FAQ's

1. Write a note on what you understand about High Rise Buildings and its components.

Emporis standards-

"A multi-story structure between 35-100 meters tall, or a building of unknown height from 12-39 floors is termed as high rise.

Building code of Hyderabad, India-

A high-rise building is one with four floors or more, or one 15 meters or more in height.

National Building Code (Part 4) – Fire and Life Safety all buildings 15m and above in height shall be considered as high rise buildings.

The International Conference on Fire Safety –

"any structure where the height can have a serious impact on evacuation"

Massachusetts, United States General Laws –

A high-rise is being higher than 70 feet (21 m).

- Can be classified based on the structural material used such as concrete or steel
- Structural systems of tall buildings can also be divided into two broad categories:

1) Interior Structures

2) Exterior Structures

- This classification is based on the distribution of the components of the primary lateral load-resisting system over the building. A system is categorized as an interior structure when the major part of the lateral load resisting system is located within the interior of the building. Likewise, if the major part of the lateral load-resisting system is located at the building perimeter, a system is categorized as an exterior structure. It should be noted, however, that any interior structure is likely to have some minor components of the lateral load-resisting system at the building perimeter, and any

exterior structure may have some minor components within the interior of the building.

Interior structural system

1) Rigid Frame

- A rigid frame in structural engineering is the load-resisting skeleton constructed with straight or curved members interconnected by mostly rigid connections which resist movements induced at the joints of members. Its members can take bending moment, shear, and axial loads.
- Consist of columns and girders joined by moment resistant connections.
- Can build upto 20 to 25 floors

2) Shear Wall Structure

- Concrete or masonry continuous vertical walls may serve both architecturally partitions and structurally to carry gravity and lateral loading. Very high in plane stiffness and strength make them ideally suited for bracing tall building
- Usually built as the core of the building
- Can build upto 35 Floors

Exterior structures

1) Tube system

- The tube system concept is based on the idea that a building can be designed to resist lateral loads by designing it as a hollow cantilever perpendicular to the ground. In the simplest incarnation of the tube, the perimeter of the exterior consists of closely spaced columns that are tied together with deep spandrel beams through moment connections. This assembly of columns and beams forms a rigid frame that amounts to a dense and strong structural wall along the exterior of the building.

The different tubular systems are-

1) Framed tube 2) Braced tube 3) Bundled tube 4) Tube in tube

2) Diagrid systems

- With their structural efficiency as a varied version of the tubular systems, diagrid structures have been emerging as a new aesthetic trend for tall buildings in this era of pluralistic styles.
- Early designs of tall buildings recognized the effectiveness of diagonal bracing members in resisting lateral forces.
- Most of the structural systems deployed for early tall buildings were steel frames with diagonal bracings of various configurations such as X, K, and chevron. However, while the structural importance of diagonals was well recognized, the aesthetic potential of them was not appreciated since they were considered obstructive for viewing the outdoors.
- Efficiently resists lateral shear by axial forces in the diagonal members but have Complicated joints

3) Space truss

- Space truss structures are modified braced tubes with diagonals connecting the exterior to interior. In a typical braced tube structure, all the diagonals, which connect the chord members – vertical corner columns in general, are located on the plane parallel to the facades.
- However, in space trusses, some diagonals penetrate the interior of the building.

4) Exo skeleton structure

- In exoskeleton structures, lateral load-resisting systems are placed outside the building lines away from their facades.
- Due to the system's compositional characteristics, it acts as a primary building identifier – one of the major roles of building facades in general cases.
- Fire proofing of the system is not a serious issue due to its location outside the building line.

5) Super frame structures

- Super frame structures can create ultra high-rise buildings upto 160 floors.

- Superframes or Megaframes assume the form of a portal which is provided on the exterior of a building.
- The frames resist all wind forces as an exterior tubular structure. The portal frame of the Super frame is composed of vertical legs in each corner of the building which are linked by horizontal elements at about every 12 to 14 floors.
- Since the vertical elements are concentrated in the corner areas of the building, maximum efficiency is obtained for resisting wind forces.

2. Explain briefly about a Typical Floor Construction Cycle.

In the construction of a high-rise building, one of the planning objectives is to ensure the early completion of the structural frames to generate floor areas for the execution of finishing works, building services installation and internal fitting out. The completion of the structural frames is therefore critical in the overall programme. For a building of 42-storeys high, it may consist of 40 typical floors resting on two podium floors. It is not surprised to have construction programme aiming at a 2-day or 4-day cycle for the typical floors. It would be a time-cost trade off problem in determining the duration for a project in project-wise considerations or in selecting construction methods for major construction activities. Planning engineers have to balance the resources inputs and the duration for activities in order to ensure a smooth flow of work sequences in meeting the project duration.

In minimizing the construction costs for constructing a reinforced concrete frame, the formwork cost is one of the key concerns. It is well recognized that formwork is a temporary work for forming moulds for wet concrete. The cost of formwork is highly related to the number of re-use or re-cycling. It is a general assumption that a set of formwork can be re-used for at least six to eight times and 100 times for timber and steel form respectively. Steel formwork systems are prevailing in high-rise building construction because of their durability, good concrete finish and environmental sustainability.

However they are expensive unless the formwork system is designed to yield a high number of reuse. Taking the above example, a set of formwork for 40 typical floors is still uneconomical. Consequently, it has

to subdivide the floor area into zones in order to generate a high number of reuse.

The subdivision of a floor into two or four zones will be a feasible solution. It is obvious that dividing the floor into four zones would yield a high number of re-use, that is 160 times. The following example shows the arrangements of a 6-day floor cycle for a typical residential building block.

Example-Construction of a 42 Storey Building

Each floor is divided into four zones. One set of steel wall form covering the quantity of one zone and two sets of slab timber forms with each set covering the whole area of one floor are used. In order to speed up the construction, precast façades and semi-precast slabs are employed.

The construction cycle aims at ensuring smooth and balanced resource allocations between trade workers, concreting work and formwork installation. As a result the resources rotate horizontally between zones at the same floor level and move upward to the upper floor in the next cycle. The schedule is prepared assuming that the activities are carried out at constant duration. However, the

duration of activities varies due to factors such as supply of materials, skill of workers, weather and efficiency of plant and equipment.

On the other hand, material hoisting plays an important role in high-rise building construction. As the building 'grows', the transportation time increases and thus extends the duration for the crane-related activities.

3. Explain briefly how to make a simulation model for a typical floor construction cycle.

Simulation techniques have been used to predict activity duration and improve planning. However, the building up of simulation models requires planners to have a good knowledge of simulation. A network based simulation can be used in this study. This simplifies the skills and knowledge required for modelling a simulation network as general simulation programme can be difficult for general users.

Planners who have the knowledge in constructing critical path network and bar charts could be able to use the simulation model. The construction of simulation network for modelling is similar to the critical path network using the 'activity on node' format except that loops are

allowed to show the re-cycling of resources. During the simulation process, the activities may either be inactive if the constraints are met or otherwise in an idle mode.

	Duration (hours)		
Activity	**Mean**	**Maximum**	**Minimum**
Precast facade fixing	1.00	1.25	0.85
Wall steel fixing	7.00	6.75	7.15
Wall form fixing	2.25	2.50	2.00
Wall concreting	4.00	4.50	3.75
Stripping form	2.25	2.50	2.00
Semi-precast slab fixing	3.00	3.50	2.75
Slab form fixing	7.50	8.00	7.00
Beam and slab steel fixing	8.00	9.00	7.50
Electrical conduiting etc.	2.50	3.00	2.00
Beam and slab concreting	4.00	4.50	3.75

Table 1 Activity duration for a typical floor construction cycle

Simulation Results

Working period	Activity Duration	Cycle (days)	Compared with 6-day cycle
8:00 - 18:00	Constant	6.21	3.5
8:00 - 18:00	Variables	4.45	-25.8
8:00 - 19:00	Variables	4.41	-26.5
7:00 - 19:00	Variables	3.77	-37.2

Table 2 Simulation results for different 'Working Period'

Selection of appropriate schedule

The simulations provide alternatives for planners to make decisions on initial scheduling and subsequent updating. The simulation results enable planners to locate the upper limit of the floor cycle, ie approaching to the crash time solution. However, it is a general rule in planning that the normal time should be used in the planning stage unless the project duration would have already been overrun. When deciding the appropriate floor cycle duration, planners have to review the factors and the merits prior to determine the strategies.