Control towers

ARUP


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TAM

Advanced engineering solutions

The Control Tower is the central hub for coordination of hundreds of safe and efficient aircraft movements through an airfield every day. In addition to this, the Control Tower offers the opportunity to create a landmark structure that is the symbolic reference for the airport and its status.

As control tower designers, our challenge at Arup is to create a highly efficient operational building and combine this with an elegant form, that offers an iconic visual point of reference for the airport. We work across all aspects of planning, design and construction, working closely with clients to deliver an optimum control tower solution tailored for their specific airport needs.

Left: Artist's Impression of Sabiha Gokçen International Airport control tower, Istanbul, Turkey.

Why Arup?

Arup is at the forefront of the engineering of control tower design. Our work is sought after because we have a reputation for setting new standards in aviation solutions.

Aviation expertise

Arup has been involved in aviation development for more than 50 years, working on a wide range of assignments at more than 100 airports worldwide. With aviation teams based around the world combined with strong knowledge sharing networks we capture and share the learning from our aviation and other sector experience to deliver better solutions for our clients.

We understand the challenges that airports face from future uncertainties in meeting rising air traffic capacity demands, shifting markets and even climate change. Around the globe, airlines, airport operators, investors, developers and regulators come to Arup for holistic solutions, from transaction advice right through to operational readiness. We have the expertise to negotiate the complex relationships between demand, capacity, connect time, passenger flow, regulation and investment. Through innovative planning, design, technology and management consultancy, we help aviation clients solve complex business, development and operational challenges. Our solutions are realised because they are fundable, buildable and deliverable without interrupting day-to-day operations.

Our control tower teams

Our teams have worked on over 15 of the most prominent control towers across the world and we continue to be at the forefront of engineering advances in control tower developments. Through our global network, we are very well connected at national, regional and local levels. We facilitate staff movement to meet the needs of our clients' projects, wherever these may be. By sharing knowledge and expertise with colleagues across engineering disciplines, we have access to a wide range of specialist skills and the latest engineering techniques.

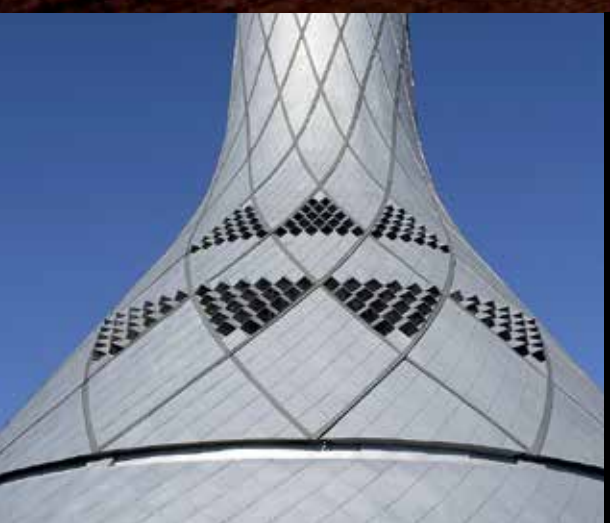
Innovative solutions

Each airport at which we work has a specific and unique set of requirements for their control tower design. The physical layout of the airport, the geographical location, air traffic demands, future expansion aspirations and air traffic control (ATC) modes of operation all have an important influence on the development of the control tower design. No two towers are the same. We foster a creative working environment where staff explore innovative solutions that deliver added value. Our teams work with our clients to provide a tower that integrates all these factors into a design that meets their strict operational needs and adds style and flair to these iconic buildings.

Sustainable development

Our aviation planners bring greater value and sustainability to airports worldwide. They provide a consistently excellent multi-disciplinary service, which incorporates our concern for the environment. Arup is committed to sustainable design, to its increasing incorporation in our projects and to industry-wide sustainability initiatives. We deliver innovative, sustainable aviation facilities and achieve BREEAM, CEEQUAL and LEED certification on many commercial buildings.

Opposite - top to bottom, left to right:
Heathrow Airport control tower, prefabricated cab transportation; Edinburgh Airport control tower, UK;
Sabiha Gokçen International Airport control tower, Turkey, technical drawings and models;
Arup designers at work and Heathrow Airport control tower, UK

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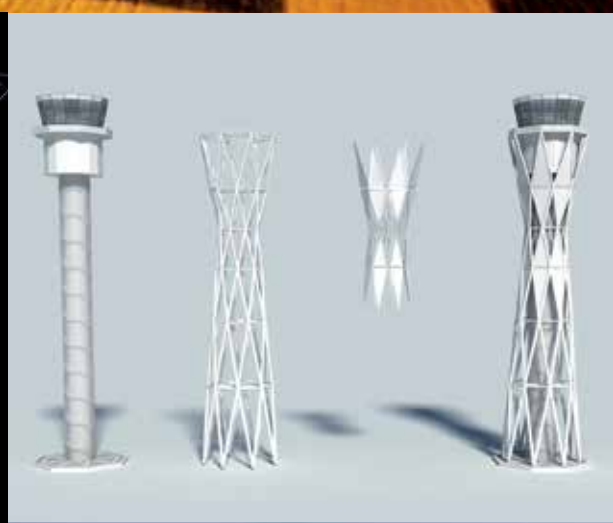


Total design services

At Arup we provide a total design service across all stages of control tower development through to completion of these highly integrated structures.

Planning

Whether building a new control tower on a new airfield or replacing an existing control tower, planning the height and location is the first aspect of design to be addressed. Arup works closely with the airport operator and air traffic controllers to establish the key ATC aspects of the airfield before any development starts. We take account of sight lines and views to all parts of the airfield to facilitate the efficient and safe operation of an airport. Replacement towers are usually taller than their predecessor and so during construction of the new tower, any obstruction to views from the existing tower needs to be part of the planning assessment.

Design

The primary function of the tower is to provide safe air-traffic control movements for the airport. As such the safety of the tower, its operators and the resilience of all the ATC and essential building systems is a top priority for all our designs. The design of the building structures to support this resilience strategy is elegantly combined to create the highly functional, yet aesthetically attractive tower.

The Visual Control Room (VCR) demands very careful consideration involving multiple specialists who coordinate the seating layout for each air-traffic controller. The design process considers the desk, equipment layout and sightlines from each seat together with the sun-shading, lighting and air conditioning requirements for day and night time operations. By its very nature the VCR contains very large areas of glass. Arup provides façade engineering expertise to ensure that the correct balance of solar protection and shading is provided by the glass specification whilst retaining the optimum optical properties for night time vision and avoidance of optical distortion and light reflection. The design of the control tower mast considers the integration of lifts, stairs and multiple fire segregated service risers. An important aspect of our design of taller towers is consideration of wind turbulence causing tower oscillations and the need for additional damping to ensure the comfort of the ATC staff working to the top of the tower. In many parts of the world, the risk of earthquakes is a major consideration in the design of the tower foundations. Our expert seismologists assess the risks and mitigation measures to ensure severe earth tremors do not cause damage to the tower.

Construction

Construction planning of a tower, particularly on an operational airfield, is an important consideration in the design process. Arup has used a wide range of pre-fabrication and mast erection techniques to minimize the construction programme and to avoid disturbance of airport operations or interference with ATC radar coverage. Our designs are tailored to suit the chosen methods of erection which are in turn based on the specific construction industry skills available in the region in which the tower is to be built.

Bringing into use

Once a control tower has been constructed we offer a range of services for bringing these important facilities into use. New towers are usually fitted with the latest ATC equipment which in turn requires careful training and familiarisation programs to enable the safe transition from the existing facilities to the new control tower operation. Arup can offer specialists who plan and run organisational change and transition programmes on these and many other airport facilities.

Balancing complex technical requirements

Design considerations

- Visual sight lines
- Fire escape
- Logistics
- Security
- Services
- Technical connections
- Wind comfort
- Earthquake protection

Arup control tower expertise

- Acoustic design
- Architecture
- BIM (Building Information Modelling)
- Building commissioning
- Building physics
- Building services engineering
- Construction planning
- Cost Management
- Environmental consulting
- Façade engineering
- Facilities management
- Fire engineering
- Geotechnical engineering
- IT and communications systems
- Lighting design
- Mechanical and electrical engineering
- Operations consulting
- ORAT (Operational Readiness, Activation and Transition)
- Organisational behaviour
- Project management
- Security risk and resilience
- Seismic engineering
- Structural & civil engineering
- Transaction advice and economic planning
- Vertical transportation design
- Vibration engineering
- Wind engineering

Worldwide experience

Arup has experience of designing control towers across the globe. The following selected case studies demonstrate our breadth of services in delivering advanced engineering solutions for our clients.

Arup control tower experience

Left: Visualisation of Chhatrapati Shivaji International Airport control tower, Mumbai, India.

Sabiha Gokçen International Airport, Turkey

Designing earthquake resistant control towers

The requirement for this new 112m control tower in Istanbul brought the twin challenges of designing an iconic structure for the enlarged airport while facing up to the severe engineering challenges of designing for the extreme earthquakes that affects this area of Turkey.

Control towers are critical for the safe operation of an airport and airports are an essential part of a city's transport infrastructure especially following a severe natural event such as an earthquake. To this end, critical facilities such as a control tower have to survive the earthquake and be immediately operable to allow emergency communications to be maintained. This is a far higher level of design performance than is applied to most other building structures.

Arup Associates undertook the integrated architectural and engineering design of this tower introducing a lightweight but strong diagrid steel exoskeleton working in conjunction with a special base isolation foundation to allow the ground to move independently of the tower. This design gives the building exceptional structural performance while maintaining a sleek and iconic structural form to satisfy the client's brief.

Right: Visualisation of the control tower.

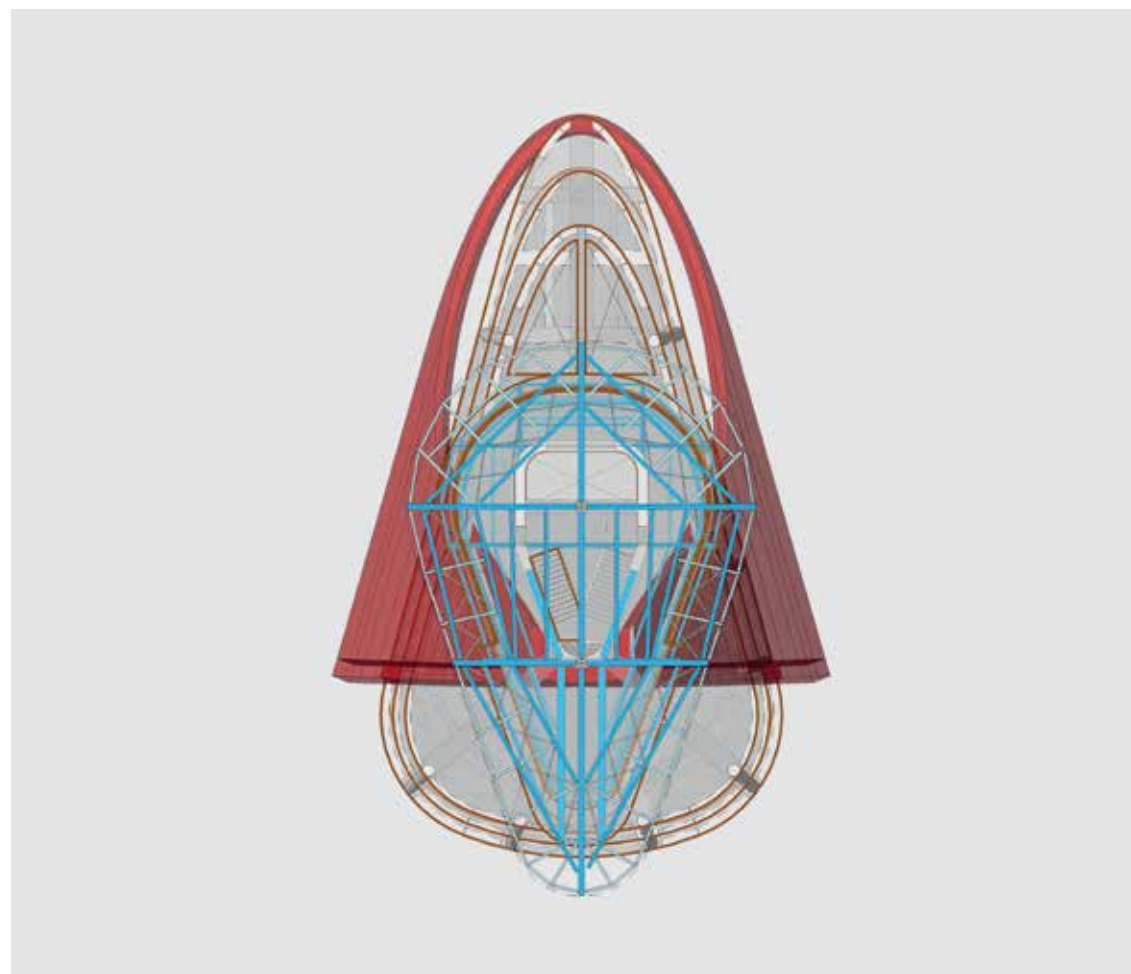
Chhatrapati Shivaji International Airport, India

Designing within a constrained site

The restricted site for this 84m tall air traffic control tower in Mumbai brought considerable challenges to the HOK Arup design team for this award winning project. The tower emerges from the middle of the base building with sloping skirts shrouding the mast and creating a dramatic iconic form.

Arup provided structural, geotechnical, building services and acoustic design for the tower all of which was coordinated through the use of a Revit BIM model. The engineering design made use of the sloping skirts of the tower to break up the wind flows around the tower and inhibit the formation of vortex shedding that would otherwise cause wind oscillations of the cabin.

Below: Completed tower and technical drawing.



Edinburgh Airport, UK

The Tower as an elegant landmark

Edinburgh's 57m airport control tower was designed by Arup and 3DReid Architects to respond to a specific client brief for an efficient operational tower and one that would provide a landmark centerpiece at the entrance to Edinburgh Airport

The tower achieves a 200 degree fully glazed view of the airfield for the air-traffic controllers without interruption from cladding mullions supporting the cabin roof. A number of low energy concepts have been integrated into the tower design including the use of free air cooling, rainwater harvesting and greywater recycling.

The sculptural fluted form of the tower elegantly accommodates the base building within the sleek metal tiled exterior. The resultant building achieves an optimised floor plate with a maximum internal floor space, enveloped within minimal cladding. The sleek form of the finished building is an architectural and engineering achievement and a demonstration of Arup's philosophy of holistic design and engineering integration.

Above: Completed control tower.

Sydney Airport, Australia

Elegant design within a tight budget

At only 40m tall, the air traffic control tower at Sydney Kingsford Smith's airport is not the tallest tower in the world but it is one of the most striking and unusual.

In a conventional tower of this height a 6m diameter concrete shaft containing the lift and staircase, would appear very stumpy. Instead this tower uses a 2.5m diameter, post-tensioned precast concrete shaft with an external glass enclosed lift shaft encircled by a helical escape stair like a giant helter skelter. The slender shaft is restrained laterally by post-tensioned stainless steel rod stays at 120 degree angles and above the shaft, the main accommodation is contained in a clover leaf form that cantilevers out from the cable stayed shaft and is surmounted by the cabin itself. The cabin provides unobstructed views outwards by using a single column to support the roof which is then tied down by 6mm rods located outside every glass to glass joint. The glazing is used to laterally brace the cabin resulting in a very light and economic design.

Designed by Ancher Mortlock & Woolley and Arup, the final outcome provides panoramic views from a very futuristic and innovative tower that was completed within a very tight budget. Arup provided the civil and structural engineering for the tower.

Below: Completed control tower.

Heathrow Airport, UK

Constructed whist the airport remained operational

In 2008, Heathrow opened its new Terminal 5 to serve the airport with a total passenger capacity of 75million per annum. The new terminal and its position within the airport complex meant a new control tower was needed to replace the existing facilities in order for the air traffic controllers to see aircraft movements around the entire airfield. Arup, working with architects Rogers Stirk Harbour + Partners, engineered the design of an 87m steel tower to offer a control room design with one of the largest cones of vision in the world.

For the construction of this tower, a unique form of engineering was developed to allow daily aircraft operations to be maintained around the base of the tower site, while it was being built. The top 8 storeys of the control room were constructed on a remote airfield location and transported overnight to the tower site. Over the following weeks the control room was jacked up to its full 87m height as tower sections were added underneath it. This tower won multiple awards for its design and construction.

Below: Construction of Heathrow Airport control tower.

Dublin Airport, Ireland

Value by design

Dublin Airport and the IAA (Irish Aviation Authority) needed a new control tower to operate a planned expansion for the airport and to provide communication services across local airspace as well as the eastern half of the North Atlantic.

The new control tower design developed by Arup and architect Scott Tallon Walker provides an 80m tower with a 5 level cabin at the top of the mast, as well as area control functions which are handled within the base building. Unobstructed views of current and future runways, acoustic control, resilience of power and communications services, were key client aspirations. Top class maintenance access to reduce downtime, access control for security reasons and quick evacuation in case of emergency were additional factors incorporated into this new design. Arup provided mechanical, electrical, civil and structural engineering, in addition to waste and EIS consultancy bringing the project from concept to detailed design stage.

Right: Visualisation of Dublin Airport, control tower.

Frankfurt Airport, Germany

Maximum visibility in a replicable design

The 70m airport control tower at Frankfurt airport was designed by architects Ondra & Partners, and planned to ensure it the air traffic controllers had the best possible views across the airfield, without being hindered by window mullions. A multidisciplinary Arup team of façade planners and structural engineers, worked closely with the glass supplier, to create a glass strong enough to take on a structural role which would reduce the need for structural support mullions. The design challenge was to make the glass strong enough but not so thick that it would cause optical distortion or cause production and installation problems.

As a result of this design, Deutsche Flugsicherung (DFS), the German air traffic control agency appointed Arup to provide similar services on Berlin's new Brandenburg International Airport control tower. Both the Frankfurt and Berlin projects are part of a consistent, replicable design concept for control towers developed by architects Ondra & Partners and operated by DFS.

Below: Completed control tower at Frankfurt Airport, including meeting room.

Birmingham Airport, UK

Enabling airport expansion

Opened in May 2013, Birmingham Airport's new traffic control tower is equipped with state of the art radar and navigation equipment and gives controllers full views of the airfield, overcoming sightlines obstructed by new terminal buildings. Its construction was a prerequisite for a runway extension that was completed in 2014, allowing airlines to fly to more long haul destinations worldwide.

Arup provided civil, structural, MEP and fire engineering services. The seven storey tower at 34m height was an ambitious project in construction terms. The fast track construction involved slip forming the mast in a 10 day continuous concrete pour process. In parallel with casting the mast, the cabin was prefabricated off-site and lifted into place. The scheme was crowned Project of the Year and Best Regeneration Scheme at the UK 2013 RICS West Midlands Awards.

Above: Completed control tower.

About Arup

Arup is a global firm of planners, designers, engineers and business consultants. We provide a diverse range of professional services to clients around the world, exerting a significant influence on the built environment. The firm is the creative force behind many of the world's most innovative and sustainable building, transport and civil engineering projects and design technologies.

Established in 1946, Arup has over 11,000 employees based in more than 90 offices across 39 countries, working on up to 10,000 projects at any one time. Its unique structure, with the firm held in trust on behalf of its employees, gives us complete independence.

Arup helps aviation clients solve complex business, development and operational challenges through innovative planning, design, technology and management consultancy.

Arup worldwide offices

90+ offices in 39 countries:

Australia	Hong Kong	New Zealand	Spain
Botswana	India	Nigeria	Taiwan
Brazil	Indonesia	Philippines	Thailand
Brunei	Ireland	Poland	Turkey
Cambodia	Italy	Qatar	UAE
Canada	Japan	Russia	UK
China	Macau	Sabah	USA
Colombia	Malaysia	Singapore	Vietnam
Denmark	Mauritius	South Africa	Zimbabwe
Germany	Netherlands	South Korea	

For further details refer to www.arup.com/aviation

Right: Visualisation of Sabiha Gokçen International Airport control tower, Turkey

Image credits

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p03	Arup designers at work	© Noah Sheldon / Julian Richards
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