

# **February Newsletter – T2 Roof – Mega Closure**

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## **Planning**

The human skin is a unique organ. It seals, protects, thermally modulates and gives a distinct visual quality to the body. A similar thought was used when planning the mega closure for the Mega-roof. It provided a weather proof, sealed and efficient wrap to the terminal. This massive mega closure is made of the roof coverings and the facades.

Planning for the roofing systems was an immense task starting with focus on the type, form and materials. The three planning parameters used were local weather conditions (precipitation), efficient closure (weather tightness) and aesthetically pleasing form. The planning efforts concluded with a flat roof system with low slopes. This roof system envelopes the entire construction while maintaining the integrity and attaching an aesthetic value to the structure. In terms of size and scale of application, this is the first such system in India.

Similar to the roofing system, planning efforts for the facade focussed on four elements - local weather conditions (precipitation), efficient closure (weather tightness), natural daylight harvesting (allowing diffused sunlight) and aesthetically pleasing form. The facade is made of three different categories, namely the skylights, cable systems and the curtain wall

systems. These come together create a truly world class facility.

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## **Design and Engineering:**

### **Roofing system**

The roofing system is staggered at two distinct levels, the Mega-roof and the podium area. This light-weight system uses a single ply membrane and provides an environment that is unaffected by external elements. The tough membrane keeps out the rain and reflects the sunlight that falls upon it.

The membrane system is engineered with a thermal insulation zone under the outer skin. The integration of the outer colour of the roofing and the insulation layer limits the solar heat gain, playing a vital role in keeping the interiors cool. This adds to the environmental efficiency of T2, as it would require much more artificial cooling in the absence of the roofing system. It also provides acoustical insulation by reducing the amount of aircraft noise that might permeate through, benefitting the passengers within.

## **Facade system**

### **Skylights**

Adorning the entire terminal are various skylights, allowing valuable daylight to permeate through. These skylights are embedded within the roofing system, making the terminal less dependent on artificial illumination, other than in the night. They also allow the passengers and staff to be in tune with the natural day cycle.

The roof area consists of 28 large and 244 smaller secondary skylights. The larger skylights are oval in shape and are 24 m wide x 32 m long. These are located directly above the mega columns, throwing light down on to the base. The low roof area has a single continuous ribbon skylight, which is 5 m wide and is in the shape of a necklace. The skylights put together, illuminate the various internal areas of the vast terminal.

### **Curtain wall and Cable Net wall**

Encompassing the mega closure is the 52,000 sq. m long building facade. It is made of two principle sections, the Cable Net wall with the Head House Roof (HHR) and the Curtain wall around the rest of the building.

Made up of high performance glass panels, enveloped by aluminium frames, the Curtain wall covers all major passenger levels in T2. Providing clear views for the passengers and the staff, the Curtain wall maximises the daylight that pilfers in and minimises the effects of solar heat gain. The entire wall, comprising of insulated glass units, was chosen for the exterior

skin keeping in mind the effect of dust flow that is prevalent in Mumbai.

The use of high performance glass is more impactful in the lower sections that form the enclosure beneath the HHR. Known as the Cable Net wall, it comprises of large glass sheets connected together by structural silicone joints. Supported by small stainless steel clamps, these sheets of glass are attached to vertical cables resembling a large curtain of glass. The system has been implemented in installations around the world, providing exceptional views from inside the enclosure. An arriving passenger is treated to the wondrous experience of this curtain of glass, which appears to rest gently on the Check-in hall floor, 15 m above the departure level.

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## **Construction Challenges**

Every massive construction process comes with certain challenges. The project schedule formed the largest challenge in this effort, more so within the HHR area. The fast track nature of the project demanded the simultaneous completion of the Mega-roof structure, the glazing and the roofing.

The solution was to hand over the Mega-roof structure to the closure team immediately after the levelling was completed. Tight logistics and handover processes allowed construction to continue within the allowable tolerances of each system.

Another major challenge was the varying nature of the Mumbai weather. This was dealt by

sealing the entire glazing system, using expandable silicon sealants. 65 dampers were used to accommodate for any movement due to wind or other forces. These are similar to a piston in operation and were tailored from the USA to fit the HHR.

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### **Operations and Maintenance**

The mega closure sees to it that the total cost of ownership of the airport facility is balanced out through the utilisation of natural light, weather tightness, acoustical and thermal insulation. In spite of the high costs associated with such an enormous facility, the mega closure has an advantage over a traditional roof system which is subject to heat and lighting loads.

The large flat roof system, with the membrane technology, requires little maintenance. To facilitate the regular cleaning of the large surface area, domestic water hose bibs are provided along the length.

The façade system on the other hand, requires a combination of automation and manual intervention to carry out maintenance. This blend is implemented for the Cable Net wall and the Curtain wall. It varies on the basis of the height, working safety, manoeuvrability based on ground conditions and ease of use. Skylights use a manual system with life safety harness for continuous maintenance.

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### **Interesting aspects**

The mega closure leaves a sense of awe in the minds of everyone who flies in and out of the airport. Being aligned with the main runway, passengers are given a view of the technically advanced roof system with ornate skylights adding grace to the design.

### **Few Facts**

1. The roofing system is spread over 450,000 sq. ft.
2. The modern roof system weighs 75% less than a conventional roof, with an average weight of 60 kg/sq. m as compared to a conventional concrete roof weight of 350 kg/sq. m.
3. The Curtain wall, the Cable Net glazing and the 309 skylights adorning the terminal, use over 1 million sq. ft. of glass.
4. The HHR has 28 major skylights, consisting of an intricate combination of 272 pieces of glass (sourced from China) built on a steel framework. At 500 sq. m each, these are the largest skylights ever built in Asia. Along with the major skylights are 244 minor skylights, with a size of 140 sq. m each.
5. The entire layout of 272 skylights covers over 45,000 sq. m, resembling a diamond studded jewel in the HHR.
6. The Lower Level Roof (LLR) is adorned with a skylight running as a necklace for 410 m, having a glazed surface of 1756 sq. m. The LLR also houses 65 smaller skylights which totals up to 430 sq. m.
7. The total length of the terminal's external facade is 2.92 km.
8. The Cable Net wall forms the interface between the HHR and the LLR. This

glazing is supported on vertically tensioned steel cables and at a height of 18 m it claims to be the highest cable net wall in Asia.

9. Each cable has a tension of 160kN, which is equivalent to a weight of 16,000 kg.
  10. The Cable Net is 1 km long and has a size of 10,885 sq. m
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### **LEED Rating:**

The LEED rating system is divided into 5 categories, which are Sustainable Site (SS) Water Efficiency (WE), Energy & Atmosphere (EA), Material & Resources (MR) and Indoor Air Quality (IAQ). Each category carries certain mandatory credits and certain tradable credits. In this issue, one shall find out our plan that targets the LEED credits for roof and facade.

The highly reflective membrane, covering the T2 roof surface, reduces the heat island effect. The heat island effect is the thermal gradient difference between developed and undeveloped areas. The minimisation of the impact on micro climate, targets 1 credit against Sustainable Site Credit 7.2. Heat Island Effect: Roof.

The glazing and skylights, that comprise the long facade, provide daylight and views to most occupied spaces at all levels. Thus 2 credits are targeted against Indoor Environmental Quality 8.1 & 8.2, Daylight & Views respectively.

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### **HSE**

1. 2.29 million hours were achieved on the Project without any reported injuries.
  2. MIAL Project's Health and Safety Policy is expected to be released by the first week of March 2012.
  3. An ongoing undertaking is the publishing of alert bulletins and appreciation messages for reporting unsafe conditions.
  4. MIAL Project Health & Safety Department has a vital contribution in the celebration of the ongoing 'Safety Month' that was initiated by the contractor. This is done via training and setting a good safety practice.
  5. Spearheaded by the MIAL Project Security Department, the MIAL Health & Safety Department was instrumental in the successful evacuation of the Project Office. This was during a mock drill conducted on 7<sup>th</sup> January, 2012.
  6. MIAL is implementing stringent safety measures and nurturing a strong safety culture.
  7. MIAL is committed to a zero accident, zero incident policy.
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