

Challenges in high-rise buildings

For high-rise structures, the wind force becomes a major concern in design of the structural frame

Post World War-II, there has been an increasing influx of people to cities from rural hinterland. This has created a situation where high-rise buildings have become a necessity in cities due to a number of contributing factors, the principal among them are an acute scarcity of land in urban areas, increasing resistance of farmers on the fringes of urban agglomerations to land acquisition and rising demand for housing stock and various facilities and amenities.

The planning and design of high-rise buildings presents a host of challenges. This article is an attempt to enumerate these challenges. While some of the challenges are peculiar to high-rises, some are independent of height of the structure, but assume critical importance in case of high-rise structures.

Embodiment of community

Since the boom in high-rise construction in Indian cities is recent, a high-rise structure stands out automatically. But at the same time, it should not look intimidating for onlookers as well as residents of surrounding properties.

On the contrary, it should be a kind of structure that professes to serve its neighbourhood. This is particularly true for older localities in cities, which have several heritage structures.

The high-rise, no doubt, will look imposing but it should not give a feeling of visual aggression or aesthetic oppression. In other words, it has to be in harmony with its streetscape. This could be achieved

only by drawing on the architectural heritage and culture of the place.

At the same time, a high-rise edifice should not only be aesthetically pleasing but should also combine practicality.

Thus evolving a coherent design concept becomes a challenge in itself.

Technical challenges

The columns and shear walls of lower floors carry progressively higher loads increasing their size progressively as one moves downwards. In order to get maximum usable space and preserve the usability of rooms, it becomes necessary to restrict the size of columns and thickness of shear walls. This leads to adoption of higher grades of concrete and reinforcement steel as you come to the lower floors.

Beyond a certain height, composite structure incorporating structural steel becomes inevitable as RCC columns will be too large as to make a room unusable with large corner projections.

The use of higher grades of concrete is necessitated, which calls for closer quality control.

Since the size of columns and thickness of shear walls is restricted, there will be increasing congestion of reinforcement bars in lower floors. This presents challenges in placing and compacting of concrete, and workability of the concrete mix needs thought.

Higher cement content of higher grades of concrete entails higher evolution of heat of hydration and higher shrinkage.

As the structure rises higher and higher, it takes longer for lifting or pumping the concrete to the required height and use of appropriate admixtures becomes inevitable.

As the structure rises upwards, it takes longer for all other materials to reach the working floor and the personnel also require more time to reach there and for coming down at the end of the day's work. This results in lesser output as the structure progresses upwards.

There is a need to factor this in while working out the time period for a project.

Personnel lift/s installed will have to be retained till at least one of the regular elevators is operational. This affects completion of external finishes and site development in the portion occupied by the personnel lift/s and delays final handing over.

Expansion and contraction

Problems associated with daily and seasonal expansion and contraction of the structural frame need to be taken into account in structural design as well as in installation of various services like pipelines. Integrity of various architectural finishes also assumes greater importance.

For high-rise structures, the wind force becomes a major concern in design of the structural frame. The tilt induced by wind force has to be taken into account. Apart from the design of the structural frame, this tilt can affect architectural finishes and the alignment of various services.

Because of the strong winds to which high-rises are subjected, watertightness of the building envelope in general and watertightness of the windows and balcony doors and rattling of shutters needs consideration.

The pumps required for water supply (for human consumption, for fire-fighting and for air-conditioning) have to be of high capacity. The pipes, fittings and fixtures are also required to withstand this high pressure.

Since there is an economical limit to the high pressure to which these can be subjected, introduction of break-pressure tanks at certain interval becomes a necessity. This in turn requires provision of service floors at intervals.

Working at height makes safety a paramount concern. Thus the scaffoldings, staging, safety curtains, barricades, railings, etc. all have to be planned and designed carefully. This applies to subsequent maintenance and repairs of the building during its service life.

Furthermore, access for maintenance and repairs will have to be planned in advance and the building should be designed to facilitate maintenance and repairs. This is particularly so in case of the building envelope and its accessibility.

Safety for all

Enclosing the structure under construction with safety curtain also needs to be planned with due care not only for the safety of the personnel, but to protect surrounding properties and their occupants as well as vehicular and pedestrian traffic in the adjacent streets.

One should bear in mind that even a small piece of stone falling from great height can prove fatal and therefore the safety curtain should be such as to arrest even a small piece of aggregate that goes into concrete.

Problems of safety and rescue of the occupants in case of emergencies is very important, irrespective of the height of the structure. However, in case of high-rises, this assumes critical importance due to the time required to bring people down to safety. Therefore, apart from provision of fire lift, rescue chutes, planning and design of passages, corridors and staircases need careful planning.

Constructing a high-rise in place of an existing smaller building using extra FAR, significantly increases load on the local infrastructure – particularly water supply and sewerage system.

Therefore, it is necessary to provide a sewage treatment plant for treating the entire sewage from the building and recycle it for flushing, gardening, etc. so that the demand on the municipal supply is kept to the minimum.

Similarly, the design of the building and particularly its envelope should be such that it reduces the requirement of air-conditioning and artificial lighting, thereby reducing the demand on the power utility.

Commercial considerations

The cost of structural frame, the cost of services and cost of construction does not bear a linear relationship with height of a structure. It increases rapidly with height.

Besides, as pointed out above, the productivity declines as the structure rises higher and higher and raises the cost of construction. Longer construction period pushes the overheads apart from impact of rising inflation.

By its very nature, a high-rise building will require more time for completion as compared to a low-rise group of buildings having the same total built-up area, in which case, work can be expedited by opening more work fronts.

Thus, the probability of changes in regulatory environment, changes in taxes, changes in public policy and a host of such imponderables are higher and can impact the cost of a project.

To minimise this impact, it will be prudent to adopt innovative design concepts and construction methods which can help in reducing the time required for construction.

Regulatory issues

A high-rise structure has to conform to a host of stringent norms, notably those stipulated for fire safety.

Complying with all the rules and regulations of a host of authorities is a challenge in itself. Two examples could be cited.

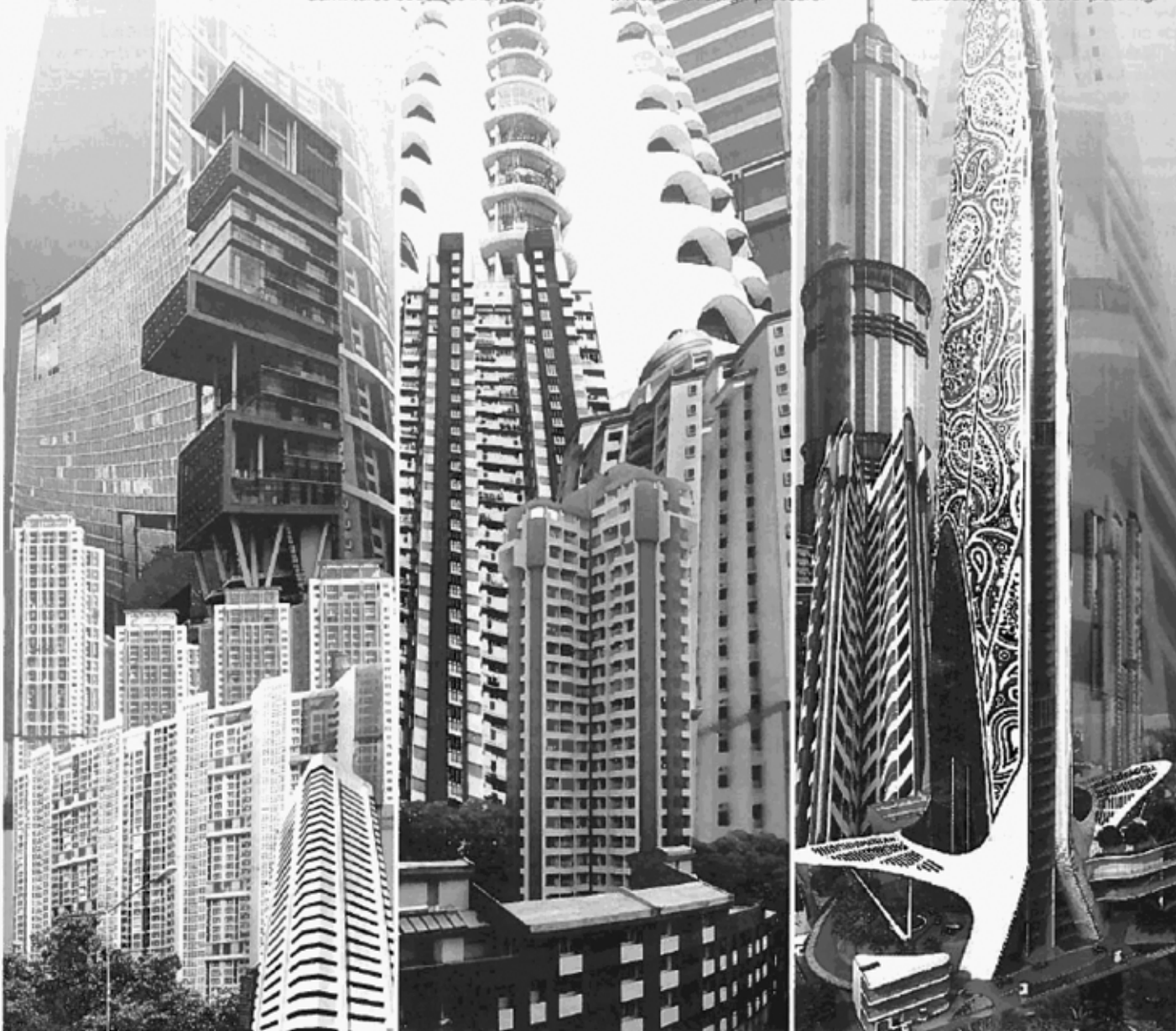
In airport zone, there is restriction on height of a structure depending on the distance of the structure from the airport reference point. It is in the form of a number of concentric circles, with lesser and lesser permissible height for each successive inner ring.

Here, the designer must plan to utilise the permissible FAR fully and yet stay within the permissible height. At the same time, there is a limit to which footprint of the building could be extended, as one has to provide mandatory open spaces on all the sides and proper access around the building/s.

Similarly, there is height restriction for properties abutting a railway line. Here also, utilising the FAR fully becomes a challenge.

Simultaneously, the structure has to be designed to meet the needs of end-users. In case of mixed development (which is often the case with many high-rise buildings), this is quite complicated. And all the while, the designer has to aim at utilising fully the permissible floor area ratio.

Therefore, it will not be an exaggeration to say that planning and design of high-rise structures requires an all-encompassing approach to overcome the challenges in order to deliver a project that will lead to satisfaction for all the stakeholders.



Jeet Kapadia
The author is
Management
Executive,
B. E. Birlimitra
& Co. Ltd.