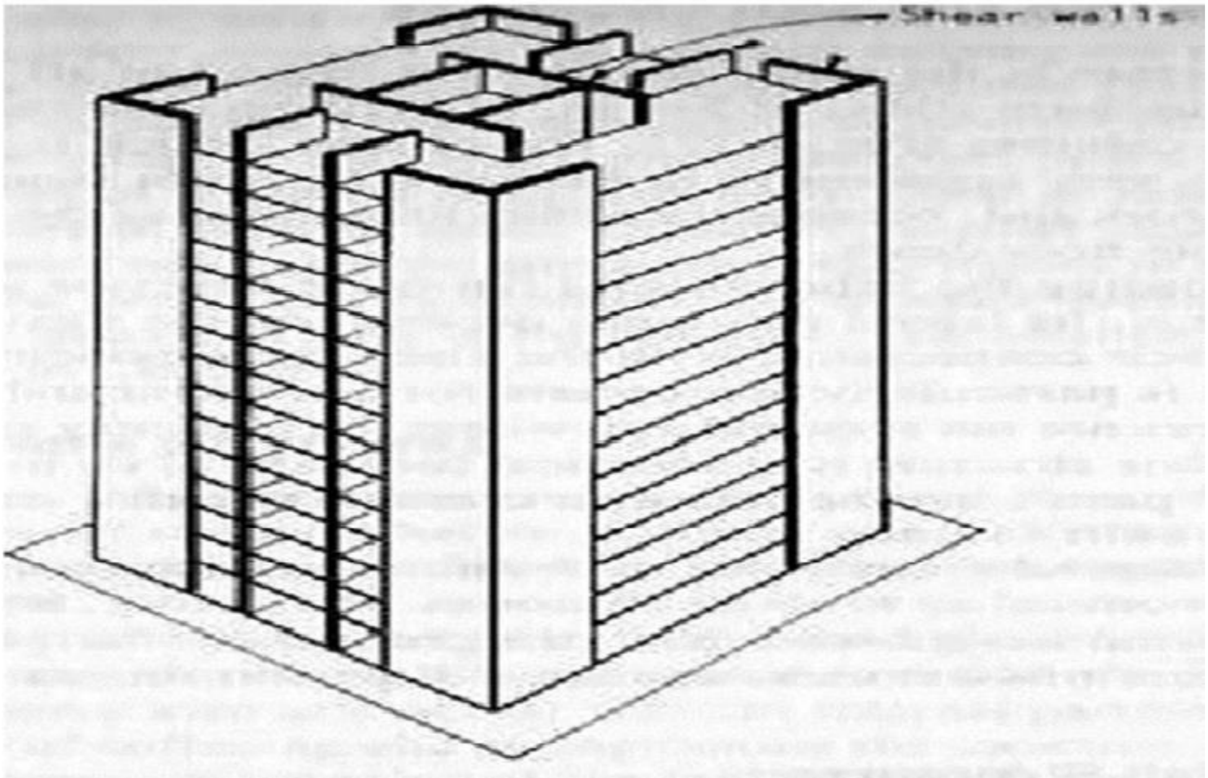


Fig. 4.8 Shear wall structure.

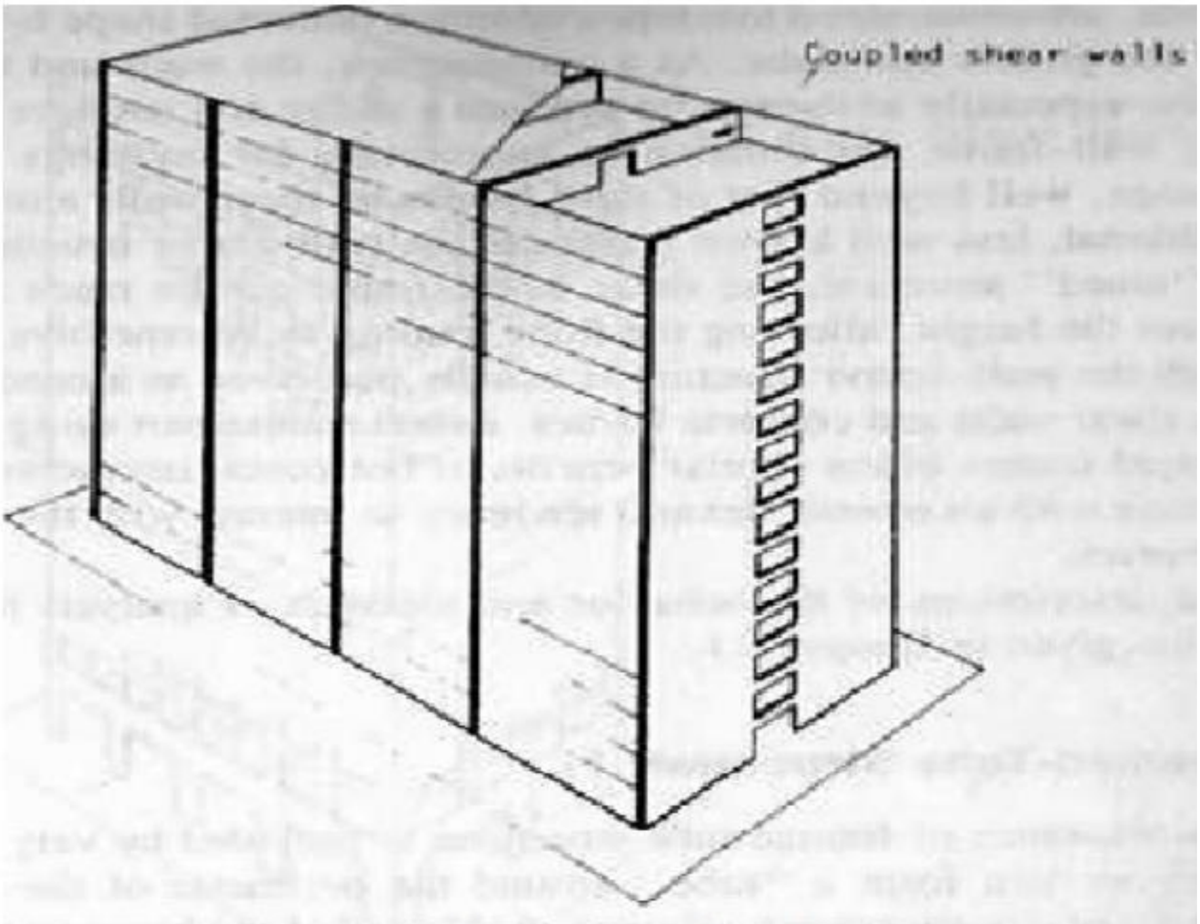
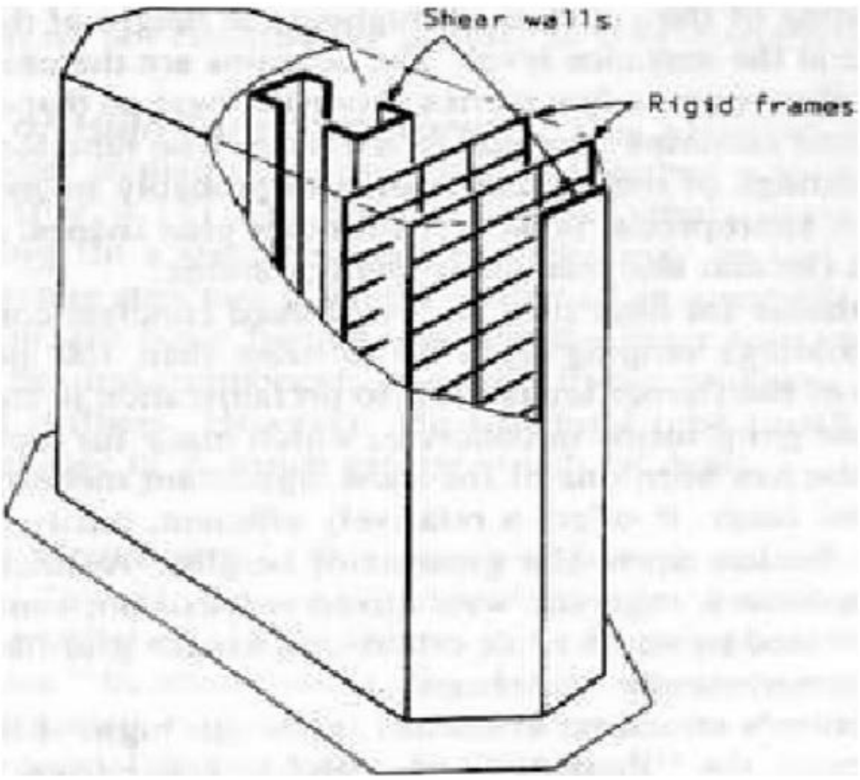


Fig. 4.9 Coupled shear wall structure.



WALL FRAME

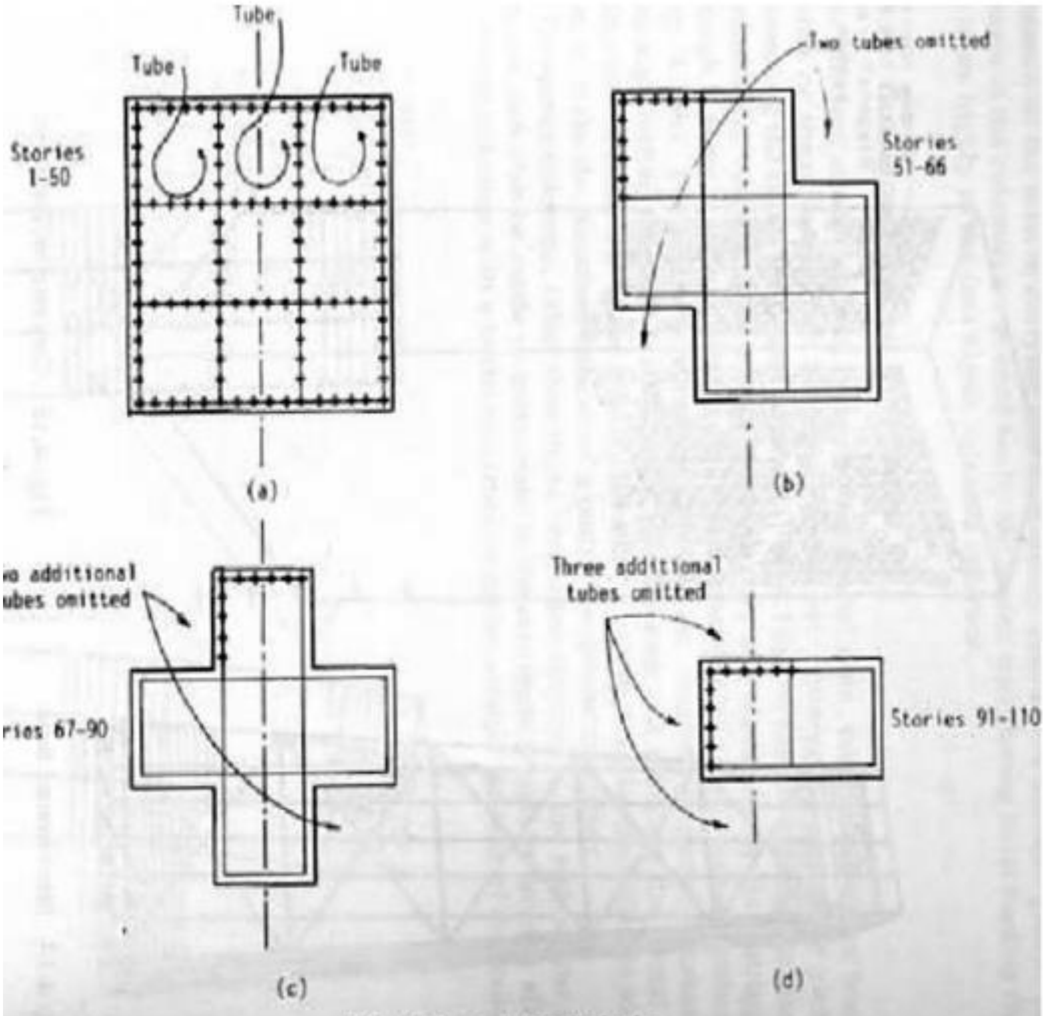


Fig. 4.13 (a-d) Bundled-tube.

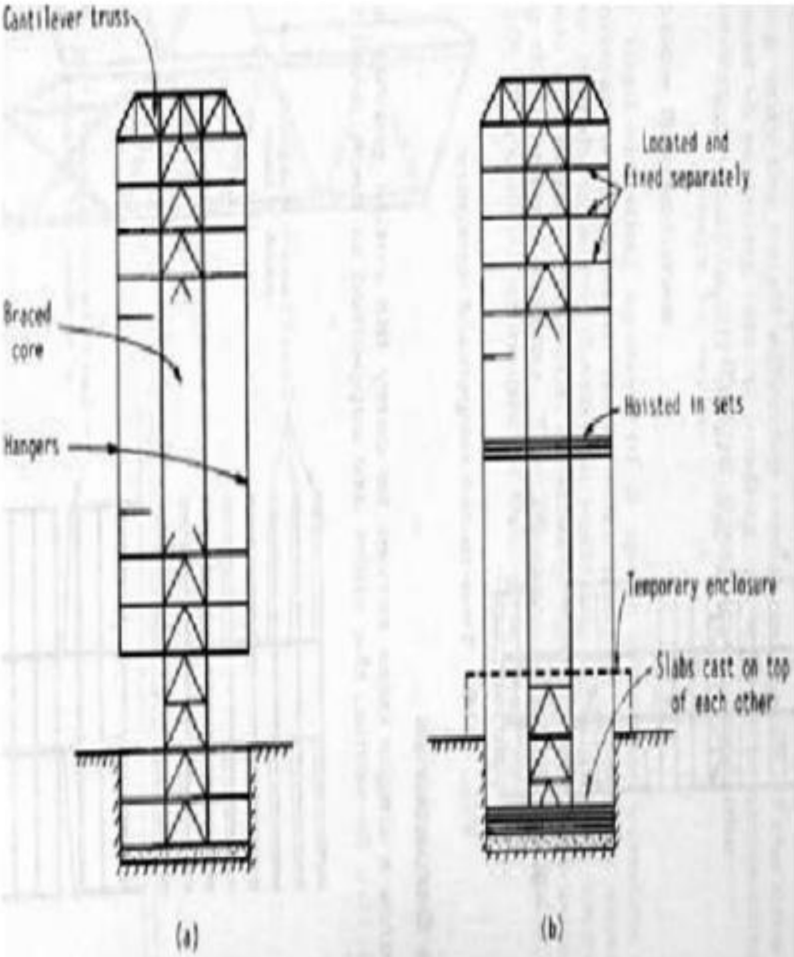
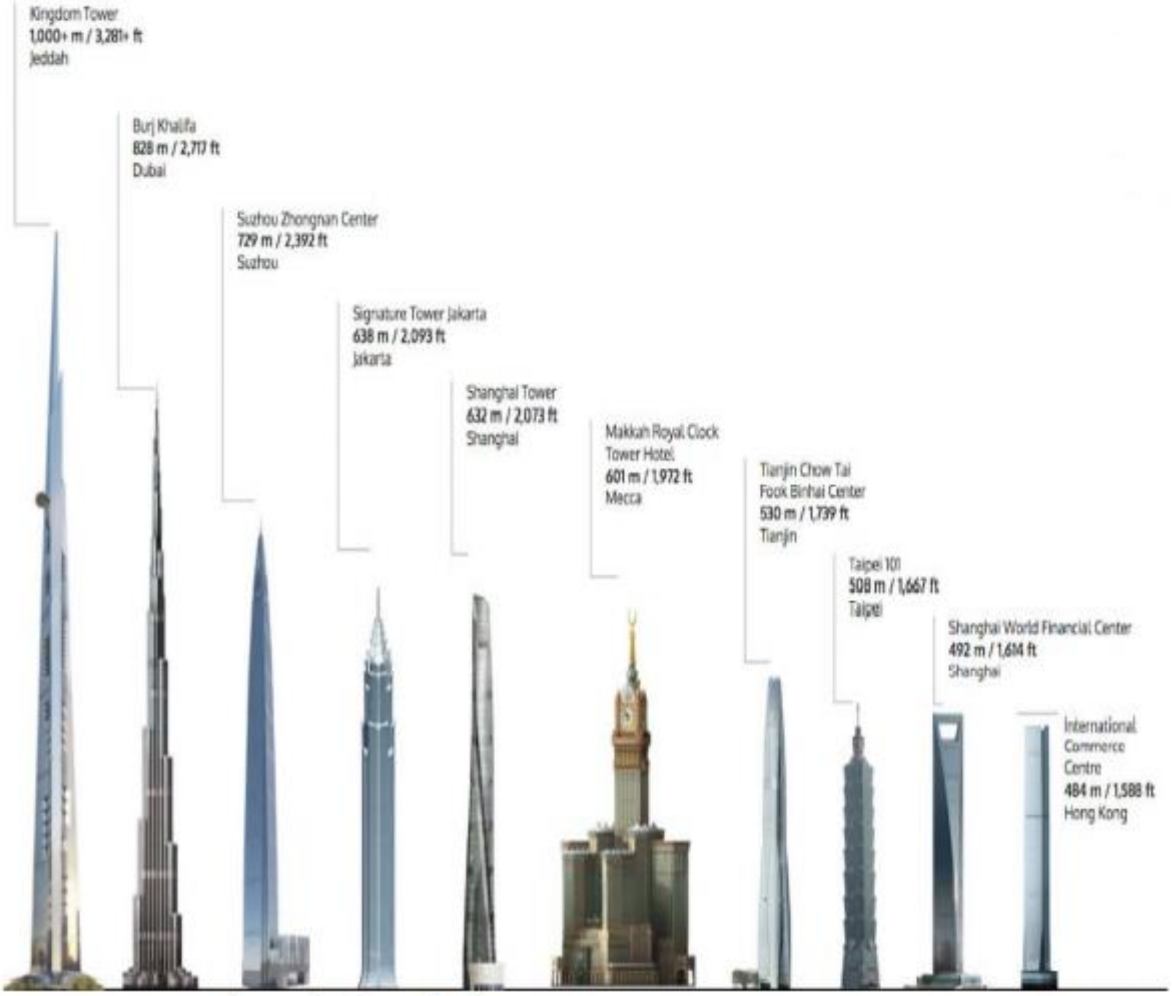
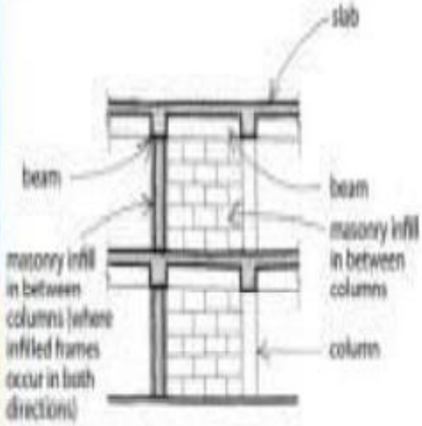


Fig. 4.17 (a) Suspended structure; (b) sequence of construction—suspended structure.

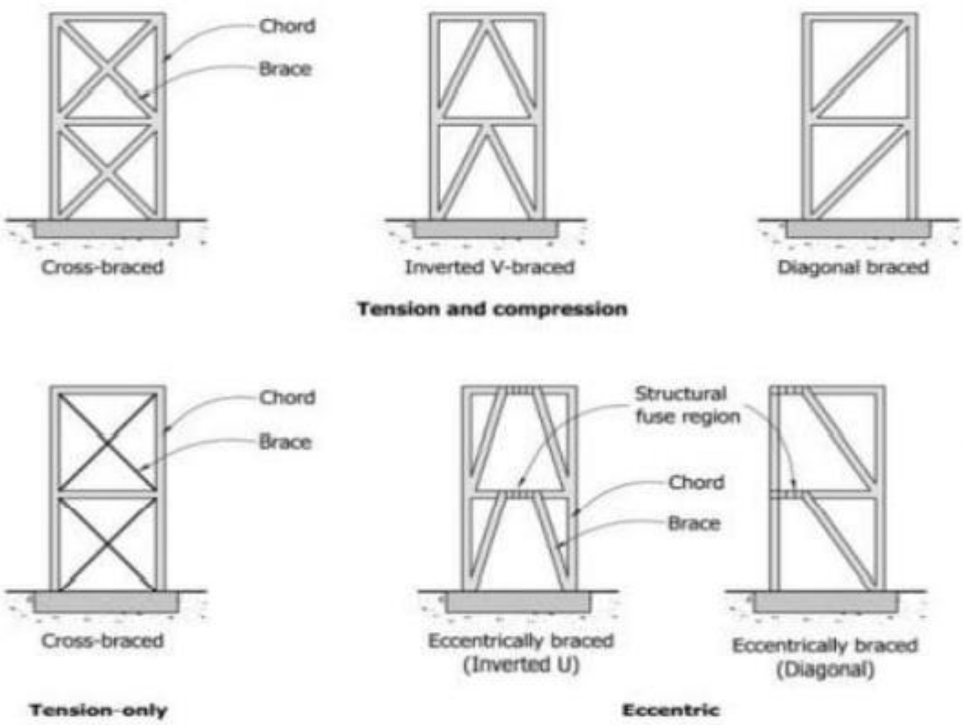


habitable structures

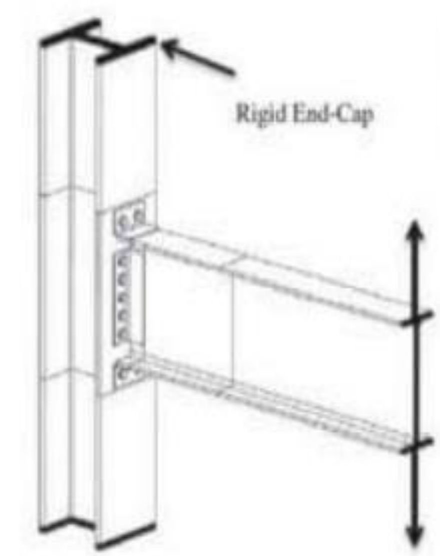
In filled frame structural system



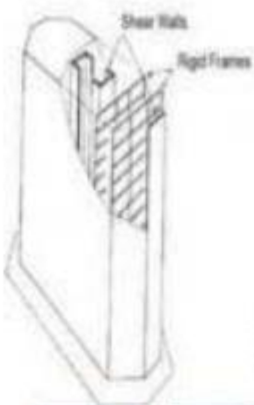
Braced frame structural system

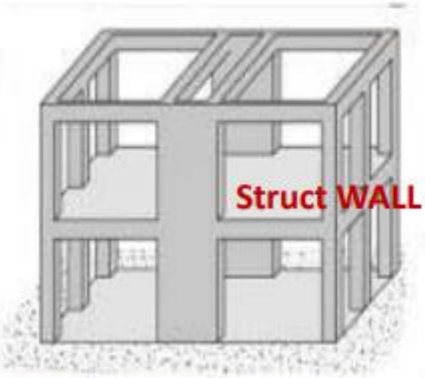


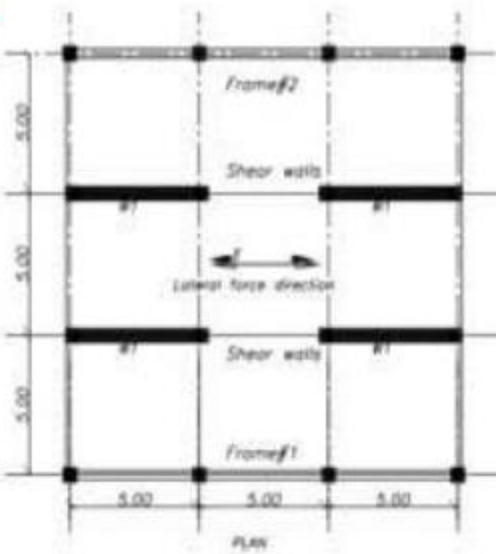
Rigid frame structural system



Wall-frame system (dual system)

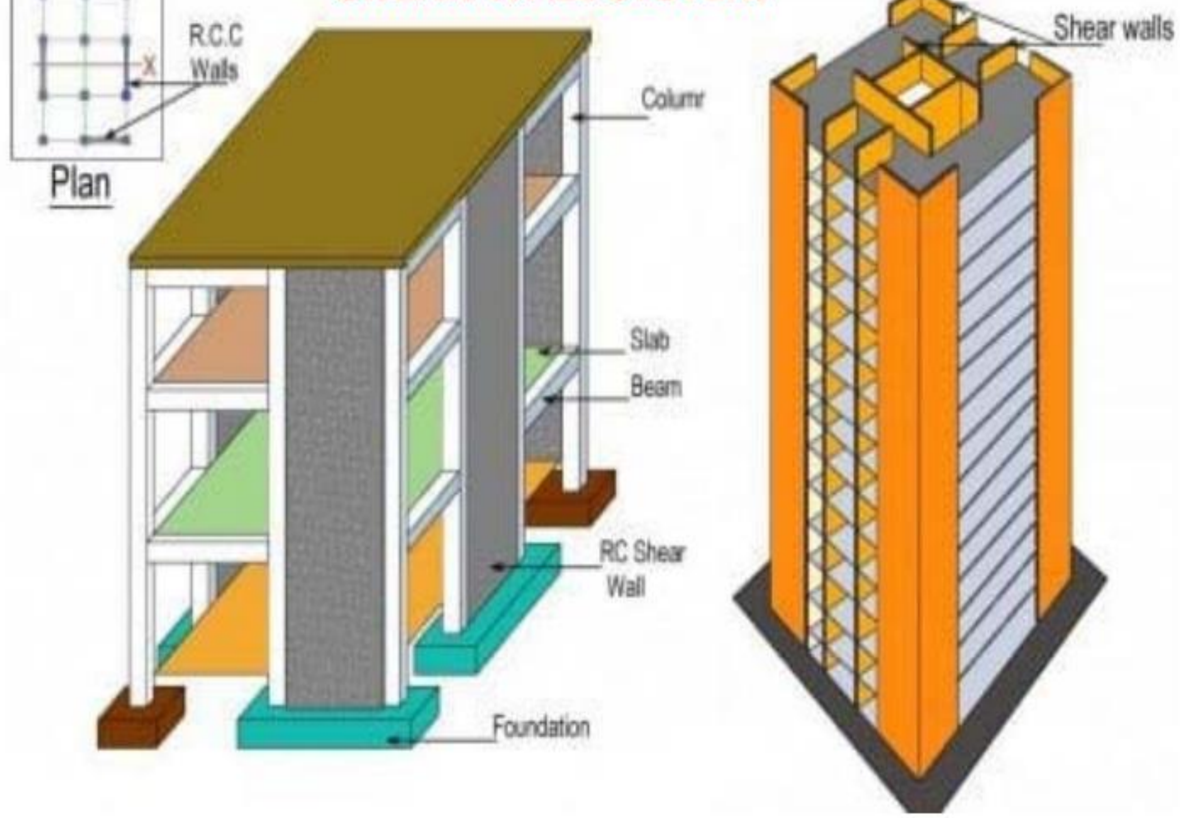




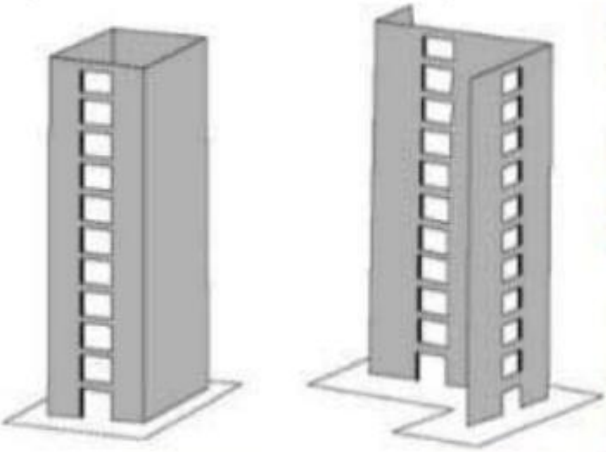


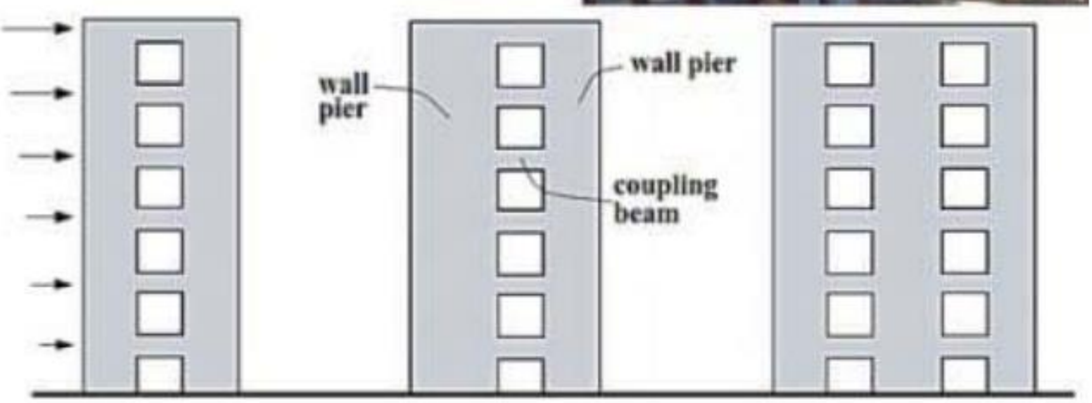
PLAN

SHEAR WALL SYSTEM

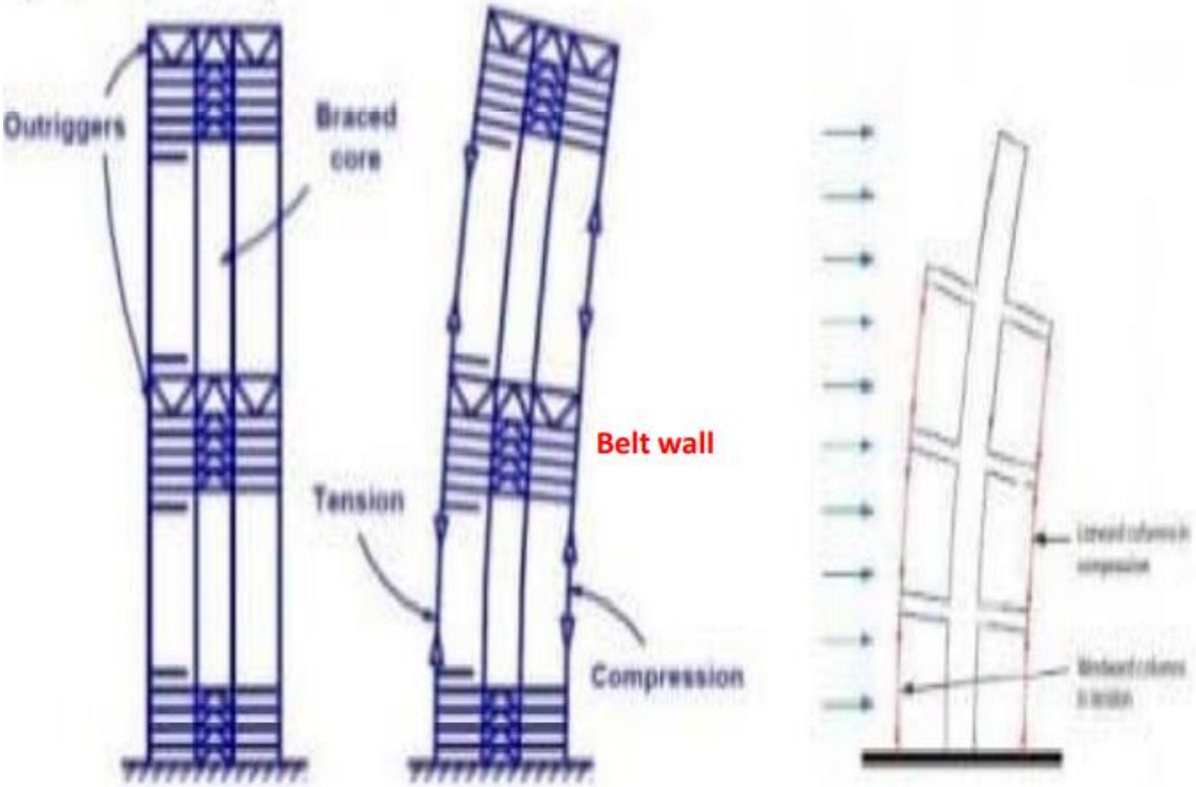


Coupled Shear wall system

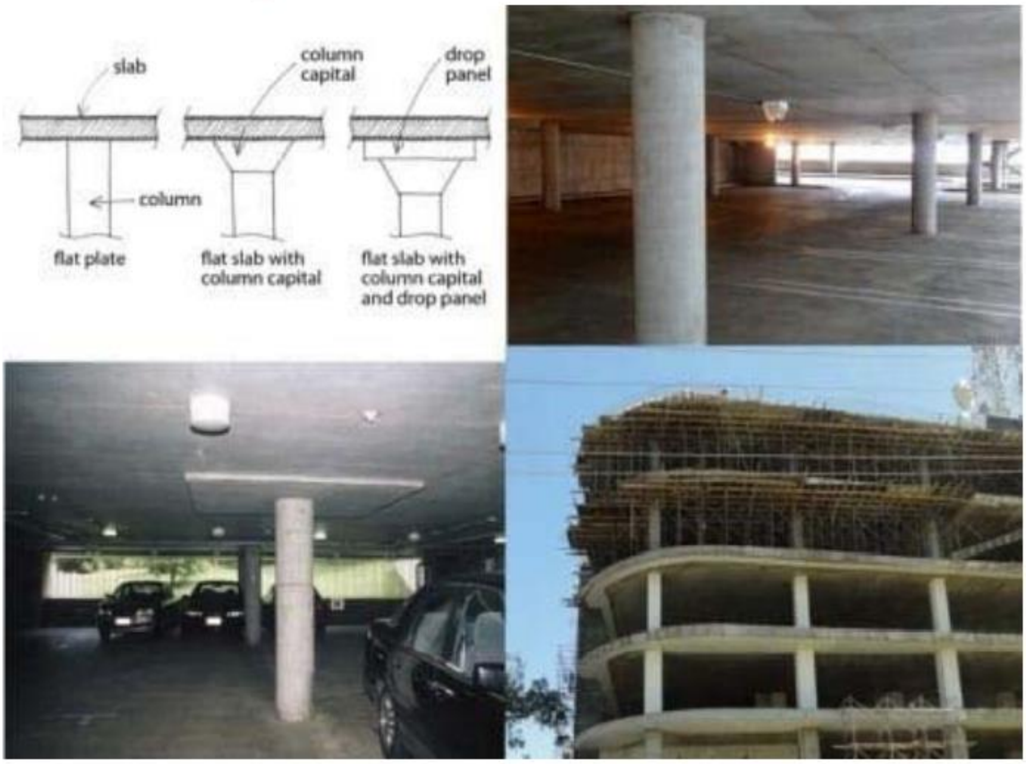




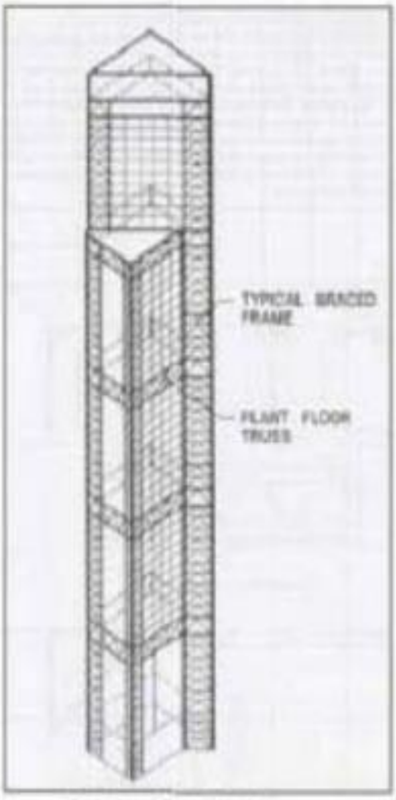
Core and outrigger structural system



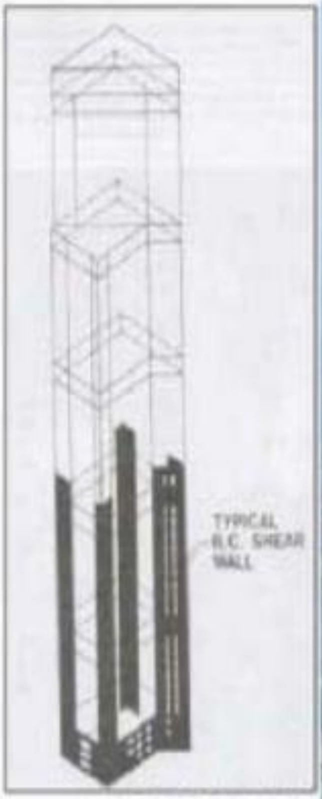
Flat plate and flat slab



Hybrid structural system



Structural Steel System



Primary Shear Wall

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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – IV – Tall Buildings – SCI1618

I. ANALYSIS AND DESIGN

Syllabus

Modeling for approximate analysis, Accurate analysis and reduction techniques, Analysis of a building as total structural system considering overall integrity and major sub system interaction

Structural elements - Sectional shapes, properties and resisting capacities, design, deflection, cracking, prestressing,

UNIT 4

Vertical load analysis

• 2D FRAME-PLANE FRAME

• 3D FRAME- SPACE FRAME

• 2D

• Moment distribution method

• Slope deflection method

• Kani's rotation method

• Substitute frame method

• Matrix method of analysis

• Stiffness matrix method

SOFTWARE FOR 3D FRAME-A FEW

• Stadd pro v8i

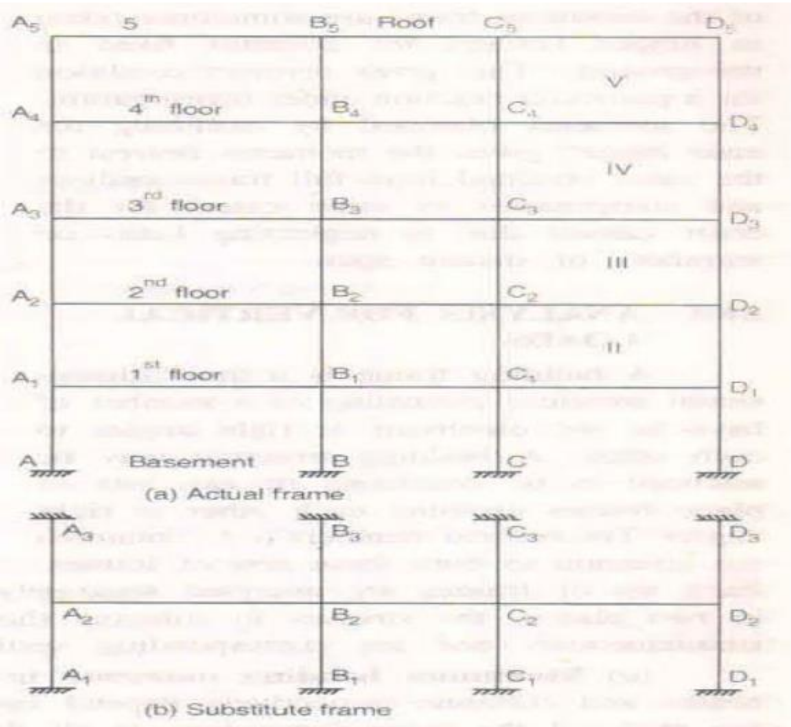
• ETAB

• SAP 2000

• STRAP

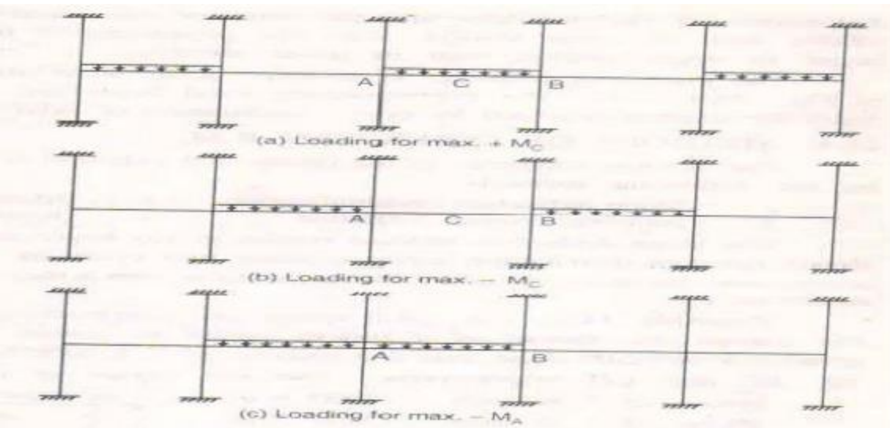
- ANSYS
- ABAQUS
- MIDAS
- STRUCT
- MSC NASTRAN

SUBSTITUTE FRAME METHOD



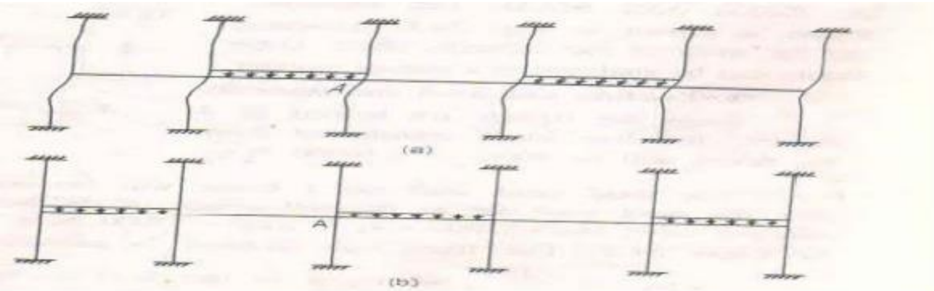
SUBSTITUTE FRAME METHOD

COLUMNS



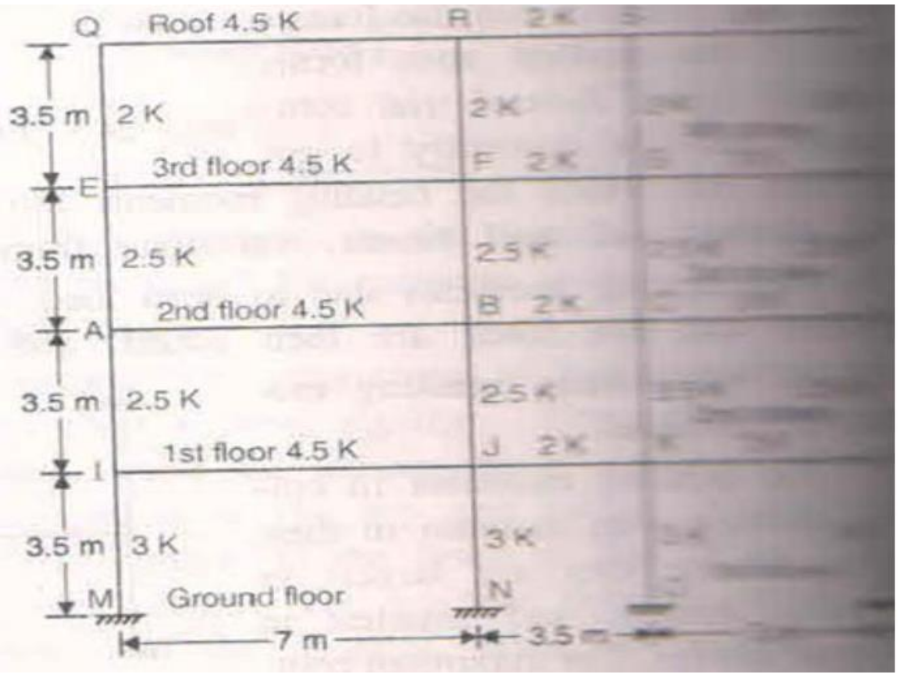
COLUMNS

BEAMS



BEAMS

DISTRIBUTION FACTORS



DISTRIBUTION FACTORS

LATERAL LOAD ANALYSIS

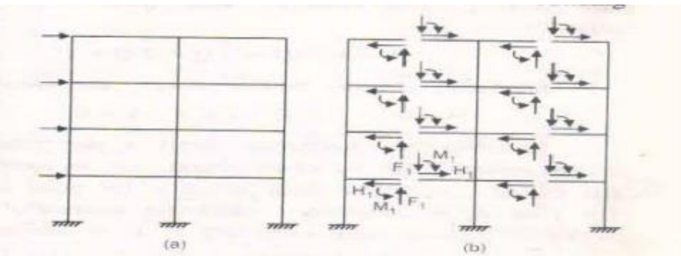
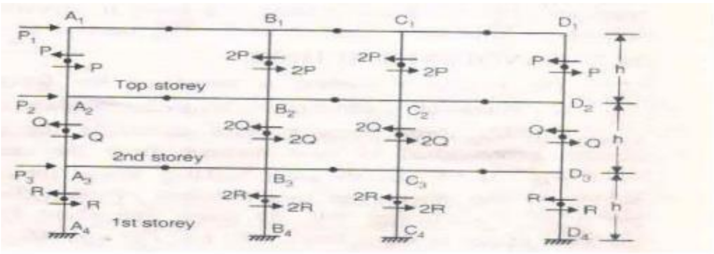


FIG. 24.7

er method. 3. Factor method.

LATERAL LOAD ANALYSIS

PORTAL METHOD



PORTAL METHOD

Pre stressed concrete

• Prestressing of concrete is a method for overcoming the weakness of concrete in tension and can be accomplished in three ways:

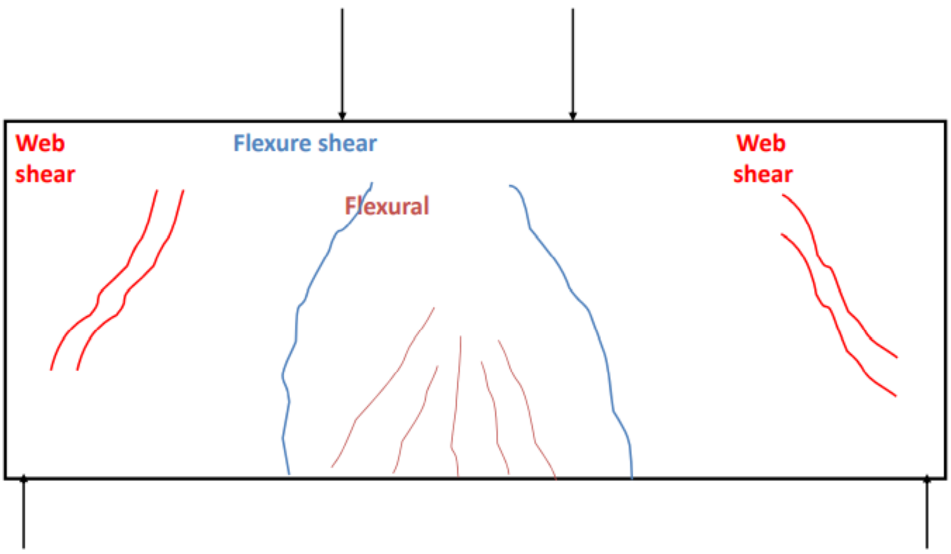
• Pre-tensioning, and

• Bonded (Grouted) or

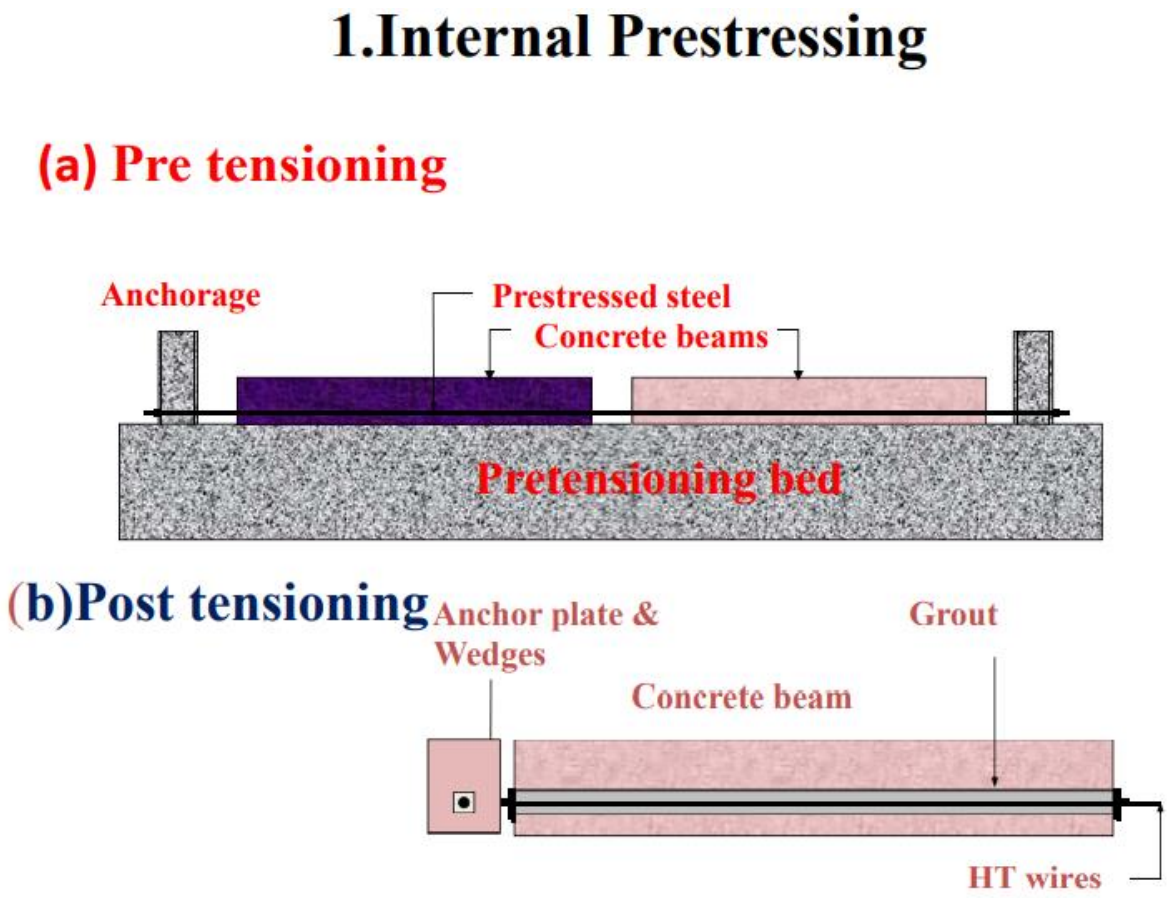
• Unbonded (ungrouted) Post-tensioning.

• Concrete in which internal stresses of such magnitude and distribution are deliberately induced (introduced) to counteract with the stresses induced due to dead and live loads to a desired degree. – T.Y.Lin

Type of Cracks

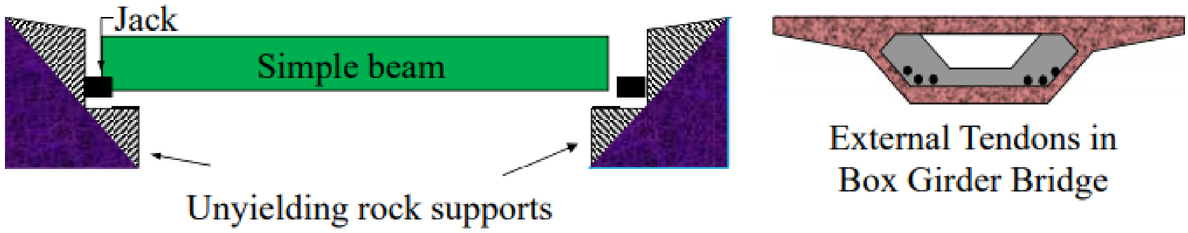


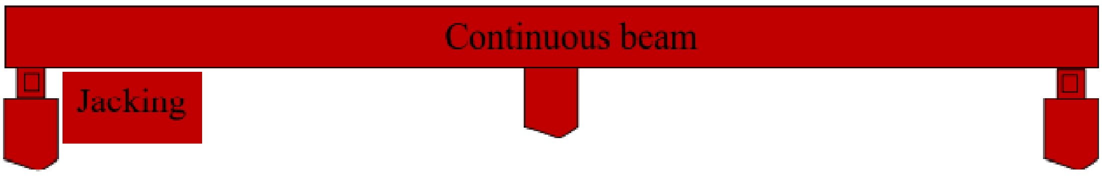
Internal Pre tensioning



External Prestressing

2.External Prestressing





Prestressing cables/ Strands

Prestressing cables/ Strands

 Wires 3-8mm dia

- Cables
- Strands Of High tensile steel

PRESTRESSING SYSTEM

• Wedge action producing frictional grips on the wires.

• Direct bearing from rivets or bolts at the end of the wires.

• Looping the wires around the concrete

ADVANTAGES OF PSC

Compared to RCC

• High strength materials used

• Slender Sections(less weight)

• More Cover

• Crack Free

• More Protection & Cover To Steel

• Economical as Long Span & Large Diameter -Sized

• Longer life

• Varying lever arm

Comparison of PSC vs. RCC

Comparison of PSC vs. RCC

PSC	RCC
High strength concrete	Ordinary strength conc
High tensile strength steel	Ordinary tensile strength
Full c/s of conc .is utilized	Only conc. above N.A is used
Diagonal tension is controlled by pre comp. Stress.	Closed vertical stirrups are reqd to control diagonal tension.
Span to depth ratio is more	Span to depth(l/d) is more

PSC	RCC
Highly economical for large span structures.	Uneconomical
Shrinkage is very less	Shrinkage is high
Creep is very less	Creep is high
Serviceability conditions must be checked	Need not be checked always.
Varying lever arm	Constant lever arm
Highly complex technology	Easy technology.
Need auxiliary units for prestressing	No need

PSC

• High strength concrete

• High tensile strength steel

• Full c/s of conc .is utilized

• Diagonal tension is controlled by pre comp. Stress.

• Span to depth ratio is more

• Highly economical for large span structures.

• Shrinkage is very less

• Creep is very less

• Serviceability conditions must be checked

• Varying lever arm

• Highly complex technology

• Need auxiliary units for prestressing

RCC

• Ordinary strength conc

• Ordinary tensile strength

• Only conc. above N.A is used

• Closed vertical stirrups are reqd to control diagonal tension.

• Span to depth(l/d) is more

• Uneconomical

• Shrinkage is high

• Creep is high

• Need not be checked always.

• Constant lever arm

• Easy technology.

• No need

Types of prestressing

• **Type 1** full pre stress:

no tensile stresses are allowed

• **Type 2** Limited prestress:

tensile stresses are allowed but no visible cracks are allowed.

Type 3 partial prestress:

cracks are allowed with limitations without affecting the serviceability

SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – V – Tall Buildings – SCI1618

I. CONSTRUCTION TECHNOLOGY FOR TALL BUILDINGS

Syllabus

Assembly of buildings, Safety Policy, Stages of Site investigation, On site tests, Foundation, Basement construction and Water proofing, Materials, Selection & handling, Wall & Floor construction, Roof Construction.

UNIT 5

CONSTRUCTION TECHNOLOGY FOR TALL BUILDINGS

- Assembly of buildings,
- Safety Policy,
- Stages of Site investigation,
- On site tests,
- Foundation,
- Basement construction
- and Water proofing,
- Materials,
- Selection & handling,
- Wall & Floor construction,
- Roof Construction

Assembly of buildings bottom up constn/top down constn

cast in situ construction

- PT slab and beams
- Alu form work / Mivan
- Jump form tech and Slip form tech
- Tunnel form work

Pre-cast construction

- RCC panels
- Prestressed panels
- EPS panels
- GFRG panels

Safety policy

- Mechanization
- Safety to labourers
- Safety net
- Time and working hours
- Night works
- Precautions during operation
- Helmets, safety belts etc.
- Insurance to workers, machinery and professionals

Stages for site investigation

- Before preparing the plan for construction-
- To ascertain the dimension of the site in all four sides.
- Checking of road width w.r.t doc and site.
- Transformers/HT lines in the site
- Soil exploration stage
- Dispute of boundaries with adjacent site
- Miss matching of area at site with respect to document

Difference of measurement with respect to patta,chitta,FM sketch and ADANGAL

- Before submitting for approval to dev. authority
- Location of bore well/ground water testing
- Soil bearing capacity-disagreement with the recommendation of geo tech report
- Type of footings to be provided
- Depth of footing
- Back filling with or without excavated soil
- Height of basement based on road and civic development

On site tests

- SPT FOR SOIL
- Sieve analysis for Sand and coarse aggregate
- Bulkage of sand
- Testing of cement
- Initial testing
- Final setting
- Consistency OF CEMENT
- Colour
- Fineness
- For concrete
    - A.slump test
    - B. casting and testing of cubes to find out comp.strength
    - C. water absorption test for bricks

On site test on concrete

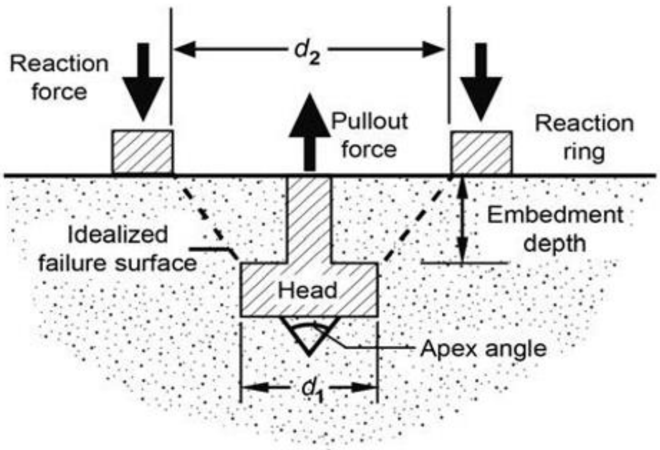
Part I - Existing Structures

1- Compression Test On Concrete Cores

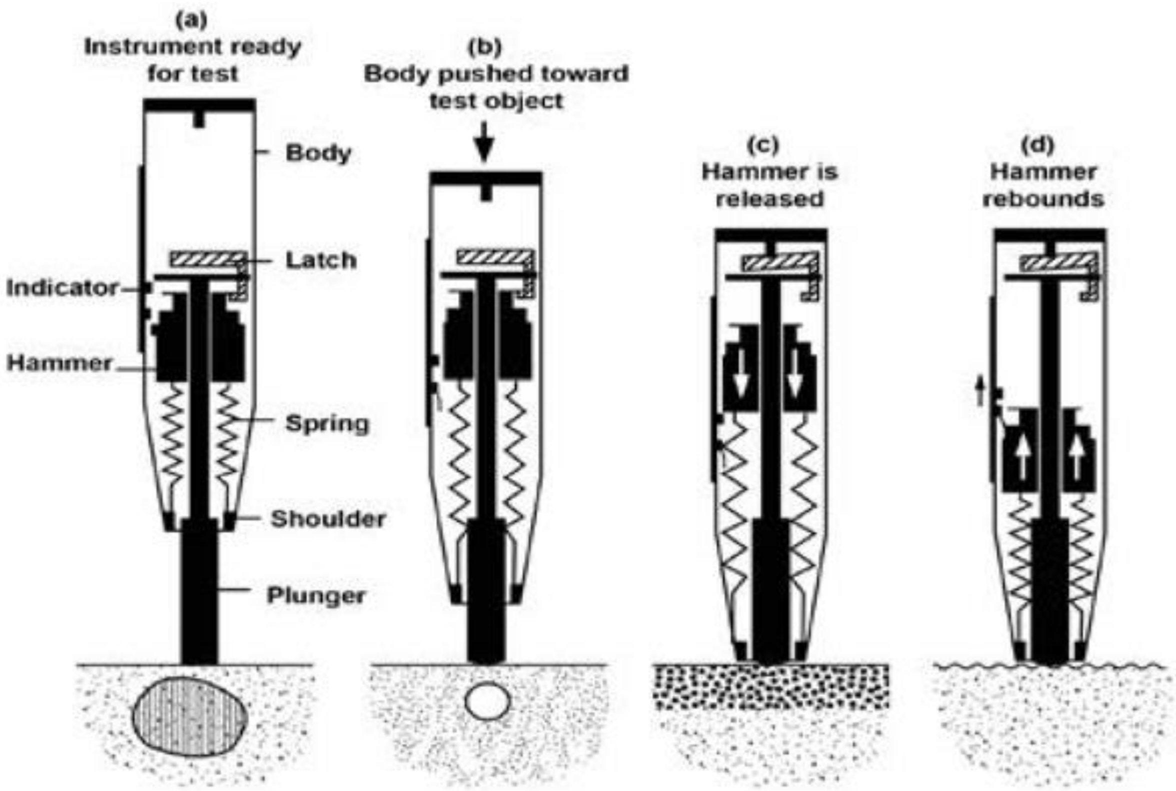
- It is destructive.
- Not only it damages concrete integrity,
- it might affect reinforcing bars in RC structures
- Rebar locating tools,
- Ground Penetrating Radar – GPR are needed to avoid this problem
- Selecting test locations can be difficult.
- Selecting the best location of cores is relatively subjective.
- The locations of cores needs to be repaired.
- Coring is not an option for important structures,
- especially when there are concerns about further damaging the structure

2- The Pull-Out Test

- The concept behind Pull-Out Test is that the tensile force required to pull a metal disk, together with a layer of concrete,
- is related to the compressive strength of the concrete.
- The pull out test is normally used for early diagnosis of strength problems.
- However, it can be used to evaluate the strength of concrete in existing structures.
- Pull out testing involves attaching a small piece of equipment to the exterior bolt, nut, screw or fixing.
- This is then pulled to the designated stress load level to determine how strong and secure the fixing is.

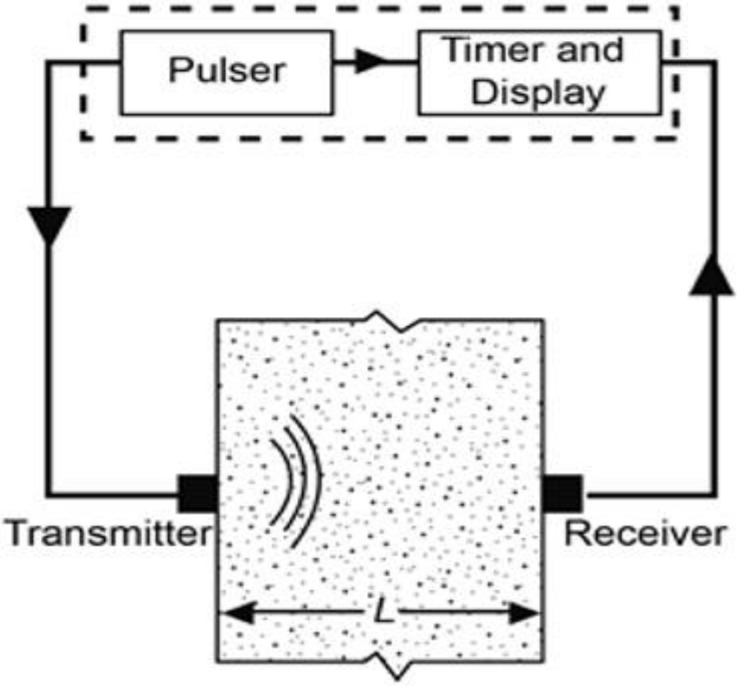


- Relatively easy to use
- If relationship to strength is established,
- The method can deliver robust test results.
- Pull-Out test often involves crushing and damaging concrete



- In-place uniformity of concrete,
- to delineate variations in concrete quality throughout a structure, and
- It is easy to use for most field applications.
- The test can be used to study the uniformity of concrete
- surface condition, presence of rebar,
- Presence of sub-surface voids can affect the test results

4.Ultra sonic Pulse Velocity - UPV



1 Determines the velocity propagation of pulse of vibrational energy through concrete.

2.The pulse velocity can be correlated to elastic modulus and the density of concrete.

3.As elastic modulus and strength are not linearly related, the correlation is not linearly dependent

3.Highly influenced by the presence of reinforcement as well as aggregate and moisture

4.Also applicable to assess the quality and uniformity of concrete

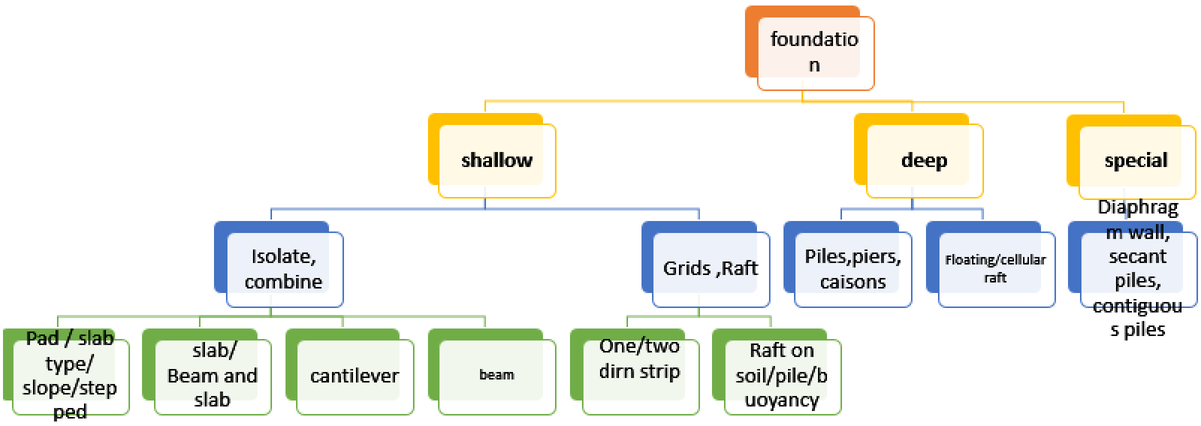
5.To find the availability of cracks and voids

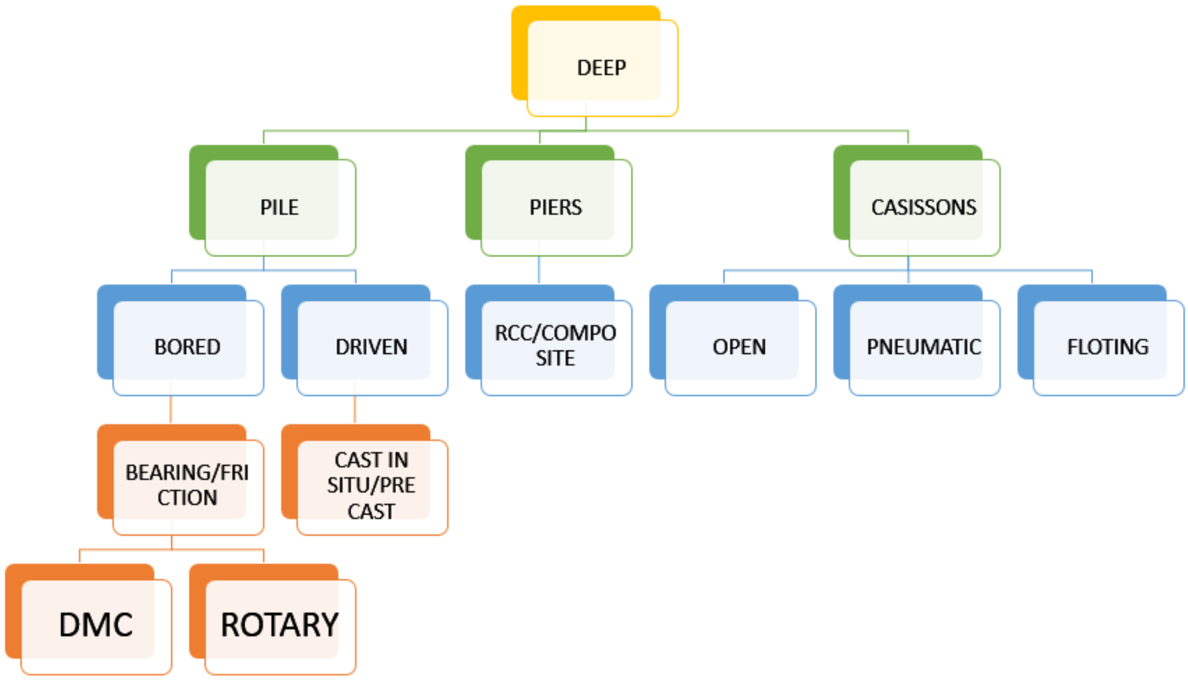
- Ultrasonic Pulse Velocity (UPV) is an effective method for quality control of concrete materials,
- and detecting damages in structural components.
- The UPV methods have been traditionally used for
- the quality control of materials,
- Mostly homogeneous materials such as metals and welded connections.
- With the recent advancement in transducer technology,
-
- The test has been widely accepted in testing concrete materials.

- The test procedure has been standardized as “Standard Test Method for Pulse Velocity through Concrete”
- The concept behind the technology is measuring the travel time of acoustic waves in a medium,
- and correlating them to the elastic properties and density of the material.
- Travel time of ultrasonic waves reflects internal condition of test area.
-
- UPV can be used to detect other sub-surface deficiencies
- The method is affected by presence of rebar, voids, and cracks.
- There is no enough results for assessing the reliability of the method in the field.

FOUNDATION SYSTEMS

- RCC
- COMPOSITE
- SHALLOW width of footing =depth of excavation
- DEEP
- SPL FOUNDATIONS
- FLOATING
- MMP FOR OP
- JETTIES
- TG FOUNDATION
- MACHINE FONDATION
- DIAPRAGM WALL
- SECANT /CONTIGUOUS PILE





- BASEMENT CONSRUCTION
- WATER PROOFING
- SELECTION OF MATERIALS AND HANDLING
- WALL AND FLOOR CONSTRUCTION
- ROOF CONSTRUCTION

Foundation for high rise building

- RAFT
- PILED RAFT
- CELLULAR RAFT
- Diaphragm walls

BASEMENT CONSTUCTION

- SINGLE BASEMENT
- MULTIPLE BASEMENT

- PANEL SLAB
- GRID SLAB
- RAFT TOP
- SLAB TYPE
- SLAB WITH BEAMS
- SLAB WITH INVERTED BEAMS

Basement Water proofing

- Water proof treatment
- Grouting at PCC top
- Layer of water proof mortar
- RAFT CONCRETE
- Grouting of raft concrete
- Membrane water proofing
- Epoxy grouting
- Finishing layer
- Grouting of basement walls

WALL AND FLOOR CONSTRUCTION

- Shear wall with boundary elements,
- coupled,ORDINARY sh wall
- Rcc wall
- In filled wall
- Brick wall
- Block wall

Floor construction

- Slab with beams

- Waffle slab
- Fuller slab
- Grid slab

Roof construction

- Shell roof
- Folded plate
- Composite
- Trussed roof- metal sheets
- Space frame structure