BUILDING BLOCKS

THE MAKING OF VERTICAL CITIES

INDIAN CITIES SKYLINES HAVE BEEN CONTINUALLY ALTERING, REFLECTING THE CHANGING RELATIONSHIP BETWEEN PEOPLE, BUILDINGS AND URBAN DENSITIES. FROM DESIGN AND ENGINEERING TO BUILDING SERVICES, THE NEW INNOVATIONS ARE SUPPORTING THIS TALL GROWTH OF THE CITIES.

By: Remona Divekar

Across the globe, the buildings are growing taller than before, because of physical, social, and economic needs. In recent times engineering advancements, height limitations, maximizing space for commercial and residential growth and technology breakthroughs have become the focus of city planners, architects and designers worldwide.

Indian cities too are witnessing vast geographical and demographic expansion, especially due to the huge demand for housing. In line with increasing population densities, unprecedented residential and commercial spaces requirement along with need for more open spaces in cities, tall buildings have become the way forward.

WHY WE NEED SKYSCRAPERS

Tall buildings are a result of necessity of addressing housing shortage by providing high density development. They are the tools to control urban sprawl with their relatively small foot print. Tall buildings have often been criticized for overloading the infrastructure, being too costly to build and the fire safety concerns. However, the pros outweigh the cons much more and if the tall buildings are planned in context to their settings with appropriate measures for safety and design, they can contribute to quality of life and engineer more sustainable cities and reduce consumer waste.

Elaborating on the need for vertical growth of Indian cities, architect **Reza Kabul, President, ARK Reza Kabul Architects** said, "Space crunch is one of the major issues we face as a developing nation, with increasing population and the burden on public infrastructure. Metropolis like Mumbai are overburdened, and the ideal solution to this would be to move away from residential, commercial and entertainment pockets across the city, into one a more vertical mixed-use zonal development. This not only reduces the load on public infrastructure, but also de-clutters major nodes within the city, thus reducing the average travel time from one place to another."

"AS THE FOCUS ON THE FUTURE OF THE COUNTRY COMES INTO PERSPECTIVE, EFFORTS HAVE BEEN MADE BY VARIOUS ORGANIZATIONS TO POPULARIZE SUSTAINABLE CONSTRUCTION PRACTICES. DEVELOPERS ARE SHOWING STRONG COMMITMENT TO DELIVER ADVANCED DESIGNS WITHOUT DRASTICALLY INCREASED BUDGETS."
REZA KABUL

Vijay Shreenivas, COO, Shapoorji Pallonji Real Estate added, "The Indian economy has been on a steady, high-growth path for the past several years. The construction sector is today at an inflexion point and it has played a stellar role in putting India on the path of economic development. There has been an increasing appreciation that the full potential of the construction sector in the economic development of the country has not been realized due to various challenges. One of the major challenges has been the efficient use of land, which is scarce and very expensive, especially in major cities. The government`s mission of Housing for All by 2022 is now in a very advanced stage of implementation in urban areas and, hence, in light of limited land availability, construction has to move vertical in the form of high-rise buildings, which can overcome many of our developmental challenges in urban areas."

Harsh Pareek, Regional Sales Director, India and SAARC, Trimble Solutions concurred that there seems to be a universal consensus that in India's already-crowded metros and tier-1 cities, where land is both scarce and expensive, vertical growth in the form of tall buildings or high-rises is the answer to addressing the growing demand for housing and commercial real estate. "Tall buildings not only help in maximizing the utilization of land in metros and other big cities, but can also ensure that housing remain relatively affordable and within reach of a larger number of people who live in these cities. Further, high-rises can also address sustainable development goals by integrating latest technologies and processes and are thus a valuable

consideration for holistic urban planning in India."

Amit Gossain, MD, KONE Elevator - India & South Asia was of the view that the tall buildings, especially residential are clear winners in densely populated cities where building space is almost impossible to find. "In India, the phenomenon is more pronounced, and there are no surprises here. Oxford Economics states that 17 out of the 20 fastest-growing cities are in India. This is where well-planned tall buildings placed at strategic locations can reduce the demand for available natural resources and yet speed up the rate of urbanization in the right direction. Overall, the presence of tall buildings devised by urban planners and builders will lead to a better quality of urban life."

As per **Manohar GM - Head - Marketing Services, Geberit Plumbing Technology India Private Ltd,** the exploding population, largely urban coupled with increasing real estate cost, creates an increasing demand for tall buildings plus the growing economy means increased urbanization. "Clustering of buildings in the form of tall buildings in densely built-up areas is generally recognized as efficient in terms of transportation and reducing carbon footprint and helps save costs, as tall buildings can accommodate many more people, on a smaller land than would be the case with low-rise building on the same land. In a nutshell "A tall building is in effect a vertical transformation of horizontal expansion," he said.

TALL BUILDINGS HELP IN MAXIMIZING THE UTILIZATION OF LAND AND ENSURE THAT HOUSING REMAINS RELATIVELY WITHIN THE REACH OF A LARGER NUMBER OF PEOPLE. FURTHER, TALL TOWERS CAN ALSO ADDRESS SUSTAINABLE DEVELOPMENT GOALS BY FREEING SPACES FOR GREEN COVER AND PUBLIC TRANSPORT.

"A SUSTAINABLE SKYSCRAPER IS ONE THAT IS EFFICIENT ENOUGH TO PERFORM ALL OF THE BUILDING FUNCTIONS WHILE PRODUCING AN EQUAL AMOUNT OF ENERGY AS IT CONSUMES, THEREBY BEING ENVIRONMENTALLY CONSCIOUS, ENERGY-SAVING, AND UTILIZES RESPONSIVE AND RENEWABLE MATERIALS AND SYSTEMS."
VIJAY SHREENIVAS

DESIGN AND PLANNING CONSIDERATIONS

The approach to the design of tall buildings has changed rapidly, becoming an integral part of a complex structural engineering process. Today the skyscrapers are being designed in keeping with the profile of the occupants and the building orientation for maximizing sunlight and natural ventilation as well as the streetscape.

From a developer's perspective, **Vijay Shreenivas** feels factors which affect the design of high-rise buildings vary from place to place, such as climate, zoning regulations, cultural conditions, and technological opportunities. "To start with, space planning and furnishing that responds to user requirements is the floor shape. Square, circular, hexagonal, and octagonal are more space efficient than rectangular plans with high aspect ratios and irregular shapes. Planning of service core is an increasingly important aspect of architectural building design in high-rise buildings. At the concept stage, the design team should consider the implications of a proper core placement, fire regulations as per NBC, overall structural stability, building typology, and cost. Other design considerations are automatic sprinkler systems, provision of fire lifts, combustible material per unit of floor area, basement ventilation, etc."

Indeed, the major influences on the architecture of a building are the society, economics, technology and the surrounding environment. The interaction of all these aspects is vital in creating an efficient and useful building product, more so in terms of a tall building that looms large on the skyline of a city and are expensive in its construction.

According to **Reza Kabul**, "An effective architectural design is one that minimizes the negative environmental impact by efficient and moderate use of resources, energy, and space. Recently vertical mixed-use developments have presented themselves as a phenomenon, with potential and advantage over the typical single-use structures, making them the next step for sprawling urban cities. Instead of spreading horizontally, vertical mixed-use developments make efficient use of existing and available landmass. One of the main advantages of vertical transportation is that it drastically decreases the time taken from point A to point B. This directly results in lower fuel consumption and pollution levels, and decrease in burden of public infrastructure. The landmass that is made available on account of vertically stacking the users can be utilized for green open spaces."

"High-rise buildings are particularly vulnerable to external elements including wind and rain, and must be designed and engineered to withstand an earthquake. Further, they often have complex design structures, which alongside limited availability of space for their construction requires extensive planning and testing. Tech-enabled planning and design workflows can be highly valuable particularly in the case of high-rises, as they provide a solid foundation for subsequent construction and management or maintenance. For example, creating digital twins right at the design stage in the form of constructible BIM models can give developers a powerful head start in minimizing the complexities of building a high-rise," stated **Harsh Pareek**.

"LACK OF AWARENESS TO ADOPT TO THE INNOVATIVE SOLUTIONS OWING TO PRICE EQUATION COUPLED WITH LACK OF SKILLSETS AND KNOW-HOW AMONG THE BUILDING FRATERNITY IS A CONCERN, WE HAVE BEEN OFFERING END TO END SOLUTION PACKAGE WHICH INCLUDES DESIGN AND BOQ SUPPORT, ONSITE TRAINING, SUPERVISION AND CERTIFICATION."
MANOHAR GM

"As high-rises will be the future of the urban landscape, there are some essential considerations associated with high-rise construction, which are: Proper access to higher floors with the use of lifts, Use of reinforced concrete and steel, Adherence to safety norms to counter geotechnical risks like unstable ground structure or bay mud, Proper consideration of the design of HVAC, fire exits, stairwells, Development of infrastructure like playgrounds, schools, healthcare facilities, public transport, and roadways and Better sustainability with a lower carbon footprint and reduced energy consumption," added **Amit Gossain**.

The decision to create a tall building is one which can have far-reaching consequences. Every tall building needs to have its own unique context and requirements .Tall buildings should have a positive relationship with surrounding features and other buildings. The architectural quality of the building, its scale, form, massing, proportion, silhouette, and cladding materials are equally important and they should set exemplary standards in design because of their high profile and local impact. Ideally, proposals should exceed the standards set by regulations and planning policies. Tall buildings are expensive to build, but it is extremely important not to dilute the design quality throughout the process of procurement, detailed

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design and construction. Lastly, tall building proposals must address their effect on historic buildings, sites, and landscapes, both near and far," shared **Manohar GM**.

THE ROLE OF TECHNOLOGY

Construction of tall buildings has always relied on modern technology to ensure that the project gets completed on time and within budgets – while meeting or exceeding world-class quality and sustainability standards. Harsh Pareek shared, "Advanced construction techniques and technologies like prefabrication, Constructible BIM and digital twins, and cloud-enabled collaboration tools are today being employed in every step of the construction process, leading to significant time and cost savings and improved efficiencies. These technologies further enhance the design and help reduce errors and rework at the time of construction. Technology leaders like Trimble with its portfolio of products like Tekla Structures, Trimble Connect, SketchUp and ProjectSight are at the forefront of leading the tech-enabled construction of sustainable high-rises in India and around the world.

Furthermore, smart and sustainable practices applied to high-rise buildings not only enhance the quality of life for the building occupants, but also lower the consumption of energy and other precious resources like water and gas. Structures designed to be smart and sustainable can adapt and reconfigure more easily to the changing environmental and urbanization conditions. Much of the recent innovation and new technology developed globally

"HIGH-RISES HAVE THEIR OWN SET OF CHALLENGES COMPARED TO OTHER LOW-RISE BUILDINGS. HENCE, BOTH CANNOT BE GROUPED UNDER THE GOVERNMENT'S EXISTING STRUCTURAL SAFETY STANDARDS IN PLACE. EXPERTS SUGGEST THE NEED FOR A SEPARATE CODE FOR SKYSCRAPERS WHICH IS NOT PRESENT IN INDIA CURRENTLY."
AMIT GOSSAIN

in the construction industry has centered on sustainability. New building materials, 3D printing, prefabrication, and modular approaches are among the leading trends enabling the construction of sustainable high-rises. The use of advanced software across the build-design-operate lifecycle as well as deployment of cutting-edge mobility and collaboration tools also help cut down wastage of natural resources during the construction stage."

Amit Gossain said, "The rise of connected services, digital tools, and automation will influence how people use high-rise buildings. KONE Ultra Rope uses lightweight yet sturdy carbon-fibre hoisting technology that ensures upward travel to 1000 mt (1 km) with a significant reduction in moving parts during operation. With pre-set themes with curated music and animated lights, ecosystem partners, information screen, and touchless signalization, KONE DX Class Elevators series is future-proofing buildings with market-leading elevator technology. As preventive maintenance becomes critical in tall buildings, we use real-time data, innovation and analytics to come up with smart solutions. KONE 24/7 Connected Services uses AI-based analytics to identify and fix potential issues in elevators and escalators before they cause problems."

Reza Kabul concurred, "Tall buildings require efficient vertical transportation systems. Advancements in elevator technology enable us to design taller energy efficient structures. One of our upcoming projects that stands at 363 meter tall, has a total of 50 elevators catering to the different spaces and users. Varying in speeds from 4m/s to 8m/s, the elevators are designed with destination control systems for effective traffic movement. Two double-decker elevators connect the 360 degree observatory at 350m to the entry levels at the base of the structure. Incorporating this technology enables us to cater to a higher number of people travelling to and from, without additional burden onto the structure of the tower. Other recent advancements such as Alternating Current (AC) and gearless motors, regenerative drives,

machine-room less technology, and traffic management software can yield significant savings in overall operating cost of the building. Even the conventional steel belts have been replaced by composite materials which are more tensile, durable and result in reduced energy loss."

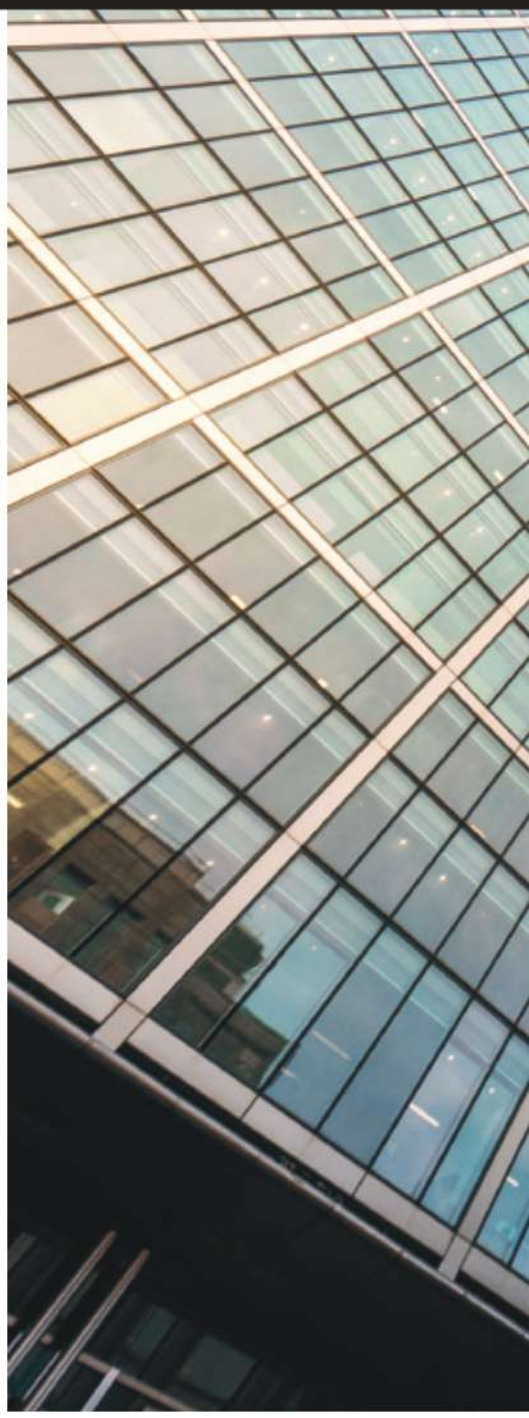
Manohar GM stated, "One of the most efficient methods for tall buildings construction is the use of prefabricated components manufactured in a controlled, offsite environment. This solution is cheaper because it significantly decreases construction times by enabling construction and engineering challenges to be addressed before construction starts. It also reduces the number of workers, as fewer activities are carried out onsite - which in turn reduces noise and minimizes the impact of construction on the local area, including lower air pollution and CO2 emissions. In addition, usage of sustainable quality solutions which complies with the LEED/ IGBC norms and standards especially for the building's utility management systems e.g., Lifts, Plumbing, HVAC, and sewage treatment systems minimizes the operation and maintenance costs."

Vijay Shreenivas agreed, "New construction technologies like monolithic construction use jump formwork, aluminium formwork, tunnel formwork, self-climbing forms, or stay-in-place formwork. Due to the speed required and space constraints, steel, composite, hybrid structures, prefab, and precast elements are also used. The use of information technology is being used in architectural, structural, and MEP

"ADEQUATE AND JUDICIOUS USE OF MODERN TECH TOOLS CAN HELP DEVELOPERS EXECUTE THEIR HIGH-RISE PROJECTS WITH GREATER EASE AND CONFIDENCE, WHILE ALSO BENEFITING FROM GREATER PRODUCTIVITY AND PROFITABILITY."
HARSH PAREEK

design, operation, and maintenance. Building Information Modelling (BIM) has been extensively used for clash detection. Smart services, robotic parking, smart equipment, and smart building concepts are being used in high-rise buildings.

Moreover, the sustainability of a high-rise building must be viewed as part of a city's sustainable growth. A zero-energy building is a possibility through high-performance design, integrated physical systems, a symbiotic building within its context, and an interactive power grid with the building's energy-generating system. The basic



principle of sustainability is the advancement that meets the needs of the present without overlooking the requirements of the future. Energy efficiency can be obtained by passive solar gain, facade technology, harnessing solar energy, harvesting wind energy, fuel cells, combined heat and power systems, rainwater harvesting, biomass energy, and geothermal energy."

DESIGN AND PLANNING PLAYS AN IMPORTANT ROLE IN A SKYSCRAPER DESIGN. PLANNING AN EFFICIENT ENVIRONMENT INSIDE, OFFERS HEALTHY LIVING TO PEOPLE USING THE BUILDING AND DESIGNING A CONTEXTUAL FAÇADE GIVES A POSITIVE RELATIONSHIP WITH SURROUNDING FEATURES TO THOSE OUTSIDE THE BUILDING.

THE CURRENT MARKET SCENARIO

Real estate developer Vijay Shreenivas feels that now various state governments are promoting skyscrapers. "Last year, in 2021, the Gujarat government came up with a policy to promote skyscrapers as tall as those in Dubai and Singapore. The Gujarat Government approved the "Tall Building Policy", which will allow the construction of buildings up to 100 metres, and the cities where such tall buildings can be built are Ahmedabad, Vadodara, Surat, Rajkot, and Gandhinagar. Earlier, buildings were permitted only up to 23 floors or within a height of 70 metres. In Chennai, high-rise developers had to wait for nearly a year to get their files approved, and now, due to new reforms being initiated by the housing secretary, the housing department has given powers to the member secretary to clear files pertaining to buildings above 18.30 metres and up to 30.00 metres rather than sending these files to the government. Many more such reforms are needed for speedy approvals by introducing single window clearance and aligning accountability of approving authorities, thereby fulfilling the legislative intent of RERA."

Harsh Pareek agreed that while

there is no central government policy in place to promote the development of high rises, various state governments have relaxed norms for building new skyscrapers in recent years to cope with urbanization pressures in several metros and state capitals, paving the way for the development of more and more high-rises in India. "Construction of a high-rise building is a challenging endeavor, and it is made more complex when there is limited space around the project site to keep all the equipment and materials. Cutting-edge technology tools from companies like Trimble are a key enabler in addressing these and other challenges of building a high-rise. However, their adoption is still not widespread; for example many developers are yet to warm up to the immense power of digital twins in the form of Constructible BIM models. As a result, they frequently struggle to complete projects on time, or end up doing extensive rework which directly leads to reduced margins," he added.

Manohar GM expressed similar thoughts, "Respective state governments have been relaxing the FSI norms (Floor space index) in Tier 1 and Tier 2 cities to promote construction of high-rise structures. For e.g. The Municipal Corporation of Greater Mumbai has suggested that the minimum height for a building to fall under the high-rise category be increased to 32 metres from 24 metres earlier. Apart from this, an expert committee appointed by the Maharashtra state government has recommended that the civic chief be made the sanctioning authority for buildings up to a height of 120 metres, or about 40 floors. This will help simplify and expedite approvals for real estate development across the city. Similar exceptions have been provided by other State governments of Telangana, Gujarat and Karnataka as Vertical growth is the only solution for the densely populated cities."

"The government of India and state governments have recognized the need for more tall buildings to cope with the demands of the influx of population into emerging and existing cities. Be it the repeal of the Urban Land Ceiling Act or various state government's nod to skyscrapers, there are many steps taken that promote more skyscrapers to come up. The central government had also lifted a ban on the construction of skyscrapers in Delhi and Mumbai in 2014. The current government has rolled out initiatives like Smart Cities Mission, Pradhan

CHALLENGES OF CONSTRUCTING GIANTS IN THE SKY

A high-rise building is a building with a small footprint, a small roof area, and immense facades. There are still some challenges- like the availability and sourcing of high-performance concrete and its availability for use onsite is a constant challenge for various high-rise projects. The approach to the construction of a high-rise building is challenging with respect to the following factors:

- They are designed as lightweight structures making the selection of materials a big challenge.
- Unavailability of better façade becomes more complex with every floor increase in a high-rise. The façade should be resistant to wind sway and temperature effects.
- Wind and earthquake forces demand lateral design of structures; residents may get nausea effect due to large deflections.
- Geo-technical investigation should go as deep as the height of the building.
- The construction of a basement for parking with retaining walls, diaphragm walls, and underground waterproofing pose a challenge for designers.
- Vertical transport systems must be highly efficient and fast.
- Safety in High rise buildings is to be incorporated through structural safety, and worker safety during construction and maintenance.
- Speed of construction is achieved by high-strength concrete with the latest formwork techniques.
- Repairs and maintenance of High-rise buildings.
- Provision of efficient plumbing systems, water storage, water pressure, wastewater treatment, and recycled water system along with maintenance and repairs of the plumbing system.

Mantri Awas Yojana – Housing for All (Urban) (PMAY-U), and Swachh Bharat Mission (Urban) (SBM-U), to emphasize the importance of urban development, "added Amit Gossain.

According to architect Reza Kabul there is a lot of inconsistency and uncertainty in the legislative norms that eventually slow down tall building construction. "For instance there is a lot of back and forth in the height restrictions set by the Ministry of Civil Aviation (MoCA). At times a building in close proximity to the airport receives a clearance for 150m but one that is in some area further away doesn't. Another factor that slows down the clearance process is the committee appointed for high-rises. It is a futile process of going through the entire clearance process with a review committee that has no final authority. You go to the committee, they disagree with your design, and you go back to the drawing board to rework the design. And in several cases the process of changing one element results in a change in the overall structure and design of the building. Instead they should collectively lay down guidelines and mandatory minimum requirements that allow you to design and puts everyone at par."