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Giving India A Flying Start

Bengaluru International Airport
Airports being gateways to the respective regions are critical in creating the right impression on the visitors to our country. They also play a major role in the development of business activities and growth of the areas catered by these airports.

Favourable demographics and rapid economic growth point to a continued boom in domestic passenger traffic and international outbound traffic. To meet this ever increasing demand, the Government of India introduced the policy of “Open Skies” some time ago and this has provided a powerful spurt in traffic growth during the last two years. Indian private airlines such as Jet, Kingfisher, Air Deccan, Sahara and Spicejet accounts for around 60% of the domestic passenger traffic. Some of these airlines are also operating international flights.

While there is no doubt about the growth potential, the key question that needs to be addressed is building of airport infrastructure to sustain the boom in the long run.

At present, passenger traffic is concentrated at five major airports. About 70% of this traffic is confined to metros with Delhi and Mumbai airports alone accounting for 45% of passenger traffic. In view of this the Government in addition to expanding the airports in the metros is planning to divert traffic to non-metros for distributing growth evenly and to reduce the pressure on metros.

Several non-metro airports are being developed partly through the PPP model. Airports Authority of India (AAI) is developing the airside facilities and terminal buildings of these airports while city-side development works are carried out on private partnership basis. It is said that the government has already awarded contracts for terminal building at 15 airports and airside development, contracts have been awarded at 24 airports.

The new Greenfield airport at Hyderabad International Airport developed through PPP is already functional from March 2008 and similarly
Airport Village at Hyderabad

Escalators at Bengaluru International Airport
the Bangalore International airport is ready for operations from May 23, 2008. Modernisation and expansion of the Delhi and Mumbai airports are in progress. Chennai and Kolkata airports are also proposed to be taken up for expansion/modernisation. In order to ensure balanced airport development around the country, a comprehensive plan for the development of 35 non-metro airports is also under preparation at an estimated investment of Rs.40,000 crore for modernisation of airport infrastructure.

As traffic moves up, the number of airports would also increase significantly in the years to come. The country is expected to have a good number of private airports, popularly described as merchant airports.

**Largest Airport Builder**

With the completion of construction of Hyderabad and, Bangalore airports and work in progress at, Delhi and Mumbai International airports, L&T is one of the Largest Airport Builder in this part of the world for Design & Construction of aviation infrastructure. Some of the features of these new generation airports are given below:

**Bangalore International Airport Limited (BIAL)**

- State-of-the-art terminal building having an area of around 1.00 million sq. ft.
- Construction of a 4km runway and other infrastructure.
- The airport will cater to the projected traffic demand of 11.5 million passengers and handling 3 lakh tons of cargo per annum.
- Modular construction adopted to ensure smooth and seamless expansion to cater to future growth.
- Integrated Cargo handling facilities with of a total built up area of 6.00 lakhs sqft
GMR Hyderabad International Airport Limited (GHIAL)

L&T built the Greenfield International airport at Shamshabad involving terminal building and other airside works including taxiways, runways, etc. The airport is functional and is designed to handle 12 million passengers per annum. Some of the features include:

• The seven level Passenger Terminal Building with an area of 1.17 million sq.ft.

• Airside works involved construction of 4.26 km long runway including developing many other infrastructure.

Delhi International Airport Private Limited (DIAL)

A World-class Airport for Delhi is a few years away. L&T is executing the design and construction of terminal building, runway and associated works of Delhi International Airport valued at about Rs. 54.00 billion to be commissioned by 2010 for Commonwealth Games. Some of the features include:

• The Passenger Terminal Building (T3) will cater to both domestic and international traffic and will handle 25 million passengers per annum, more than twice the present traffic. The total built-up area of the new terminal building (T3) will be 5.2 million sq.ft..

• A new code F runway, at 4.43 km, will be one of the longest in Asia and equipped with CAT IIIB – a landing system.

• All airport facilities like baggage handling systems, IT, communication, passenger boarding bridges, flight information and displays etc.

Mumbai International Airport Ltd (MIAL)

A World-class Airport for Mumbai will also be ready in 4 years. L&T has been entrusted with

The New Rajiv Gandhi International Airport, Hyderabad
design and construction of terminal works, airside works and ancillary facilities at Chhatrapati Shivaji International Airport (CSIA) to be commissioned by 2012. The new terminal (Terminal 2) will come up in the existing international terminal amidst various challenges.

- The terminal will handle 40 million passengers per annum and this will be commissioned in a phased manner from 2010 to 2012. The total built-up area of the new terminal building (T2) will measure 4.84 million sq.ft.

- Airside works including runway reconstruction, construction of new aprons and additional taxi ways.

- All airport facilities like baggage handling sytems, IT, communication, passenger boarding bridges, Flight information and displays etc.

**Calicut Airport**

L&T recently completed the renovation and rebuilding of Calicut airport. The total built up area being 1.74 lakh sq.ft.
The New Rajiv Gandhi International Airport at Hyderabad

Inside view of the passenger Terminal Building at Hyderabad
With the touchdown of Lufthansa flight LH752 from Frankfurt at the Rajiv Gandhi International Airport in Shamshabad at 00.25 hours on Sunday March 2008, the commercial operations began at the new Airport. To receive and welcome the first ever international flight carrying 276 passengers from Frankfurt, Germany the entire airport was fully-lit up, with relatives and friends thronging the arrival area. The same aircraft was scheduled to depart at 2.30 am for Frankfurt, thus becoming the first international flight to take off from the airport.

All passengers and crew members were given a rousing reception on their arrival at the new airport, which was declared open by Mrs. Sonia Gandhi on March 14, 2008.

Passengers reaching the new Hyderabad International Airport for the first time were indeed surprised to see an awe inspiring and an entirely new looking modern airport incorporated with world-class facilities and amenities, unprecedented in the country. This is the first Greenfield airport built in public-private partnership and incorporates the best of facilities in other parts of the globe. With this, the 76-year-old Begumpet airport located in the heart of Hyderabad city was officially shut down.

Passengers who want to reach this airport at Shamshabad have to drive 25 km from the City. All along the route to the new airport one can see the work in progress of widening of access roads, criss-crossing elevated expressways, new outer ring road, etc – all leading to the new airport.

As one enters the sprawling Shamshabad facility having an area of 5500 acres, for some distance you will see a dry patch of land and from a long distance you can see the towering air-traffic control tower and
An aerotropolis is a new type of urban form comprising aviation-intensive businesses and related enterprises extending up to 25 kilometers (15.5 miles) outward from major airports.

It is similar in form and function to a traditional metropolis, which contains a central city core and its commuter-linked suburbs. An aerotropolis has an airport city at its core and is surrounded by clusters of aviation-related enterprises.

Airports have evolved as drivers of business location and urban development in the 21st century in the same way as did highways in the 20th century, railroads in the 19th century and seaports in the 18th century, according to Dr. John D. Kasrada, the American academic who defined the aerotropolis concept in 2000.

Aerotropolises are powerful engines of local economic development, attracting air-commerce-linked businesses to the land surrounding major airports, analogous to the function of central business districts in the downtown areas of major cities.

Aerotropolises typically attract industries related to time-sensitive manufacturing, e-commerce fulfillment, telecommunications and logistics; hotels, retail outlets, entertainment complexes and exhibition centers; and offices for business people who travel frequently by air or engage in global commerce. Clusters of business parks, logistics parks, industrial parks, distribution centres, information technology complexes and wholesale merchandise marts located around the airport and along the transportation corridors radiating from them.
Baggage reclaim hall

Departure lounge in the Passenger Terminal Building
Passenger Terminal Building - Highlights

- India’s first Greenfield airport
- Integrated Passenger Terminal Building with initial capacity of 12 million passengers per annum
- Unique concept of Airport village
- 130 check-in desks with CUTE and 16 self check-in-kiosks
- 46 immigration counters for Quick processing
- In-line baggage handling system with level-4 security system, the first of its kind in India
- Awarded to L&T ECC on 25th November 2008.
- Completed all the works in a record span of 28 months.
- Built up area – 1.17 million sq.ft..

Special features of construction

- Kalzip roof sheeting
- Temple leaves for tapping natural light with great aesthetics
- Bull Nose cladding surrounding PTB- the most challenging job
- Good aesthetic Interiors including False ceiling, wall cladding, Flooring, etc.

Resources

- Total Man hours (workmen) – 13.5 Million Man hours
- Total staff months – 2000 staff months
- No. of labourers at peak – 3200 Nos.
- No. of staff at peak – 78 Nos.
- No. of tower cranes at peak – 6 Nos.

<table>
<thead>
<tr>
<th>Major Quantities</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>64,500 Cum</td>
</tr>
<tr>
<td>Formwork</td>
<td>2,28,500 sq.m</td>
</tr>
<tr>
<td>Structural steel</td>
<td>4,400 tons</td>
</tr>
<tr>
<td>Rebar</td>
<td>9,500 tons</td>
</tr>
<tr>
<td>Roofing</td>
<td>42,500 sq.m</td>
</tr>
<tr>
<td>Flooring</td>
<td>97,000 sq.m</td>
</tr>
<tr>
<td>Cladding</td>
<td>52,000 sq.m</td>
</tr>
<tr>
<td>Glazing</td>
<td>29,500 sq.m</td>
</tr>
<tr>
<td>False Ceiling</td>
<td>64,000 sq.m</td>
</tr>
</tbody>
</table>

The passenger terminal building with its massive and design contoured Kalzip roof. However, as you reach closer, you can see the beautiful approaches with divided roads planted with ornamental date palm trees on the median, landscaped gardens with colourful flowering plants along the sides including fountain jets and sprinklers doing their routine of watering the plants.

The airport is a 63:11:13:13 joint venture between Hyderabad-based GMR Hyderabad International Airport Limited (GHIAL), Malaysia Airports Holding
Berhad, the Andhra Pradesh government, and the Airports Authority of India.

Equipped to handle 7.2 million passengers in 2008, the airport (without any expansion) is expected to handle 12 million passengers by 2010, subsequently scaling up to 40 million in the final phase. The corresponding figures for cargo handling is expected to touch 1.0 million tonnes from its present 1.0 lakh ton capacity.

The airport is South Asia’s first A-380 aircraft compatible and has India’s longest runway at 4,260 metres.

The passenger terminal building having an area of 1.17 million sq. ft. is capable of handling twelve million passengers per annum. It is provided with 42 stands consisting of 12 contact boarding bridges and 30 remote stands. There are 130 check in counters with common user terminal equipment (CUTE), 16 self-check-in- kiosks, 46 immigration counters, 30 escalators and 32 elevators. In addition, it has conference facilities for business travellers, hotel facilities, a hospital, retail shops and integrated information technology systems - in short, all the modern gadgets expected of a global standard airport.

**Airport Village**

For the first time in the country an "Airport village" has been created between the terminal building and the public land side at level D. This consists of a shopping arcade with a wide variety of stalls and food courts to serve as a place for people to "meet and greet." Those not using the airport can also drop in here for shopping.

This apart, there is a uniquely designed retail area inside the terminal building based on the walk-through concept that enables customers to move from one shop to another without having to walk in and out of shops. Moreover, plans are afoot for
developing the area around the airport as a modern aerotropolis.

In every respect, this is not just another airport. It is going to be the nucleus of the country’s first aerotropolis, a new urban form that would house business parks, hotels, residential units and entertainment areas.

**L&T’s Contribution**

L&T secured two major contracts, against international competitive bidding at GMR Hyderabad International Airport, for the construction of:

**Airside and Landside works**

The airside and landside works involved construction of a 4260m long runway, taxiways and aprons to accommodate wide-body planes (code F- aircrafts), including new generation aircraft, such as the A380. In all there are 42 parking bays – 12 contact and 30 remote. This apart, L&T executed the complete airfield lighting system, fire-fighting system, fire rescue station, installation of the aviation hydrant system, etc. involving complete HT/LT electrical power networks as well as sewage and water supply networks.

This also involved construction of more than 60 allied buildings and structures such as a large cargo terminal complex, ground handling workshops, maintenance and engineering buildings, navaid structures, crash fire resource stations, underground sumps as well as sewage / water treatment plants, a car park to accommodate over 3200 cars, the main access road as well as connectivity to the passenger terminal building.

**The Passenger Terminal Building (PTB)**

L&T executed the complete civil and facade works of the fully operational passenger terminal building - a seven level modern building having a floor area of 1.17 million sq. ft., 75m high air traffic control tower including design, supply and installation of facade works for glass, glazing and roof.

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*Airside view showing the passenger boarding bridges*
Both contracts were executed by L&T in less than 30 months, including a three-month airport operational trial period.

**Design Principle**

The basic design of the passenger terminal building is simple, attractive and loose-fit. The fluid design is such that sequences of spaces are provided to facilitate easy and comfortable movement and orientation. This spacially designed PTB ensures rapid transit between its Domestic and International concourses. In fact it has everything that gives one the out-of-the-ordinary feeling. The roof, designed as a Temple Leaf Structure, enables the natural light to filter through. Built with modular construction technique, the passenger terminal building has 16 skylights and this reflects the distinct Indian culture. L&T fabricated and erected the 75m long 3m high trusses for the erection of 40,000 sq.m Kalzip roof.

**Kalzip Roofing**

Another salient feature of the Passenger terminal building is the Kalzip roof.

The Kalzip roof is a propriety product of Corus Building Systems, Singapore consisting of composite layers including GI liner at the bottom followed by Cement board, vapour barrier, rock wool insulation and kalzip sheet at the top. The system as a whole got excellent thermal and aesthetic properties. The method of construction involved lifting of the kalzip roll forming machine to the roof level for forming the corrugated sheets at that level followed by laying and fixing of the sheets with the kalzip accessories.

**ATC tower**

The tower structure is of 75m height with conical shape. ECC encountered many difficulties in arriving at the shape on ground due to the complexity in design – both architectural and structural.

The RC shaft of the tower structure up to 54m height part was completed using Climbing formwork. The conical portion of the tower commences from 5m level and tapers outside from there till it reach 75m level. The construction imposed several challenges an working at such a height.

*The Airport Village - a place to meet and greet passengers*
A platform specially designed and fabricated was anchored to the RC shaft of the tower at 54 m level. This avoided the costly and cumbersome process of staging from ground.

**First in India**

Airport village, a new concept introduced for the first time in India, is the place for retail, restaurants, supermarkets outside the passenger terminal building in level ‘D’. The 40,000-odd sq.ft. covered village with free entry is also the place where visitors can meet, greet and see off passengers.

**Access Roads**

Incoming vehicles in to the airport can find its way in to 3 different levels as per one’s requirement. Passengers reaching the spacious car park at the ground level can take both the ramp or the elevators and reach either level D to pick up the passengers or go for a shopping spree at the airport village. From here one can reach the departure lounge in level F through elevators.

At the same time vehicles can reach level D straight away by taking the second level elevated road in the middle to pick up passengers arriving there. One can also go down the ramp or elevators to the ground level car park to pick up a pre-paid taxi with automated Flight Information Display System and a separate public transportation centre further away.

ECC faced several constraints and difficulties as follows:

On going designs supplied by Arup Consultants (HK) during the construction period imposed many problems due to frequent revisions in drawings.

As the location of project is totally isolated from the city, the magnitude of cyclones and heavy winds during rainy season was quite high. Particularly, the hurricanes in the month of March 2006 and heavy winds during May and June 2007 posed construction challenges which were successfully scaled.

**K. Sridharan, CCD, ECC-HQ, Chennai**

*with inputs from*

**S. Radhakrishnan, Construction Manager (PTB)**
Airside and Landside Facilities

The EPC contract for the construction of the airside and landside (ALS) facilities of the airport was awarded to ECC division of L&T and the entire project involving comprehensive mix of complex and multidisciplinary operations was executed by three different Business Units of ECC – Institutional & Commercial Buildings (I&CB), Roads & Runways (R&R) and Electrical, Instrumentation & Communication (EI&C).

Scope of Works

The scope of works involved detailed design, working drawings, shop drawings, construction, production, assembling, installation, testing, commissioning and integration of all works for the airside and landside facilities. In brief this involved:

The airside works

- The runway and taxiway system including adjacent restricted areas. – Runway – 4.26 km, taxiway – 4.36 km, 4 rapid exit taxiways and 12 connecting taxiways
- Aircraft aprons designated for passenger terminal, cargo terminal and aircraft maintenance facility. – Main Apron – 1120 Rm
- Aircraft isolation bay
- Airside service roads
- Aviation fuel hydrant system
- Storm water drains for runway, taxiway, aprons and airside roads, which involved:
  - Concrete lined drain – 17.75 km
  - Masonry drain – 5.662 km
  - Concrete drain – 4.772 km
  - Pipe drain – 4.257 km
  - Earthen drain – 24.5 km

Side view of the Passenger Terminal Building
- Necessary visual aids on runway, taxiways and aprons to secure that the aircraft can operate safely on a 24 hours basis.

- Civil and building works and utilities required for the communication, meteorological and navigational equipment to be supplied, erected, tested, commissioned and integrated by AAI.

**Landside works**

- Main access roads – 8.4 km
- Traffic loop in front of terminal building including upper and lower traffic forecourts.
- Parking areas inside the traffic loop – 2 lakh sq.m
- Road systems to other airport facilities
- Connectivity road from NH7 to Airport main access road
- Storm water drains for landside roads and other areas
- Utility corridor and trenches connecting various buildings and facilities
- All utilities on the landside and airside
- D G emergency power station

Construction also included some of the other major Buildings, such as:

- Cargo terminal
- Crash and fire rescue (CFR) stations
- Ground handling equipment and maintenance facilities
- Water treatment plant and Sewage treatment plant
- Engineering building for airline operators
- Building for ground handlers Menzes & Air India - SATs
- Miscellaneous buildings such as substations, pumping station and gate houses.

**Miscellaneous Works**

- 11 km airside/landside boundary wall
- Upgradation of 9 km boundary wall to BCAS spec
- Airside fire drill facility
- Operations and maintenance equipment/facilities

**Electro-mechanical services**

This involved execution of the Fuel Hydrant System, which included:

- 11 km of 18” dia piping with 3 layer polyethylene coating and lining.
- 58 fuel pit valves.
- 14 drains and 14 vents.
- Entire piping pressure tested with JETAI fuel @ 30 bar for 24 hrs.

**External Water Supply**

Water supply system for the airport catering domestic, flushing and AC makeup water with:

- 5 pumping station with 22 pump sets.
- 12 hydropneumatic systems.
- 2 water treatment plants of 2500 KLD capacity.

**External Sewage System**

This involved collecting the sewage from various building clusters of the airport and transporting them to STPs. Basically, this is a closed system with 100% utilization of treated water from STP, which is being used for AC make up and irrigation.

- 14 km of CI and RCC piping.
- 3 sewage pumping stations with 6 heavy duty sewage handling pumpsets with auto operation
- 2 sewage treatment plants of 925 KLD.
• 200 lavatories involved in ALS package with 16 km of internal piping.

**Fire Fighting System**

The fire fighting system with water as medium extended to all buildings in the ALS and the aprons consisting of the following:

• 16 km of piping.
• 2500 sprinklers for cargo bldg.
• 2 pumping stations with 10 pumpsets as per NBC.
• 40 external hydrants.

**HVAC**

Heating, Ventilation and Air conditioning for the ALS package involved:

• 182 ventilation fans.
• 230 TR cassette units for engineering buildings.
• Central AC for cargo with 190 TR chillers.
• Central AC for engineering building with 70 TR package unit.
• Precision AC for radar building with 40 TR.
• 80 Split air conditioners for auxiliary buildings.

**Security Equipment:**

Security equipments installed at the gatehouses involved:

• Fully integrated Rising bollards and boom barriers for 5 gate houses.
• Motorized swing gates for 3 gate houses.
As a part of the contract, the employer had stipulated the requirement of each of the component of the airport. Taking that as the basis the design was taken up. Expert designers in this field were given the assignment. The designs were progressively prepared and submitted to the employer for their comments and simultaneously works were taken up.

The design team stationed at ECC-HQ, Chennai encompassing all disciplines were provided with adequate and suitable hardware and software to enable detailed engineering of the project. The core design team at site interfaced with clients to get necessary inputs and to schedule delivery of requisite drawings / documents to site for timely completion of works.

**Mandatory Requirement**

- **This included:**
  - Globally recognized and accepted standards of performance and service in accordance with ICAO standards & IATA guidelines.
  - Requirements of statutory agencies viz., Directorate General of Civil Aviation, Bureau of civil aviation security, customs and immigration authorities.
  - Conditions, regulations, measures and all requirements of whatever kind set out in order issued by the Ministry of Environment & Forests, government of India and the Andhra Pradesh pollution control board.
  - Conditions, regulations, measures and all requirements of whatever kind as set out in defence and DGCA site clearance for the project.
  - Conditions, regulations, measures and all requirement of whatever kind imposed by any applicable laws.

### Major Quantities of Work - ALS

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>Excavation</td>
<td>37 lakh Cum</td>
</tr>
<tr>
<td>Embankment</td>
<td>32 lakh Cum</td>
</tr>
<tr>
<td>GSB</td>
<td>3.70 lakh Cum</td>
</tr>
<tr>
<td>WMM/FCR</td>
<td>4.70 lakh Cum</td>
</tr>
<tr>
<td>Asphalt</td>
<td>1.60 lakh Cum</td>
</tr>
<tr>
<td>DLC</td>
<td>0.52 lakh Cum</td>
</tr>
<tr>
<td>PQC</td>
<td>0.93 lakh Cum</td>
</tr>
<tr>
<td>Structural Concrete</td>
<td>0.60 lakh Cum</td>
</tr>
<tr>
<td>Filling</td>
<td>560000 Cum</td>
</tr>
<tr>
<td>Shuttering</td>
<td>275431 sq.m</td>
</tr>
<tr>
<td>Concrete</td>
<td>140000 Cum</td>
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<tr>
<td>Rebar</td>
<td>4300 tons</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>1100 tons</td>
</tr>
<tr>
<td>Roof Sheeting</td>
<td>16000 sq.m</td>
</tr>
<tr>
<td>Tile Flooring</td>
<td>4880 sq.m</td>
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<tr>
<td>Kotah Flooring</td>
<td>2596 sq.m</td>
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<tr>
<td>Painting</td>
<td>29000 sq.m</td>
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<tr>
<td>Textured Painting</td>
<td>29156 sq.m</td>
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<tr>
<td>False ceiling</td>
<td>6664 sq.m</td>
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<tr>
<td>Water Proofing</td>
<td>23163 sq.m</td>
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<tr>
<td>Glazing works</td>
<td>650 sq.m</td>
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<tr>
<td>Doors</td>
<td>390 Nos</td>
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<tr>
<td>Al joinery works</td>
<td>4743 sq.m</td>
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<tr>
<td>Masonry</td>
<td>17894 Cum</td>
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### Major Plant & Machinery

<table>
<thead>
<tr>
<th>Description</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Batching plant</td>
<td>110 Cum / hr.</td>
</tr>
<tr>
<td>1 Hot mix plant</td>
<td>160 tph / hr.</td>
</tr>
<tr>
<td>2 Pug mills</td>
<td>100 tph / hr. each</td>
</tr>
<tr>
<td>3 Stationary Crushers</td>
<td>150 tph / hr. each</td>
</tr>
<tr>
<td>1 mobile crusher</td>
<td>200 tph / hr.</td>
</tr>
<tr>
<td>Excavators at peak</td>
<td>30</td>
</tr>
<tr>
<td>Heavy duty dumpers</td>
<td>120</td>
</tr>
<tr>
<td>Sensor pavers</td>
<td>4</td>
</tr>
<tr>
<td>Slip form paver</td>
<td>1</td>
</tr>
<tr>
<td>Motor grader</td>
<td>10</td>
</tr>
<tr>
<td>Rollers</td>
<td>25</td>
</tr>
</tbody>
</table>

### Manpower

200 Staff including approximately 6000 labourers at peak.
The runway is the longest and the widest now in India. It is also the only runway in India designed and built compliant to the super jumbo Airbus A380 requirements. Currently it is the only runway to be validated by the International Civil Aviation Organisation (ICAO) for its standards and recommended practices.

It is a proud achievement for the team who put in a lot of hard work and toil to stringent standards and practices of the airfield construction. It took a little over 21 months to build this mammoth runway from start to finish.

**Key Parameters**

The length of the runway designated 09-27 is 4260m is at an elevation of 610m above MSL. The width of the runway is 60m of carriageway and 7.5m of paved shoulders on either side. The runway design took into consideration a realistic fleet mix of aircrafts based on a 20 year projection of traffic. LEDFAA design programme was used to design the structure of the runway. Essentially, the runway cross section consists of prepared sub-grade of 95% modified MDD of CBR 12%, selected fill of CBR 12% to 98% MMDD, granular subbase (GSB), fine crushed rock (FCR), wearing course consisting of DBM and BC. The finished surface of the runway has a constant cross slope of 1.5% on the carriageway and a longitudinal slope the runway of not more than 1.4%.

For the first time in India fine crushed rock (FCR) was used for runway works. International experts have appreciated the fine workmanship and quality standards maintained in laying of this material. Sensor pavers were used.

**Major Quantities**

The following are the major quantities executed for the completion of the runway.

<table>
<thead>
<tr>
<th>Material</th>
<th>Quantity (Cum)</th>
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<tbody>
<tr>
<td>Earthwork</td>
<td>365,695</td>
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<tr>
<td>GSB</td>
<td>59,296</td>
</tr>
<tr>
<td>FCR</td>
<td>89,088</td>
</tr>
<tr>
<td>DBM</td>
<td>16,586</td>
</tr>
<tr>
<td>BC</td>
<td>15,722</td>
</tr>
<tr>
<td>DLC</td>
<td>6,812</td>
</tr>
<tr>
<td>PQC</td>
<td>12,642</td>
</tr>
</tbody>
</table>
for the first time to achieve the strict tolerances on the surface. To test the surface for loose spots on the FCR and sub-grade a proof roller with 507 weights was deployed for the first time in India.

The other firsts included the use of SSI primer on pavements as against SS2 normally used. This was because of the higher penetration that was specified. The runway wearing course was laid with polymer modified bitumen to maintain a higher quality of the pavement - as opposed to ordinary grade bitumen that was recommended by the clients. To reduce the variance in the levels of the asphalt surface (down to 3mm) an averaging beam was installed at the edges of the paver which doubled up as a sensor. The surface level tolerances specified were ±3mm for BC and ±6mm for DBM. Both were strictly adhered to.

The runway works were also interfaced successfully for the provision of the airfield ground lighting ducts and utility duct banks across the runway cross section. This apart, the runway works were interlaced by intermittent extensions of connecting rapid exit taxiways. In the month of November 2006 two new rapid exitways were introduced. In the month of May 2007 another two new rapid exitways were introduced increasing the intersections on the runway to ten from the original figure of four. It is quite commendable in these circumstances that the runway works were successfully completed on schedule by August 2007.

A major challenge faced in the beginning of the project was the filling up of three major wells on the runway. This was accomplished successfully by the technique of filling with river sand and quarry dust.

Sreechand Sreedhar
Engineering Co-ordinator
with inputs from
M.R. Choudhary (CM-B&F)
Vijayakumar (CM-BUCC)
Manish Agarwal (CM - R&R)
The Electrical works involved in the project were grouped in to Airside and Landside works (Package 4 Contract), which included Airfield Ground Lighting System, HT Power Distribution and LT Electrical Distribution. The Contract Particulars are given below.

Contract value : Rs. 1500 million
Contract start : September 2005
Contract period : 30 months
Staff man months : 400
Labour man months : 1000.
Safety statistics : “ZERO” Accident

Standards & Specifications were furnished by:
- International Civil Aviation Organization (ICAO), Montreal, Canada.
- Federation Aviation Administration (FAA), USA.
- DGCA, Civil Aviation Requirements (CAR), New Delhi.

Though the contract value increased by 85%, the contract period remained the same. The E&I project team took up this as a big challenge and acted upon to complete the same within the stipulated period to the entire satisfaction of the Client. The major quantities executed involved- 300 km of AGL Illuminated view of main PTB apron
The airfield ground lighting systems (AGLS) are fully operational with the following features.

- PAPIs (precision approach path indicators)
- Runway approach lighting, Centreline lighting, edge lighting, end lighting and threshold lighting system
- Taxiway centreline lighting, edge lighting system
- Taxiway guidance signs

The following systems were commissioned and fully operational on real time basis by L&T. Moreover, this is somewhat unique and the new Hyderabad International Airport is the first Indian airport having these world-class facilities.

- AGL remote control and monitoring system, commissioned at ATC tower - State of the art
touch screen operation with OFC backbone online control and monitoring system

- Taxiway centreline lights individual lamp monitoring system is a facility to monitor individual lamps of taxiway center lights and to provide specific path to the pilot from runway to apron parking stand.

- Emergency DG backup system involved: 11kV DG Sets, 2000KVA each - 6 Nos auto changeover / synchronize / load sharing / load shedding mode for power back up to AGL critical circuits within 15 secs (CAT-I requirement) and other passenger terminal building facilities within 60 secs, using high end programmable Logic controllers (PLCs) with redundant facility.

- 11kV HT power distribution in ring main configuration for 20 cluster substations (11/0.433kV) having a length of 55km with central monitoring facility at airport operation control center (AOCC).

- Zero change over time facility for runway centre line lights, edge lights, end lights and threshold lights circuits of airfield ground lighting system (AGLS).

- Unique world class apron lighting control and monitoring system by using common Airport Community OFC Network

- Hotline communication facility, crash fire alarm system between Air Traffic Control tower, fire station and AOCC.

This project is yet another milestone in L&T-ECC’s journey towards building its capability of constructing world-class international airports on EPC basis.

A. DHANAPAL,
Construction Manager (Electrical), HIAL Project
New Bengaluru International Airport
The long awaited swanky new Greenfield International Airport at Bengaluru is ready for commercial operations from May 23, 2008.

Devanahalli, a sleepy village 35 km away from the Bangalore City, suddenly shot in to limelight in 1991, when the Central and State Governments decided to shift the existing HAL airport to this new Greenfield location. Construction work on this first ever Greenfield Airport at Devanahalli which commenced in July 2005 was completed on schedule by Larsen & Toubro (L&T) in 30 months. Test run of the commercial flight operations were conducted on March 7, 2008 and Air Deccan, Kingfisher, Jet Flights including L&T K-7 aircraft & IAF aircrafts touched down the virgin 4000m runway heralding a new era of air traffic.

At peak of construction, more than 200 engineers and administrative staff with 5200 workmen wearing yellow and blue safety helmets carried out the construction of this airport bustling with various activities, non-stop for 30 months under devastating weather conditions like heat, cold, rain, noise, dust and pollution.

With hardly any infrastructure in place for access, transport and accommodation, this virgin land on a remote location was transformed by battalions of workmen. Till end of March 2008, this was a beehive of buzzing activities and what stands today on this barren ground is a landmark structure dotted with a 4000m long runway and 71,000 sq.m terminal building, a 65m high air traffic control tower with many other amenities and facilities for a passenger
friendly air-traffic. The runway is designed and built to ICAO standards and it is compatible for B-747 aircrafts.

Of the total 4,000 acres of land, around 2,000 acres are occupied by the runways, terminal buildings, air traffic control tower, parking bays and other structures. The remaining land is used for other related infrastructure including phase-II expansion, extended air cargo terminals and cold storage including hotels, landscaping and horticulture facilities.

The air traffic control tower attracts every visitor as one approaches the airport and this leads you into the sprawling transparent passenger terminal building with its beautiful parking bays, ticketing counters, reception and spacious visitor lounges before one enters the departure bays.

The exuberance of architectural and structural elements like the large glass facade panels, extensive black granite floor studded with granite clad columns standing tall and the entire area capped with specially designed precast shell roof elements with north light glazing stretching from one end to the other is totally awe inspiring and gives you a feeling of transparency, warmth and openness. One can bubble with energy in this new environment, which is the most striking feature of this passenger terminal building. The entire structure glows with pride like a shining star during the night.

The airport went through some last-minute design changes in December 2005 to accommodate an increase in the expected passenger traffic for the projected opening in 2008. The estimated traffic
flows which stood at 6.7 million passengers during 2005-06 was expected to touch 8.5 million by 2010. Hence this necessitated an increase in the size of the passenger terminal building, number of aircraft stands, taxiways, passenger boarding bridges and the main access road enabling the airport to match the expected traffic in the coming years. The new airport has the capability to handle 11 million passengers per year and 45 aircraft per hour.

**Public - Private Participation**

Built on public-private participation, the airport was executed by Bangalore International Airport Limited (BIAL), a consortium of companies comprising Siemens, Zurich Airport and Larsen & Toubro holding 74% stake while the state government & AAI holds the remaining 26%. The detailed equity holdings held by the government and private promoters are as follows:

- Airports Authority of India: 13%
- Siemens Project Ventures: 40%
- Larsen & Toubro: 17%
- Unique Zurich Airport: 17%

The airport has been designed by Kaufmann and Van der Meer Planer AG of Switzerland. However, the structural, architectural & mechanical services design, detailing, procurement and construction have been carried out by ECC, L&T’s Construction Division.

The supply, engineering and installation of airfield lighting, the IT and communication systems, the baggage handling system as well as the power supply and the building services automation system were all executed by Siemens.

Construction of the airport mainly involved major works as follows:

*Inside view of the spacious Passenger Terminal Building*
Towering view of the Air Traffic Control Tower
Site Preparation

Site preparation involved site grading and clearance of thick bushes as well as putting up temporary structures including major earthwork excavation to the tune of 70,20,000 Cum.

Airside Infrastructure

Building the airside infrastructure involved construction of a 4000 meter long 60 meter wide asphalt paved runway including 7.5m shoulders on either side; 1,80,000 sq.m of allied taxiways; 3,66,000 sq.m of aprons with rigid pavement, aircraft isolation bay and the civil works for the airfield lighting. The runway is designed to cater to B-747 aircraft.

Passenger Terminal Building

The moment passengers descend from his or her vehicle in front of the passenger terminal building (PTB), they are led in to the spacially designed and sheltered passenger drop-off area, which can receive a large number of passengers, well-wishers and other visitors. Making an entry in to the PTB, one can see the vastness of space with a clear view of the two levels – the ground and first floor levels. The ground floor is provided with an array of 54 Common User Terminal Equipment (CUTE) with passenger check-in counters, which look very beautiful with its trim and sleek design, just to ensure quick verification and issue of boarding passes.

Automatic x-ray screening of check-in baggage helps passengers to move quickly to the security check without wasting time and take their seat in the security lounge either in the ground floor or first floor and await their boarding call. Special display system ensures operation of any counter at any point of time by any airline by selecting the required name. Vertical transportation as well as elevators and stair cases help passengers to reach the first floor level.

View of the Passenger Terminal Building as seen from the car park
Innovative Erection Method for the Unique Roof Element…

The Unique ‘S’ shaped precast concrete roof element used in the passenger terminal building at Bangaluru International Airport called for special techniques for fabrication and erection.

Since the project required a large number of roof elements, to begin with a dedicated production yard had to be established near the terminal building with necessary facilities like casting moulds, handling equipments like gantries for lifting and placing etc. Precast elements were produced using custom-built steel moulds with near zero deflection, employing prefabricated reinforcement cage and self compacting concrete. After pre-stressing, elements were shifted to storage area by high speed long stroke hydraulic jacks. From storage yard, elements were transported by a special trolley to the terminal building site for erection after attaining the required strength.

Lifting and placement of each element was carried out by custom built two tier portal gantry cranes. While the lower gantry facilitated lifting of elements by top level gantry directly from the shifting trolley, this also enabled shifting the top gantry to next bay after completing the erection in each and every bay. Similarly, the top gantry equipped with strand jacks, carried out the lifting of element from trolley, moving it and placing the same in its final position including alignment in one single operation. The most challenging aspect of erection was the handling of delicate elements, each 24m long and placing them at a height of 19m with a clearance of only 25mm. To ensure safe & trouble free operations, the entire set of erection equipment was load tested before commencing the erection works. Moreover, the entire production and erection scheme was devised in such a manner, that no element was over stressed at any stage during the erection operation.

Yet another significant aspect of this innovative erection method included the elimination of high capacity lifting cranes and avoidance of any type of modification to the main structure. This apart, every major activity was automated using hi-speed hydraulic jacks resulting in optimum cycle times and reduced manpower. Using this technique, a total of 234 elements were erected in a short span of five months with an average of 2 elements per day.

The complete erection methodology including the design of enabling structures was done in-house by an expert team of Construction Method engineers. Meticulous planning in design of enabling structures coupled with automation of activities ensured that the fabrication and erection of roof elements were completed ahead of schedule with excellent quality standards, setting a new benchmark for similar works in future.

K. SENTHILNATHAN
Head (EDRC - Transportation & Infras)
In addition there will be 18 express counters in peak hours for facilitating quick movement of passengers with just one hand baggage. Swing gates are provided for ease of operation and flexibility. There are seven baggage handling units. Around 1700 chairs imported from Switzerland are installed in various holding areas. Also 5 massage chairs – one in the VVIP lounge and 4 in the terminal are installed for the benefit of passengers to ease out their tension.

**Construction Marvel**

The passenger terminal building (PTB) is an outstanding example of marvellous construction by L&T. Having a floor area of 71,000 sq.m and built in three levels, the PTB is specially created for a hassle-free flow of passengers. The terminal building is 218m long, 147m wide and 15.7m high and at peak, this can handle more than 2700 passengers at a time.

Keeping in mind all comforts of air passengers, the terminal building is proposed as a single, fully air-conditioned structure catering to every international and domestic flight passengers. Salient features of this include easy check-in, ease of movement to departure gates, minimal queuing as well as comfortable shopping and waiting areas. Thus, the entire PTB functions like a Central Processing Building, for departures and arrivals, baggage handling, security check, departure lounges, and arrival baggage claim. Moreover, the design reflects the best of airline industry practices and caters for 24-hour-operations, under all weather conditions, meeting complete requirements of the IATA standards.

**Concrete Shell Roof**

According to Mr.Javeed Shakil, Project Manager of L&T at BIAL project, “Bangalore International Airport is the only Airport in India which is provided with
a concrete shell roof. The north light glazing is an excellent design concept which not only provides a solution for the day-lighting, but also enhances the architectural beauty as well as the functional efficiency of the building. Moreover, this is eco-friendly being incorporated with green concepts. The large glass facades and integrated columns induce a feeling of spaciousness. Since modular design concept has been adopted for the building, it can be easily dismantled and expanded whenever and wherever required for enhancing the passenger amenities”.

“The PTB has nine bays and there are 26 precast shell roof elements installed in each bay. Each element is 24m long and 7m wide. All the elements were cast in one single yard at site and transported to the point of erection. Self Compacting Concrete was used for high quality finish of the roof element”, says Mr. Shakil.

**Terminal parking**
A beautiful car park in front of the terminal building at the ground level has been developed with aesthetic landscaping and garden provided with fountains, etc. for the convenience of passengers and visitors to the airport.

**Ancillary Buildings**
The strategically located Air Traffic Control (ATC) Tower having a height of 65m enables complete view of Airside Operations for all Phases of the Airport. It is one of the few Airports which have the Tower on the landside. In addition to the above infrastructure, a number of ancillary structures have been constructed to meet various requirements for the operation of the airport. This includes:

- A three level Administration/Canteen/Security/Technical Block (5260 sq.m),
With the first touchdown of a chartered Kingfisher flight from Mumbai with invited passengers and media persons at Devanahalli airport on March 7, 2008 at 9.50 am-10 minutes ahead of scheduled arrival, the swanky new Bengaluru International airport was all set for opening to air traffic.

The aircraft taxied down the apron as the two snorkel fire tenders threw water jets into the air, creating a ‘Water Arch’, in a spectacular way, much to the cheer of the media and guests.

Following this, Mr. K.V. Rangaswami, President (Construction) & Member of the Board Larsen & Toubro arrived from Mumbai by the L&T aircraft.

Two defence aircraft also took part in the test flights. The Air Deccan flight, which took off from the HAL airport then landed in the new airport, culminating the day’s itinerary of flight arrivals.

Mr. Albert Brunner, CEO of Bengaluru International Airport Limited (BIAL) received KVR as well as all other passengers. A media meet arranged in the terminal saw Mr. Brunner address the invitees and media persons on the facilities in the airport as well as his future plans and operation strategies. KVR also interacted with the media.
• Maintenance Buildings – Civil & Electrical and Mechanical (2909 sq.m),
• Aircraft Rescue and Fire Fighting Building (1457 sq.m),
• Ground Support Equipment Building (1984 sq.m),
• Other Buildings – DG Power House, Main Power Substation, Compact Stations, Navaid Buildings (4107 sq.m),
• VVIP terminal (282 sq.m),
• Watch towers (145 sq.m),
• Security cabins (75 sq.m),
• Public amenities (326 sq.m)

Air side view showing an aircraft being docked to a passenger boarding bridge

**Landside Infrastructure**

• A four lane main Access Road
• Secondary access road
• Access roads to buildings
• Car park and bus park – departure car drop-off for 100 vehicles Arrival car pick-up for 58 vehicles Car park for 1550 vehicles, Bus bay for 10 vehicles includes Private Taxi Parking.
• Traffic Loop in front of terminal building
• 1.3 km of main access road connecting trumpet flyover outside the boundary
• Civil works for electrical services
• Landscaping and irrigation – landscape is along the main access road including rotaries, in front of terminal building and car park. Landscape design has been done to ensure that no fruit bearing trees which attracts bats and birds are planted.

Water supply, sewage and storm water drainage
• Water supply and distribution system, including fire water supply, pump houses
• Sewage supply lines, collection wells and pumping stations,
• Sewage treatment plant,
• Storm water drainage network including rain water harvesting.

Miscellaneous Works
• IOTL fuel pipelines and hydrants

• Cargo complexes for handling 300,000 tons capacity annually
• Trumpet flyover
• 5 star hotel with 321 rooms, restaurants and a world class spa.

Future Opportunities
The Airport Land is likely to see large commercial development. Likely jobs include
MROs, ISP provider building, Golf course, IT hub, Commercial development – Airport City, Railway station, Airport expansion

K. SRIDHARAN
CCD-ECC HQ,
Chennai
Kozhikode International Airport

The new Kozhikode International Airport after renovation.
Calicut Airport is one of the three international airports located in Kerala. Calicut Airport was given the status of international airport on February 2, 2006, thereby paving the way for the improvement of the infrastructure there for handling international flights.

Calicut International Airport is located at Karippur in Malappuram district, near Calicut (Kozhikode), Kerala, India.

The airport, was sanctioned after a long period of struggle which began in 1977 under the leadership of freedom fighter late K.P. Kesava Menon. Funds were collected from Gulf Malayalis for its development in the 1990s when the Union Government said it did not have funds. To raise the funds needed for airport development, the Malabar International Airport Development Society was constituted. Later major development of facilities, such as extension of runway from 1800m to 2700m to facilitate operation of big-body aircraft were carried out with loans from HUDCO.

The approach to Calicut airport runway is surrounded by hills and valleys. Airports Authority of India have provided runway lead-in lighting system for the first time in India at Calicut airport as per the recommendations of the Directorate General of Civil Aviation.

The system has been put into service for night operations since October 2003. Supplementing the above lead-in lighting system, solar-powered aviation obstruction lights are also provided at eight critical hilltops around the Calicut Airfield.

Inside view of the Passenger Terminal Building
Airlines currently operating from Calicut Airport are Air India, Air Deccan, Indian Airlines, Jet Airways, and Sri Lankan Airlines.

**Calicut International Airport**

Kozhikode International Airport also known as Karipur Airport, is located at Karipur in Malappuram district, near Kozhikode (Calicut), Kerala, India. The airport is located 26 km from the Calicut Railway Station and 27 km from Manjeri town. The closest railway station is Feroke.

**Recent Renovation, Upgradation and Expansion**

Due to the recent Rupees one billion upgradation of existing facilities, the infrastructure at Kozhikode International Airport is ready to receive international flights.
An inline baggage system, the first of its kind in India that will do away with the separate X-ray of baggage, is installed at the airport. Several airlines have sought night parking facility at the airport, which has presently 10 parking bays. Permitting night parking at the airport will soon greatly improve air-connectivity. Airports Authority of India (AAI) will provide three aerobridges (plus options for two extras) at the airport which will help passengers directly enter the terminal while alighting from an aircraft.

A 15,000-sq.m international arrival terminal has been opened to passengers, similar to the modern and spacious international departure terminal that became operational on May 14, 2007. Three modern and user-friendly conveyor belts are installed at arrival terminal and 800 stainless steel chairs for passengers in the security-hold area.

Escalators and elevators are also installed inside and outside the terminal building. Facilities for the passengers and visitors like fast-food counters, luggage room, jewellery shop, handicraft stall, traffic direction poles, restaurant, and cyber café are also opened at the airport.

The plush and practical interiors and convenient facilities, including leather sleeperettes for transit passengers, has definitely brought the airport to international standards; a great improvement from the stuffy and cramped area it once was.

**Lead-in lighting system**

The approach to Kozhikode airport runway is surrounded by hills and valleys. The approach funnel area of the runway 28 is having 30 70-m deep undulated valley up to a distance of 6000m, immediately following the tabletop runway, 2860m long. This called for a special type of approach guidance / lighting system to enhance safety for aircraft operations both during night and during rains with poor visibility conditions.

Airports Authority of India thus provided runway lead-in lighting system for the first time in India at Calicut airport as per the recommendations of the Directorate General of Civil Aviation, at a cost of Rs. 170 lakhs.

The lead-in lighting system is a positive visual guidance to the pilot along a specific approach path for reasons such as avoiding hazardous terrain, etc. It facilitates the pilot to follow the desired approach path. The system is designed in such way that one group of lights is sighted from the preceding group of lights, finally leading the aircraft to the proximity of threshold of the runway.

As per standards the runway lead-in lighting system, consist of groups of lights positioned on the desired approach path at an interval of not more than 1600 m on the extended approach path of the runway. The desired approach path could be curved or straight line.

The lead-in-lighting system at Calicut airport provides desired approach path in the extended centerline of the runway. Group of light units are installed on the top of the 30 m high lattice towers at four locations: 1826 m, 3121 m, 4721 m and 6193 m from the threshold of runway 28. Each group of light consists of three sequential flashing lights in linear configuration. The lead-in-light units are powered through solar power system at each tower locations with battery banks and inverters. The lead-in-light system is planned with radio control units for remote operation. The System operates in three pre-selected intensity level at a flashing rate of 120 flashes per minute to meet the various ambient conditions.

The system has been put into service for night operations since October 2003. The Radio Frequency control for remote operations of the system from ATC tower is also planned.

Supplementing the above lead-in lighting system, solar-powered aviation obstruction lights are also provided at eight critical hilltops around the Calicut Airfield.
Delhi International Airport
Moving on Fast Track

Perspective view of the T-3 passenger terminal building under construction at IGI, New Delhi
L&T is executing the Rs. 5400 crore Engineering, Procurement & Construction Contract for GMR Group which holds a majority stake in the recently privatized Delhi International Airport Limited (DIAL). The project scope involves Concept Enhancement, Design, Procurement and Construction of Delhi International Airport by L&T in a very tight schedule of 39 months.

The Project aims at enhancing the traffic handling capacity of the airport from the existing 12 million passengers per annum (mppa) level to 37 mppa upon completion. This means from the existing capacity of 33000 passengers per day it is expected to be enhanced to 1 lakh passengers per day by 2010 Delhi Commonwealth Games. Currently, the existing runway and terminal facilities are severely overstressed by more than 150% of its capacity utilization at peak hours resulting in tremendous discomfort to all. Hence this fast track project has been kick started and L&T was chosen to execute this project in this stringent timeframe.

Scope of Works

The Scope of work involves construction of an additional run-way, taxiways, aprons, new terminal building - T3 for international and domestic passengers with all international standard state-of-the-art specialist Airport systems like airfield ground lighting, aviation fuel hydrant system, satellite rescue & fire fighting, visual docking & guidance system, baggage handling system, passenger boarding bridges, integrated airport IT systems, etc. To support the airport infrastructure, the project also involves design and construction of many ancillary structures like multi level car park, airport services building, sewage and water treatment plants, electrical substations with large backup power facility, etc.

A section of the existing Terminal Building at the Indira Gandhi International Airport, New Delhi
Indira Gandhi International Airport

The Indira Gandhi International Airport (IGIA) at New Delhi serves as the prime gateway to international passengers for the North and North-West India, providing domestic air links to all metropolitan cities and many other cities in the country.

Located on the southern outskirts of the city, approximately 15 km from the city centre, the airport is contained within an extensive land holding of over 22 square kilometers.

The Airport presently has two runways and separate terminal complexes for domestic and international operations with the domestic complex consisting of three buildings. The two runways are designated 09/27 and 10/28. The current southern runway 10/28, is the duty runway and is used nearly 90% during the year, due to the prevailing wind direction. Runway 10/28 is 3,810m long x 45m wide while Runway 09/27 is 2,813m long x 45m wide.

Project Background

In 2005, the Airports Authority of India (AAI) initiated the process of selection of joint venture partners for the modernisation and upgrading of the Indira Gandhi International Airport at New Delhi under an Operation, Maintenance & Development Agreement (OMDA).

In February 2006 a Consortium led by the GMR Group was declared as the successful bidder for works. The consortium comprises the GMR Group, Fraport AG, Malaysia Airports Niaga Sdn Berhard and Infrastructure Development Fund. In April 2006 Delhi International Airport Private Limited (DIAL) was incorporated as an independent Joint Venture Company comprising the Consortium 74% and AAI 26% shareholding.

DIAL took over the operations management of Delhi airport with effect from May 3, 2006. The prime objective of DIAL is operating, maintaining,
developing, designing, constructing, upgrading, modernising, financing and managing the Airport. The vision formulated by DIAL is to build, operate and manage the airport to international standards with emphasis on two areas:

• World class development and expansion
• World class airport management

In addition to operations and the development of the existing Terminal T1 (Domestic) and Terminal T2 (International) DIAL shall implement a 20 year airport Major Development Plan (MDP) developed by the Lead Technical Advisor (LTA) consultant group comprising of, Mott MacDonald, HOK Architects and Pell & Fishman.

Thus MDP envisages developments in four stages with the current Project being Phase 1. Phase 1 comprises of a new runway, passenger terminal building (T3) and other supporting infrastructure.
The Phase 1 of the Project is conceived in two stages, the first (Phase 1A) is to provide an operational new runway and taxiway by February 2008 (extendable up to June 2008) while the second (Phase 1B) is to complete the remainder of the works by February 2010 to coincide with the 2010 Commonwealth Games being hosted by the Government of India.

**EPC Contract**

L&T is executing the EPC contract for the new development of Delhi International airport in Phase-1 which was awarded on December 9, 2006.

DIAL engaged Parsons Brinckerhoff Ltd., (PB) as the Project Management Consultant (PMC) for the Phase 1 of project.

**Scope of Works**

**Phase 1A**

Construction of new runway 11R/29L to 4430m x 60m along with a parallel taxiway and connecting rapid exit taxiways.

**Remote Aprons**

To be constructed to provide the additional stands required due to the new runway.

**Airfield Ground Lighting and Power Supply**

The navigation lights on the runway, taxiway and the aprons for navigating the aircrafts to the landing and stands

**Satellite Rescue & Fire Fighting**

Facility housing airport rescue fire fighting facility with high speed/foam appliances available all time to reach any part of aircraft operational surface within 3 minutes of fire accidents.

**Precast Boundary Wall**

To secure the runway and taxiway and form the boundary between airside and landside including.

Storm Water drainage and Sanitary Drains

**Phase 1B**

Passenger terminal building (T3) catering to
domestic and international travel including all MEP, IT and special airport related services, such as:

- Forecourt
- Passenger Boarding Bridges
- Visual Docking & Guidance System
- Landscaping
- Baggage Handling System
- Multi Level Car Park
- Airport Services Building
- Airport wide IT Systems
- Contact Aprons
- Twin Parallel Taxiway
- Airside & Landside Roads
- WTP & STP
- PTB link to the DMRC airport station and improving the road network.
- Fuel farms & Aviation Fuel Hydrant System

**Project Organization**

This Task Force Project emulates a unique model, where 3 different SBU’s synergize to ensure completion of the project in a record time. The complexity and enormity of the project has been abbreviated by continuous interaction for interfacing works. Leveraging strengths and inter BU resource sharing to achieve optimization at higher levels in the project are certain unique features of this Project.

The project also forms a glorious example of inter-divisional camaraderie – where L & T Infotech is lending its expertise in IT design and converting user requirements into vendor specifications.

**Current Status**

The design & procurement activities of the project have reached very advanced stage of completion and 13 international specialist vendors have
Another view of the runway

Perspective of the airport
already been brought on board. The detailed design for airside design is almost complete and the for the basic architecture for the terminal building structure and all the specialist systems design have been finalized. The ongoing design activities are mainly detailed design for terminal building structure, IT system schematic design and finalization of terminal building interior and exterior finishes.

At site, the construction works are going on in full swing with the two major packages of airside construction for Phase 1A and terminal building structure, finalized in July 2007. The work on the runway construction is completed. The airside construction team has completed the Phase 1A airside works.

The construction works of terminal building is also going on in full swing round the clock with over 16,000 workmen and 1200 design and construction staff deployed by L&T in a short time.

The peak workmen strength is likely to exceed 23000. A full fledged workmen colony with dedicated construction skills training centers have been constructed as site infrastructure.

More than Rs. 150 crores worth P&M has already been deployed by L&T to execute this challenging project.

The project being of a very high profile nature with national importance, there is a continuous media focus on the developments taking place. The project is given the utmost attention and support by L&T management with our Chairman himself being part of the Executive committee which includes the Chairman of GMR.

R. SHANKAR NARAYANAN
Planing Manager
Chhatrapati Shivaji International Airport (CSIA)
A strategic alliance between MIAL & L&T

Perspective view of the Chhatrapati Shivaji International Airport, Mumbai
As a crucial step forward in the modernization and expansion of Chhatrapati Shivaji International Airport (CSIA), Mumbai International Airport Pvt. Ltd (MIAL) on October 30, 2007 awarded the EPC contract to India’s leading technology, engineering and construction company Larsen & Toubro (L&T). According to the contract, L&T has been mandated to build the new integrated passenger terminal and expand the existing facilities, which will also include the airside and landside works to be executed on a turnkey basis. Accordingly, the new terminal, catering to both domestic and international passengers is expected to double the passenger-handling capacity to 40 million passengers per annum. The total built up area of the new terminal will be 4.84 million sq.ft..

The scope of works apart from civil and structural works in the passenger terminal building involves finishing works, electrical and mechanical installations, passenger boarding bridges, elevators, and escalators, IT systems, security systems, flight information display systems, baggage handling systems, building management systems, furniture and signage, etc.

The airside works includes re-construction of the runway (RW 09-27, RW 14-32), taxiways of 4.0 lakh sq.m and aprons of 8.00 lakh sq.m which will accommodate large wide bodied Code-F aircrafts, airfield ground lighting system, ARFF station and equipment and other airport support buildings.
Ancillary facilities include construction of new international cargo terminal of approximately 1.0 lakh sq.m, new air traffic control tower at Santa Cruz, new multi-storey car parks at Sahar and Santa Cruz, etc.

The entire project will be commissioned in a phased manner from 2010 to 2012.

About MIAL

Mumbai International Airport Pvt. Ltd. (MIAL) is a joint venture between the GVK-SA consortium and Airports Authority of India. MIAL was awarded the mandate of modernizing and upgrading Chhatrapati Shivaji International Airport (CSIA) in April 2006. CSIA is India’s busiest airport and will cater to 26 million passengers and 520,000 tonnes of cargo in 2007-08. MIAL’s vision is to transform CSIA to one of the world’s best airports that consistently delights customers and be the pride of Mumbai.

GVK

GVK is amongst India’s largest infrastructure developers with experience and expertise spanning areas including power, roads, airports and urban infrastructure. Till recently GVK has invested over Rs. 5,000 crore into infrastructure projects and has on-hand projects in the pipeline of over Rs. 12,000 crore.
Airport Mosaic

Abu Dhabi International Airport
Abu Dhabi International Airport

- Designed by Aeroport de Paris, Abu Dhabi International Airport is the gateway to the Emirates.
- ECC secured the order from the Japanese Joint Venture of Takenaka Komuten Co. Ltd and Kumugai Gumi Co. Ltd – the Prime Contractors.
- Architecturally, the airport is conceived like a mushroom shaped dome structure, 72m in DIA. The central core of the dome spreads radially to a height of 10m, like oil fountain jutting out from the ground.
- The airport construction facilitated simultaneous parking of 11 aircraft including five jumbos.
- Passenger terminal building complex consisted of six main sections - Passenger terminal, State reception, Control tower, Satellite concourse, Pre-passage ways & Link gallery
- Airport was commissioned in 1978.

Sri Sathya Sai Airport, Puttaparthi

- The airport construction included a terminal building and control tower along with an airstrip
- In-house architectural and structural design was employed
- Length of runway : 2237m
- Width of runway : 45 m
- The Airport was commissioned in 1990

Indira Gandhi International Airport, New Delhi

Visitors’ Lounge

- Design and construction of visitors’ lounge and expansion of flyover
- Involved architectural and structural design including state-of-the-art electro-mechanical services. The two storied structure with a fully air conditioned area of 10500sq.m to accommodate 2500 passengers was constructed using RCC grid slab system and columns resting on isolated footings.
- The airport lounge was commissioned in 1996.

Resurfacing main runway

- This involved strengthening / resurfacing of main operational runway (10/28) and installation of CAT 3 lighting system for the first time in India.
- Length of runway : 3810 m
- Width of runway: 45m with 7.50m shoulders on both sides
- The runway works was completed and commissioned in 2000

Airport Services

An airport is a mini city that caters to the needs of the elite traveler on an important business trip to the casual first time traveler on vacation. It also serves the various industries in their logistics and has to have an all encompassing and self serving means of sustaining operations round the clock. Various support facilities that are not only the means of revenue at an airport but also essential entities have been designed and constructed by L&T. L&T’s presence in this sector is truly a well spread mosaic that spreads across terminal buildings to hangars. A few of the support facilities that L&T has built are:

a) Cargo Services
   a. GHIAL Airport – Cargo Building for Hyderabad Menzies Air Cargo Private Limited
   b. BIAL Airport – Cargo building for SATS and Menzies Boba

b) Flight Kitchen Services
   a. Oberoi Flight Kitchen in Chennai
   b. Flight Kitchen for Taj in Mumbai
   c. Flight Kitchen for Sky Chef in Hyderabad

c) Maintenance Facilities for Ground Handling Equipment
   a. For Menzies in Hyderabad
   b. For SATS in Hyderabad
   c. GSE workshop for GHIAL in Hyderabad

d) Hangars and Maintenance Facilities for Aircrafts
   a. JET Hangar in Mumbai
   b. Air India Hangar in Mumbai
   c. Hangar in Oman Airport
Terminal building and control tower at Puttaparthi Airport

Runway at Puttaparthi Airport

Indira Gandhi International Airport, New Delhi
Air India Hangar, Mumbai
- India’s first maintenance and overhaul hangar for Boeing 747 jumbo jets
- Hangar with a structural steel roof having an overhang of 76.5m is the longest cantilever structure. The steel trusses of the roof structure are anchored to columns by tiebacks and struts.
- Columns are anchored to rock by pre-stressed cables
- The Hangar was commissioned in 1971.

Indian Airlines Hangar, Mumbai
- Existing hangar at Sahar, Mumbai extended by 8000 sq.m to accommodate wide bodied aircrafts, providing unobstructed column free space.
- The cantilever roofing system is made of continuous multiple folded plate units with prestressed concrete ties.
- Total length of Roof structure - 152m
- Consists of two cantilever roof 62.3m each connected in the centre over a 27.4m roof of the service building.
- The hangar was commissioned in 1994

Royal Flight Hangar at Seeb-Oman
- A twin bay air-conditioned Hangar, to accommodate two B-747 and A-380 aircrafts.
- Annexe building involving workshops, offices, stores and an operations building to accommodate engineering and Aircrew offices.
- Executed Complete Airfield and other infrastructure works.
- The flight hangar was commissioned in 2004.

Hangar for Jet Airways, Mumbai
- Hangar (ground + four floors with 2,200 sq.m) using structural steel trusses (maximum length of truss – 72m) near domestic airport at Mumbai including an annexe (ground + three floors) and other buildings for simulators, canteen and other facilities.
- The hangar was commissioned in 2006

Flight Kitchen at Pallavaram, Chennai
- Design and construction of flight kitchen facility for Oberoi with a capacity of 5000 meals per day.
- Consists of main building (ground plus two storey) with a built-up area of 6580 sq.m including a basement area of approx 750 sq.m in a total area of one acre
- The ground floor consists of the receiving areas. Unloading bays are located in the first floor
- The corporate areas, employee areas and the bond stores are provided in the second floor
- The main criteria for design was to ensure segregation of visitors, employees and materials’ movement
- The ancillary structures include transformer yard, LPG gas bank and security cabin
- The flight kitchen was completed and commissioned in 2007

F16 Fighter Squadron at Thumrait Airbase, Oman
- Facilities to support the operation of an F16 fighter squadron at Thumrait Airbase for Royal Air Force, Oman. Scope includes construction of aircraft maintenance hangar (6,400 sq.m aircraft space and 8,600 sq.m shop and administration space) divided into two large bays, each one to house up to seven F16s and other associated infrastructure.
Indian Airlines Hangar, Mumbai

Hangar for Jet Airways, Mumbai

Flight Kitchen for Oberoi at Pallavaram, Chennai

F16 Fighter Squadron at Thumrait Airbase, Oman