

Proposed

Air Traffic Control Tower

At
Chhatrapati Shivaji International Airport

MUMBAI INTERNATIONAL AIRPORT PVT LTD



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Introduction

Mumbai's international airport has gained a new icon – Chhatrapati Shivaji International Airport's Air Traffic Control Tower (ATCT).

Air Traffic Control Tower (ATCT) is a mandatory aeronautical facility for the operation of the Airports and is operated by Airport Authorities of India (AAI).

Intended to be one of the airport's key landmarks, the ATCT's prominence due to its height, as well as to its design, reflects a new attitude toward operations and aviation at the airport. Standing at over 80 meters, the ATCT commands a presence in the skyline that will be visible throughout the immediate vicinity, as well as upon departures and landings by the world's visitors to Mumbai.

“ The monolithic wing structure rises from the ground and embraces the core. Its aerodynamic form elevates the control center and creates a signature element for the Tower “.



Context

In comparison to general allocation of ATC Tower within airport operational area, as in case of many airports around the world, new ATC Tower at CSIA is located as part of landside infrastructure of airport, a unique reference becoming the new face of the airport.

As such, views of incoming and outbound flights, on the ground and on the airfield have dictated both the siting and the orientation of the ATCT. Positioned to maintain free and clear sight lines of all runways and approaches for up to five miles, the ATCT sits at the ideal location for controllers overseeing incoming and outbound flights. However, the objective is not to dominate the skyline, but to command it.

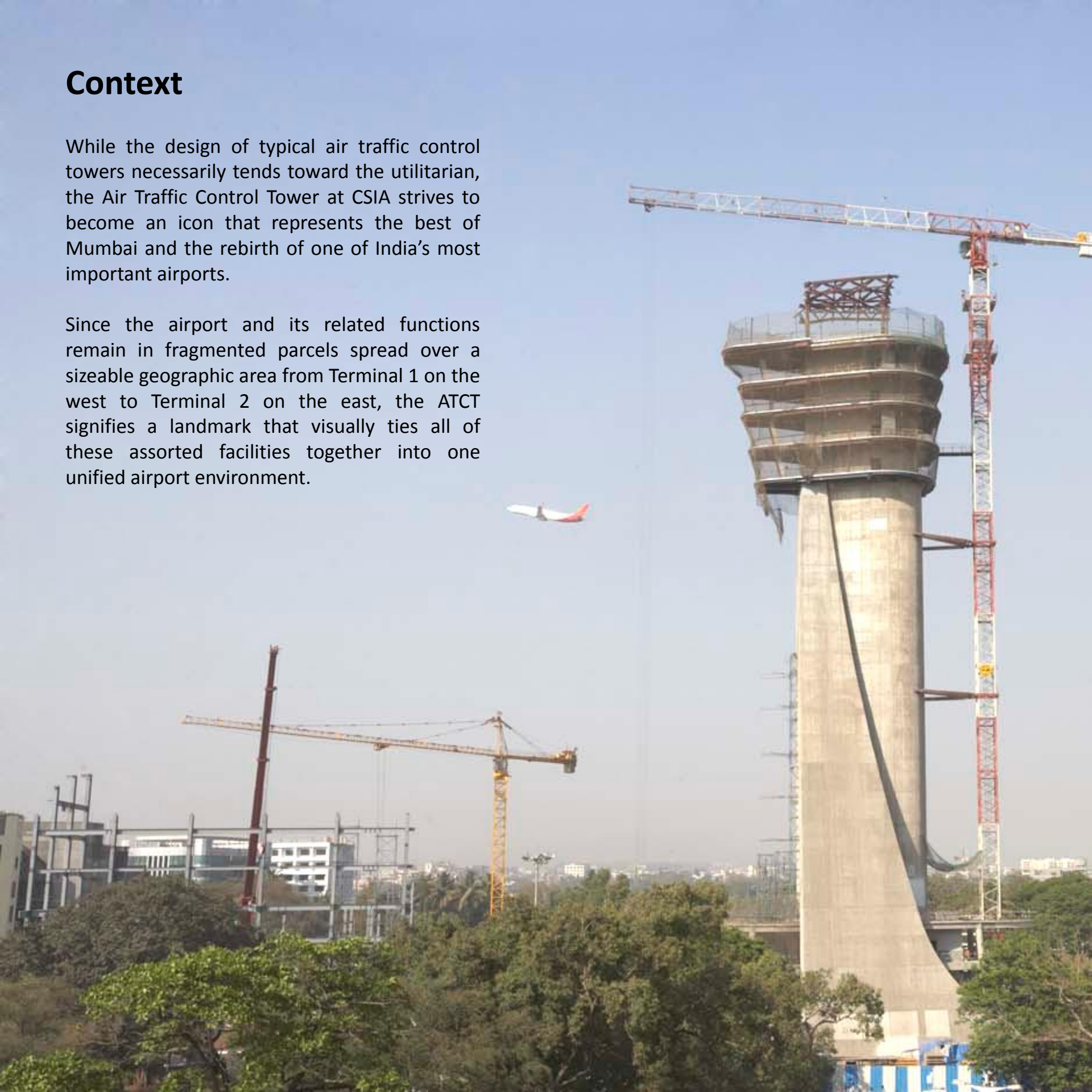
Furthermore, due to the configuration of the terminals and airfield, the ATCT has a commanding view of most all ground operations, improving safety, efficiency and security. Interestingly, the confluence of these various sightlines yielded a site on the landside area of the airport, which nevertheless opened the door to create the memorable arrival sequence when getting to the airport that the ATCT now anchors.



Context

While the design of typical air traffic control towers necessarily tends toward the utilitarian, the Air Traffic Control Tower at CSIA strives to become an icon that represents the best of Mumbai and the rebirth of one of India's most important airports.

Since the airport and its related functions remain in fragmented parcels spread over a sizeable geographic area from Terminal 1 on the west to Terminal 2 on the east, the ATCT signifies a landmark that visually ties all of these assorted facilities together into one unified airport environment.



Architectural Image

Standing at over 80 meters tall, the ATCT towers over the urban landscape, but at the same time adopts a sleek, aerodynamic look that seems light and befitting of an aviation facility. For maximum visibility for the traffic control staff manning the cab, the façade employs a curvature of glass of a large radius that avoids corners and tight radius curves that would interrupt or distort controllers' views.

Detailed analysis also resulted in an angling downward of the cab's façade, away from the direction of direct sunlight, reducing glare and ensuring optimal views.

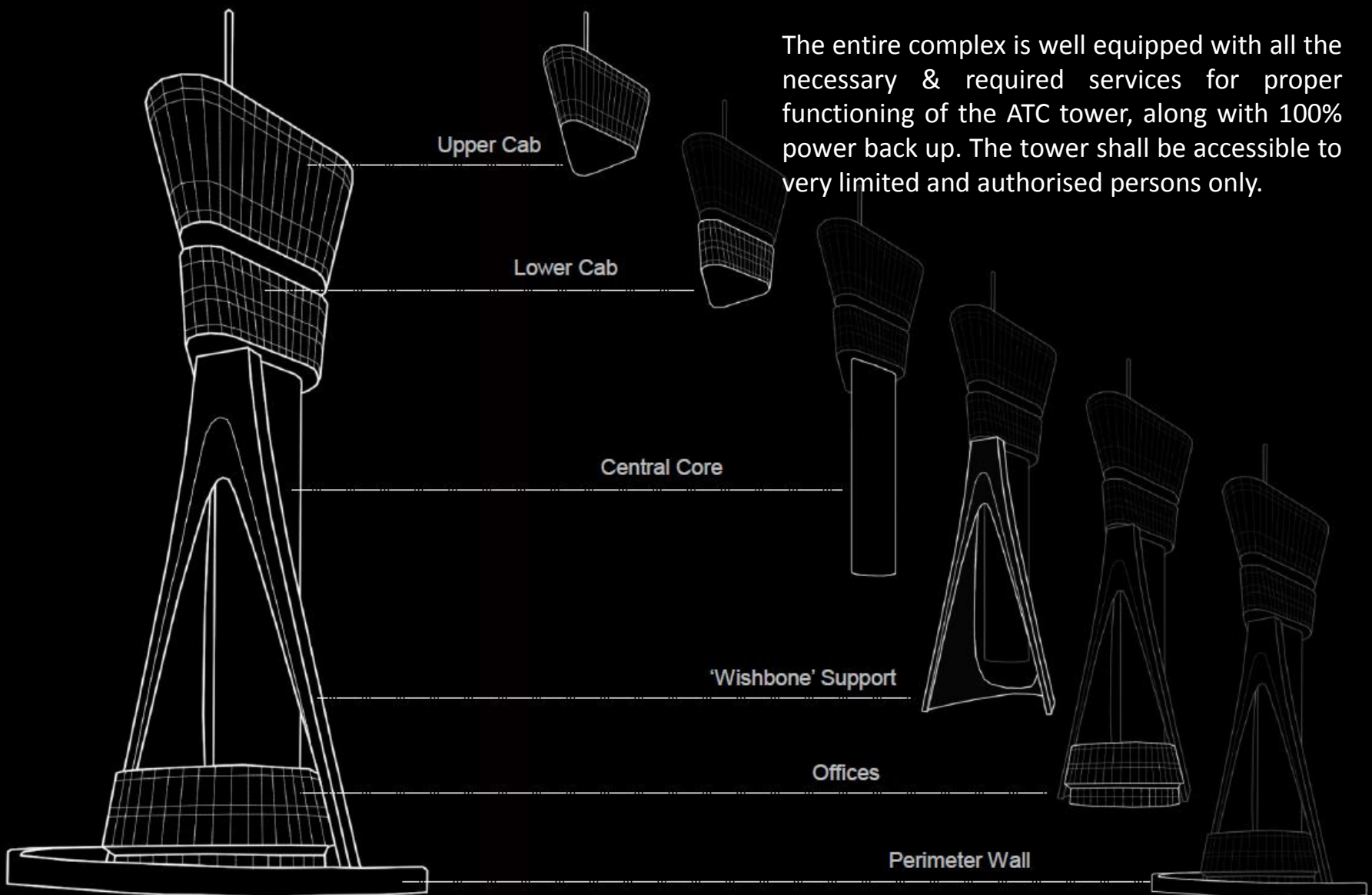
Where views are not essential for air traffic control operations, the cab becomes elongated, stretching toward the airport's approach road and housing supporting facilities. On the exterior, this tapering reduces the perceived mass of the cab into its distinctive aerodynamic shape, and this slim and sleek "bow" of the cab becomes the face of the airport for people arriving at Terminal 1.



Architectural Image

ATC Tower is 83.8 mts high structure. Although it is 83.8mts tall, it has only 4 floors at its base (for accommodating security and AAI operations staff) and 4 floors at the top (for accommodating ATC Operational area). The rest of the tower, between the base and apex floors is only a RCC shaft accommodating lifts and staircase.

The entire complex is well equipped with all the necessary & required services for proper functioning of the ATC tower, along with 100% power back up. The tower shall be accessible to very limited and authorised persons only.



Architectural Image

The emphasis of ATC Tower as a landmark is marked with its iconic massing as seen during the day light, as well as with specialized external illumination illustrating its sculptural form during night. The external illumination is designed by well known International lighting consultant 'SPEIRS + MAJORS' from UK.

The external lighting, though enforces the sculptural qualities of ATC Tower, it is being carefully designed and controlled to ensure that no up lighting shall obstruct important airport operations or flight visibility.

As the gateway to the city, and for many global travelers to all of India, CSIA has placed great emphasis on the planning and design of all its facilities, under the committed leadership of Mumbai International Airports Pvt Limited (MIAL), where the significance of the airport is not just a set of functions focused on transport engineering, but also a place where customer experience, convenience and comfort are key differentiators.

SPEIRS + MAJOR

Sculptural: Uplighting / White Light



Function

The success of the ATCT lies not simply in its capacity to be seen as the public face of the airport, but also in how clearly it oversees the airport and its multitude of functions.

The ATCT is more than just a beacon for travelers and city dwellers within the central region of Mumbai; it is the critical link between travelers from around the world and their safe arrival to engage business, loved ones and future possibilities on the ground.

Priority in the design is always given to the control tower's ability to see and hence regulate the whirl of activity and movements at the airport.

Inspired by flight and travel, but driven by functionality, the tower – while one of the tallest buildings in the area – remains at a low enough elevation to avoid higher stratum fog and haze that would inhibit visibility.



Function

The semicircular layout of the cab allows multiple viewpoints of the approaches for almost 360° without the need for the controllers to move. Each of the 36 consoles for the cab's various control and planning staff is carefully oriented to allow views that, taken together, nearly cover the entire airfield and activity on the ground – impressive given that there are two runways, two terminals, as well as numerous other potential obstructions.

Air traffic controllers are seated on a pedestal behind but above the other staff manning the cab's control room, and the structure of the tower minimized to two slim columns, so that views of air traffic are largely unobstructed.

Ground movement controllers and planners sit near the windows, but are set back from a dropped mezzanine in front of them; this lowering of the floor in front of the ground movement team expands views downward toward the grounds of the airfield and other areas where planes have parked.



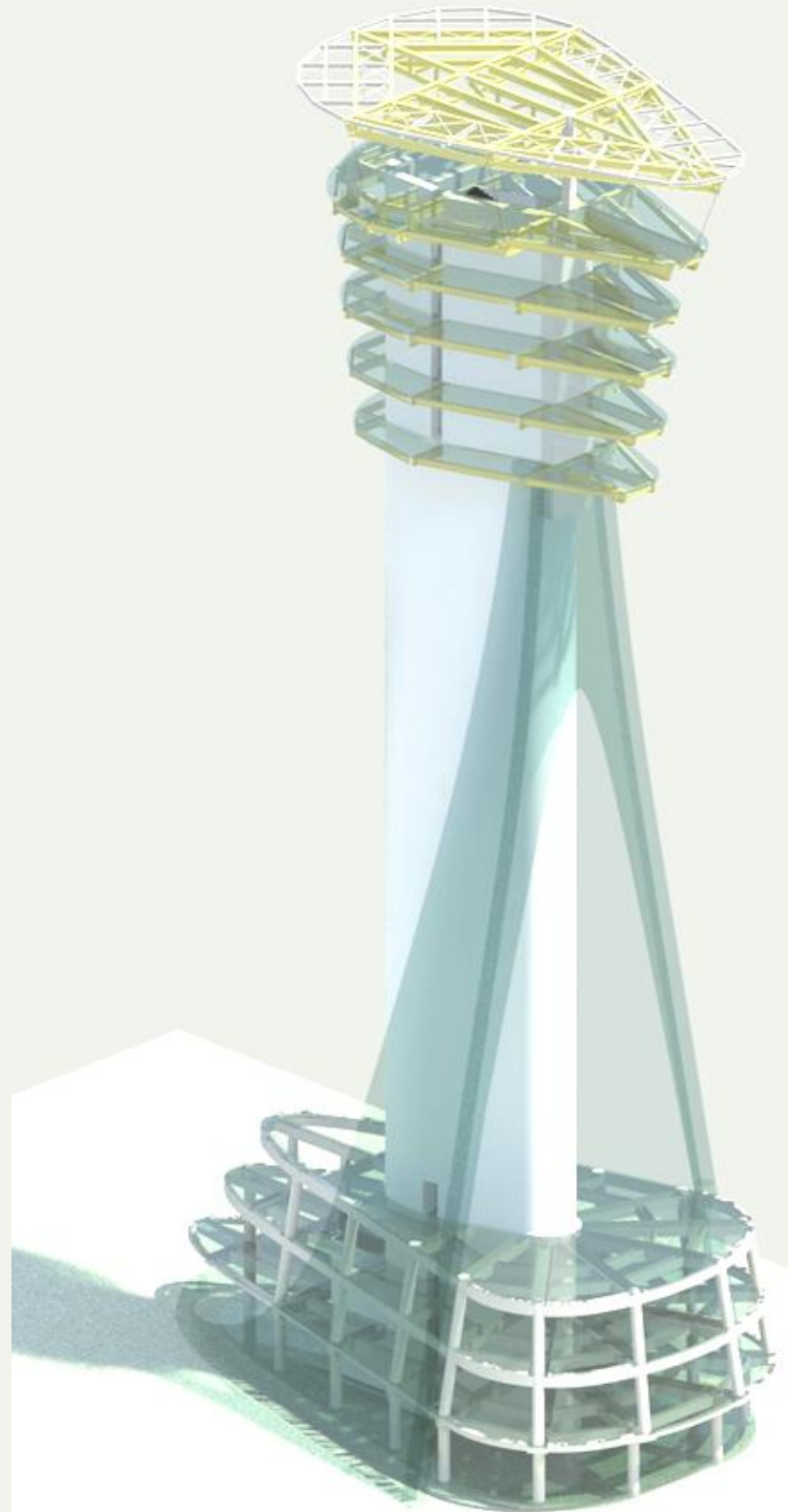
Structure

The ATCT structure was designed to lessen, instead of add to, the visible mass of the tower. Despite its height, the building's eminence in the city's skyline required a massing that reflected the modern image of the new CSIA, resulting in an elegant, slim form factor.

For instance, the skirt on either side of the tower's main column provides lateral bracing, helping to reduce the shaft's thickness and creating elegant "wings" that help to maintain the tower's aerodynamic look.

This arch-like effect is planned to be repeated across the airport's approach roads in the form of sculptural bridges, creating a thematic element symbolising arrival at the gateway to the airport.

As the cab must preserve maximum visibility at all times, the skirt also creates an alternative surface area that can be dynamically illuminated at night, combining the spirit of both form and functionality that the airport embodies.



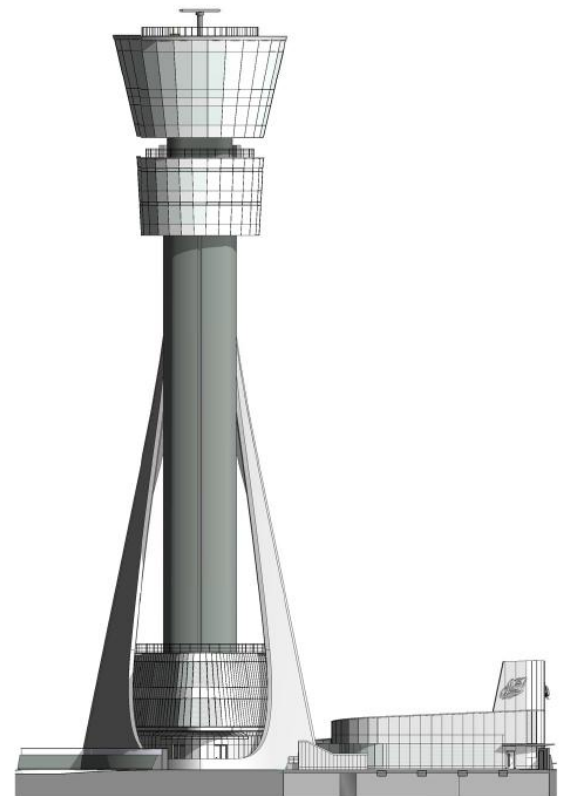
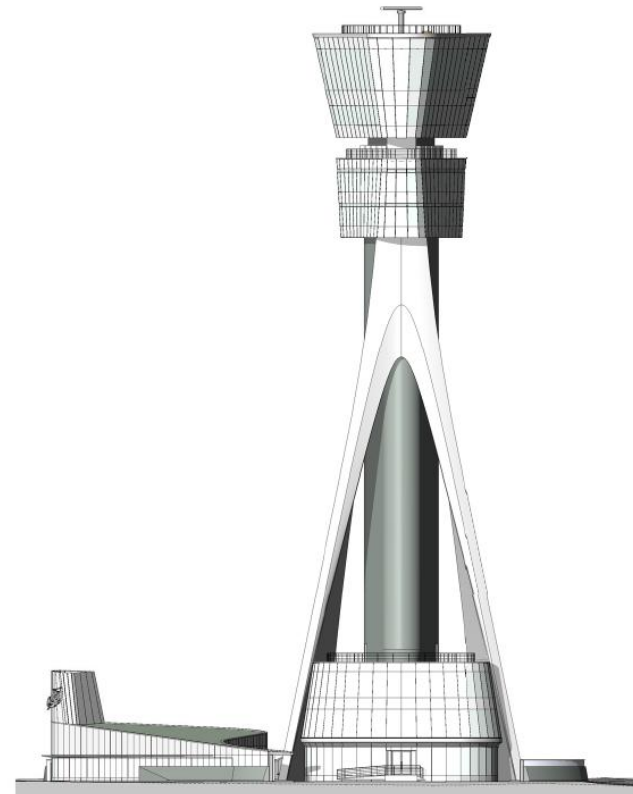
Design Challenges

Contemporary airports like CSIA are creating distinct facilities that allow for a variety of human interactions: productive business trips, touristic explorations, and families to be reunited, without sacrificing the primacy of the essential functions of efficiency and security. This people-centric focus, while conceptually easily grasped, is not simple to achieve when applied to a facility as complex as an airport.

It is through MIAL's commitment to improving not singular buildings, but the entire airport and its ancillary facilities comprehensively that has driven the transformation of CSIA over the past few years. The ATCT is hence the iconic embodiment of the marriage of design, functionality and holistic thinking that the new CSIA typifies.

Designed by international Architectural Design firm HOK and International Engineering Design firm ARUP, the ATCT is unlike the other towers dotting Mumbai's urban landscape. It is not a commercial building but instead serves as a representation of the engine of that commerce, technically proficient, purposeful and modern, the nerve center for a complex set of incalculable operations, calmly coordinated in an elegant shell.

It is a symbol of the new Mumbai. Beyond prominence by virtue of its height, its sleek curves and angularity easily evoke images of flight, conjuring romantic notions of modernity and the adventure of travel.



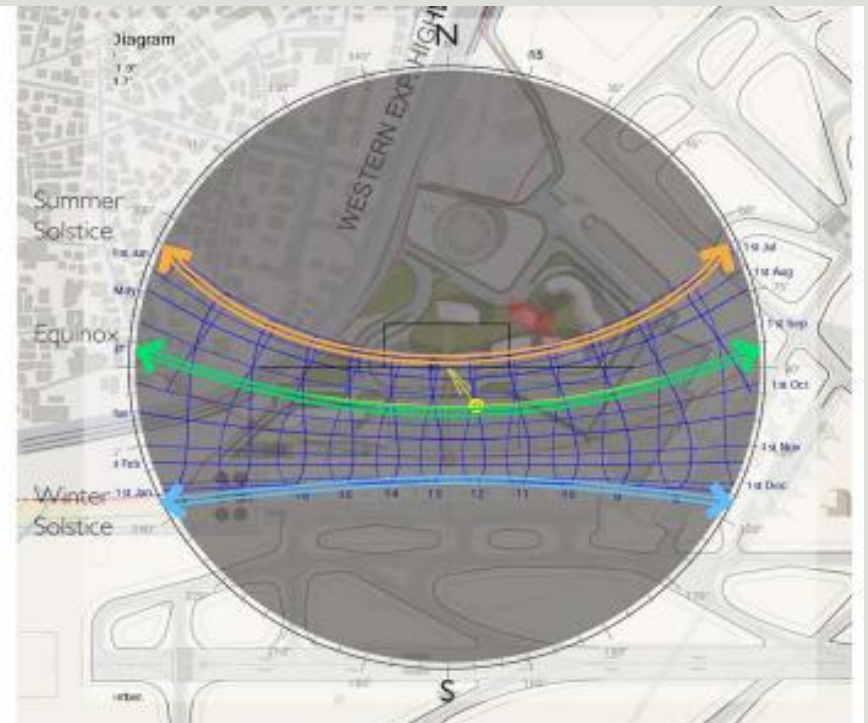
Design Challenges

The designers employed a revolutionary software tool that allowed real-time three-dimensional modeling and visualisation. Philip Bernstein, Vice President at Autodesk, the makers of the software, stated that the CSIA ATCT design uses “parametric modeling to its best possible advantage, managing the technical complexities of a difficult building type...with skill while simultaneously creating a sophisticated and memorable design solution.”

With its multitude of complex systems, verticality within a small floorplate, and delicate design tactics like sloping walls to reduce glare, the use of Building Information Modeling (BIM) was essential to merging the rigid demands of functionality with the ambition to become a design icon for the airport.

Clashes between various systems and physical elements within the building design were easily identified with the visualisations engendered by the modeling system, and hence avoided during construction.

The intelligence enabled by the design software and designers’ resulting modeling capabilities led to the CSIA ATCT being awarded an international award given by Autodesk in 2009.



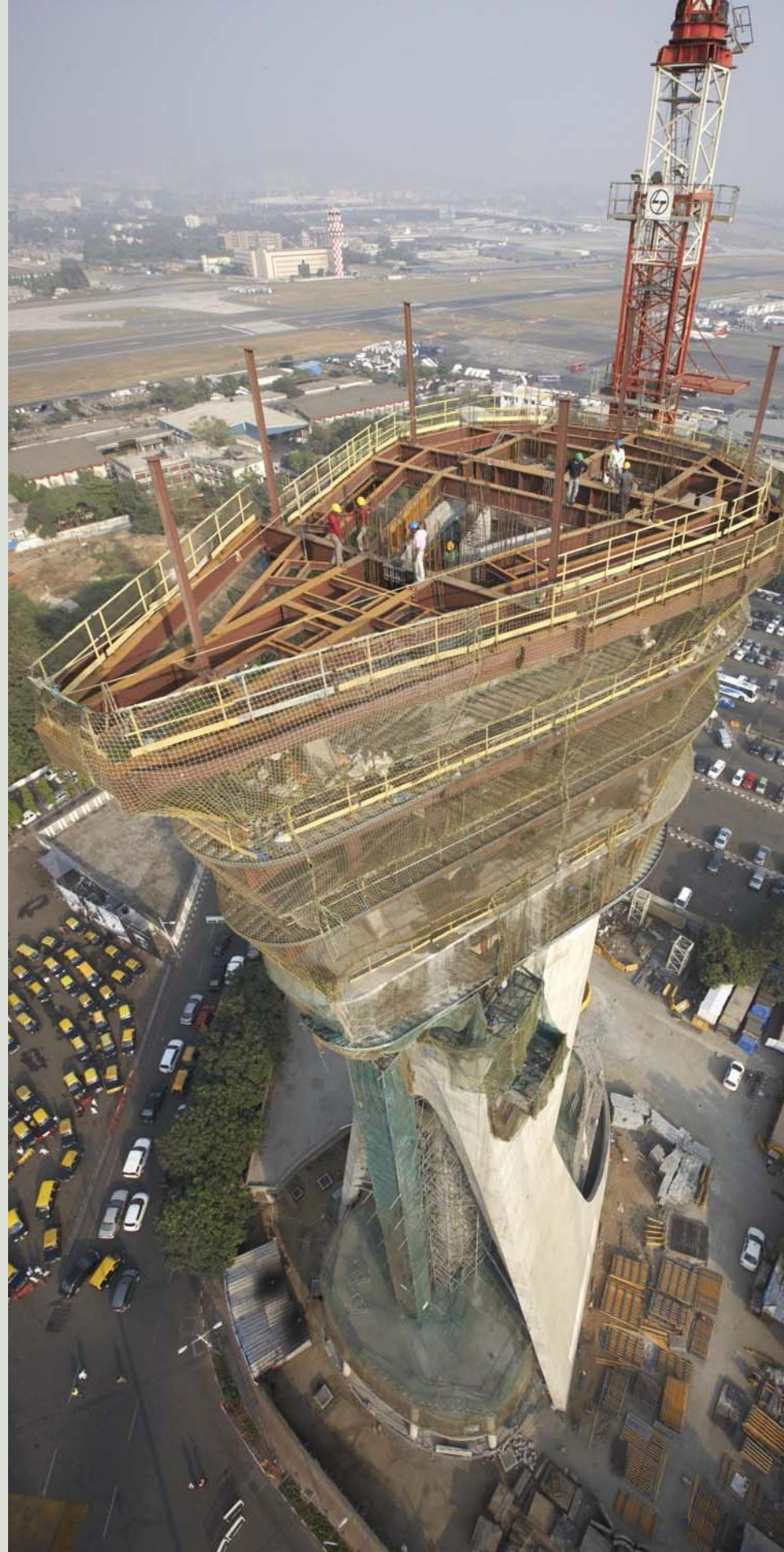
Prevailing Wind

Design Challenges

The main engineering challenges were associated with the visual and acoustic performance of the cab. The open structure at the cab, with minimised framing for the glazing, aids visibility. The sloping glazing in the cab, required for reducing reflections and visual distortion, necessitated a custom-designed cleaning solution based on gantries. The tight acoustic requirements for the various occupancies of the tower were met by an acoustic curtain wall system to minimise transmission of external noise into the building.

The height of air traffic control towers can often lead to concern over the effects of wind-driven movement. At an early stage it was identified that the distinctive skirt could reduce wind vibrations by breaking up the wind flow, which might otherwise require adoption of damping systems. This was confirmed by wind-tunnel testing using models generated directly from 3D modelling information.

Air traffic control towers house complex systems and there is a premium on space. 3D modelling tools were used to coordinate the engineering and the architecture. The geometry of the distinctive skirt was passed directly from the architectural modeling in the BIM-enabled design tools to the structural analysis software.



Construction Challenges

Implementation of a iconic high rise tower, within a small plot area at day and night operational busiest airport premises, provides a plethora of challenges for a construction team in its various form.

Transformation of design and on site realisation from inception to disbelief was achieved by the involvement of great artisan in the respective field and of course with close supervision.

Various complex challenges posed during the implementation process ranging from specialized concrete, shuttering arrangement, Unique Glazing challenges due to distinctive shape of ATC tower were successfully countered by project management and construction team.

It involved Labour strength of about 400 in peak periods to 170 in periods of not so favorable weather conditions.

Factors like Wind velocity, working in operational premises i.e., surrounded by critical road traffic movement area of domestic air passenger presented several unique challenges.

The wish bone shape of the structure which adds beauty and strength was completed in a very close planning /monitoring of the progress.



Construction Challenges

Safety Overview

- Total Fire extinguishers at a time at site: 50 Nos.
- Total Man hours worked since inception: 2 Million.
- Total area of 8900 Sqm covered by Safety Nets to prevent object falling from height.
- Especially Fabricated 60 Nos. gates to prevent Falling from height in all shafts
- Roof at a height above 80 AMSL, which shapes the entire tower was done with structure steel, fabricated and erected with great precision and safety procedure



Construction Challenges

Glazing Overview:

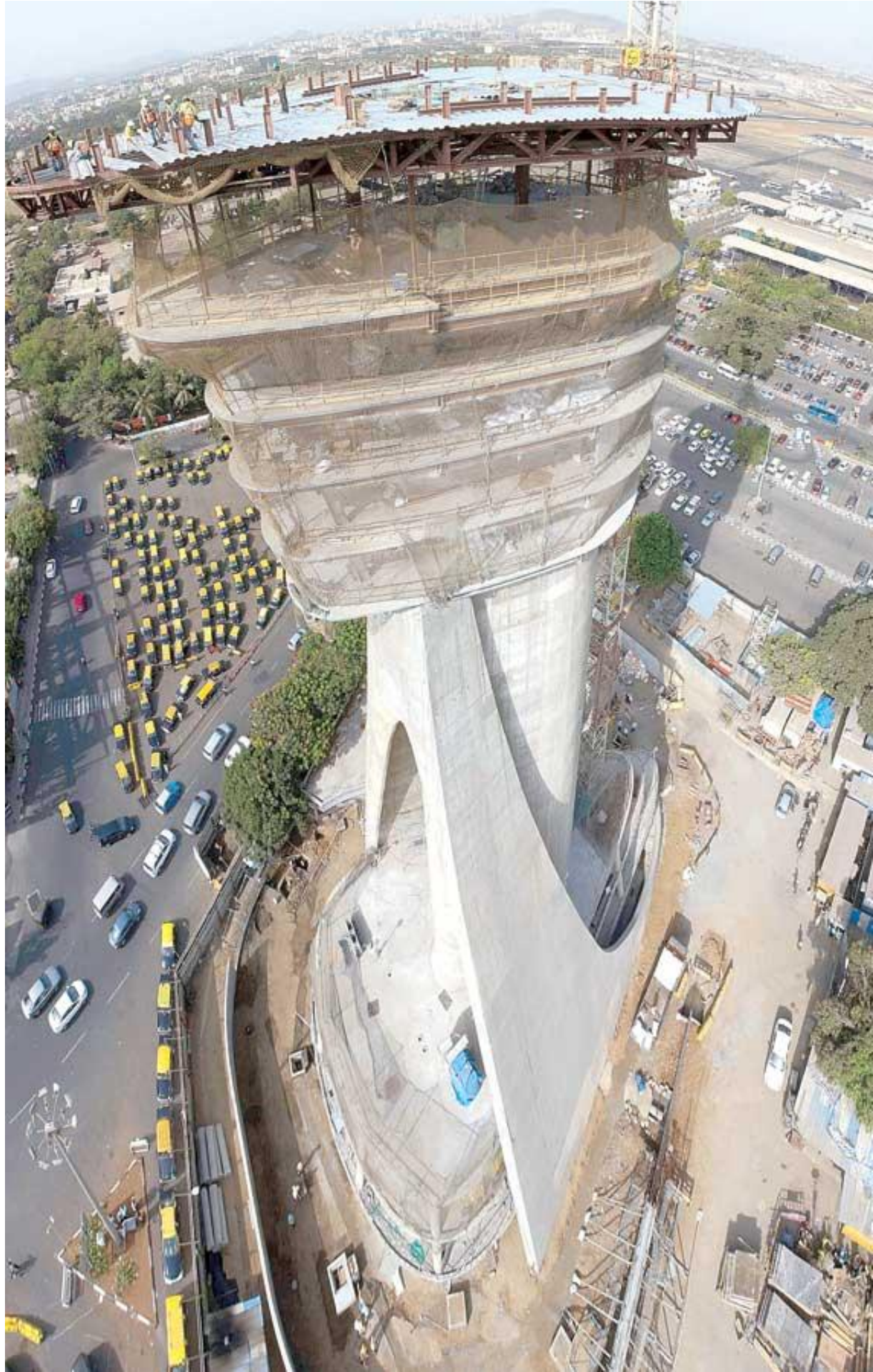
- Maximum weight of biggest size glass installed at 84m height 600 Kg.
- 3.7 km linear dimension Horizontal and vertical pressure plates with Decorative cap laid for CAB and Stalk level at a height of 60-84m above ground.
- 4.5 km linear dimension Horizontal and vertical pressure Silicon works carried out at a height of 60-84m.

RCC works:

- Self compacting concrete used for Structural Frame.
- RCC structure was made with the jump form shuttering with self compacting concrete which was poured through the Pump.



Images

























Architectural and Engineering Design credits



ARUP

PMC & Construction credits

