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Introducing:
New Perishable Cargo Centre

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A 27,000 ft² floor area refrigerated transit facility for handling fresh vegetables & fruits, flowers, frozen meat & fish, biological and pharmaceutical products, that are starting their air journey from Mumbai Airport to distant countries, has just been completed. It is the largest facility of its kind at airports in India, since Mumbai handles the maximum export of such products. It has been designed to handle 80,000 tonnes of cargo per year.

The earlier transit centre was not refrigerated, nor air conditioned and as a result flower growers exporting to Holland, which has the world's largest flower auction house and distribution centre, were unable to obtain market prices. The flowers were reaching at about 20°C even though they were despatched from their greenhouses in India at 2°C, since the transit centre often reached 35°C in summer months. The flowers in their export packing had to sit around in the old transit centre for several hours before being loaded into the aircraft, what with inefficient material handling, slow palletisation and

cumbersome customs documentation, leading to deterioration of product quality. The chaos in the old centre resembled any vegetable and fruit bazaar in the country.

The new centre is maintained at 12° or 18°C, depending on the cargo, has 9 independent cold rooms at varying temperatures from –20°C to 13°C for dedicated product storage, truck docks with seals and automatic doors, special parking with plug-in electric points for reefers, fully computerised weighing stations, X-ray machines for checking cargo, special work stations for palletisation, ball mat floors for effortless maneuvering of pallets and containers and several other modern features to expedite and simplify the growing volume of export cargos.

An inside view of the new Perishable Cargo Centre with Bohn product coolers installed in the middle of the Pre-staging area.

The receiving area, where the cargo is first unloaded from trucks is air conditioned and maintained at conditions (24°C with 55% RH) that prevent condensation on the chilled surfaces of the cardboard cartons unloaded from trucks. From here the products are moved to the pre-staging area where the products are sorted out for different destinations and maintained at 12°C or 18°C with 75% RH. The products are then palletised and put inside aluminium containers for loading onto the aircraft. Should there be delays in loading for any reason and if the cargo is of a nature that requires a lower temperature, it can be moved into one of nine cold/freezer rooms for holding.

Installing the refrigeration system and the insulated panel structure

at Mumbai international airport

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A.S. Garde is a mechanical engineer from IIT Bombay with air conditioning and refrigeration as elective subjects. He has over 25 years of experience in designing, installing and commissioning of ACR systems. He has worked with Blue Star Ltd. throughout his career and handled many large and complex projects in India and abroad.

Planning, procuring, supplying, installing and commissioning all equipment and materials required for the Perishable Cargo Centre at the Sahar International Airport Mumbai was a challenging assignment as the scope of work involved not only the refrigeration system and insulated panels for the cold room structure but also the material handling, automation, electrical and civil work involved. This article will however be restricted to the description of the refrigeration system and the panel structure.

A row of Dock Shelters, Sectional Overhead Doors and Bumpers for speedy unloading of cargo from trucks at the Truck Dock

Selecting the Refrigeration Equipment

As is customary, the first item we tackled was the preparation of our own heat loads, to ensure that with the refrigeration equipment specified, we would be able to meet the design temperature conditions. Having confirmed this, the selection of the condensing units and unit coolers was matched to ensure that the high relative humidity specified in the space would be met with low temperature differences (TD) of 4 to 6°C between the room temperature and the evaporator temperature. See **Tables 1 and 2**.

Table 1 : Design Conditions and Heat Loads

Area	Design Conditions	Heat Load	Remarks
Receiving area (31m x 14m)	24°C ± 1°C & approx. 60% RH	24 ton	Low dew point to avoid condensation
Pre-staging and Weighment workstation areas	12°C to 18°C & 70 ± 5% RH	42.5 ton	TD of 6°C for evaporator

(37m x 25m)			
Ball Mat area	12°C to 18°C & & 80% RH	11 ton	TD of 4°C for evaporator
Storage area (8 Cooler rooms) Storage area (1 Freezer room)	2°C to 13°C & 80% RH –20°C	2 to 3.2 ton 1.5 ton	TD of 4°C for evaporator TD not important

Table 2 : Equipment Selection

Area	Capacity per unit	Number of Units	Remarks
Receiving area	8.5 ton	4	3 operating, 1 standby
Pre-staging and Weighment workstation areas	8.5 ton	6	5 operating, 1 standby
Ball Mat area	5.5 ton	3	2 operating, 1 standby
Storage area			
Flowers	1 ton	2	
Meat	1 ton	2	1 unit per room,
Vegetables	1.6 ton	2	no standby
Fruits	1.6 ton	2	
Pharma	1.5 ton	1	

Type of Equipment Selected

The Receiving area is air conditioned with ducted split-type air conditioners with air-cooled condensers. Scroll compressors were selected for these units on account of their greater reliability and lower power consumption, compared to reciprocating compressors.

The remaining areas are all refrigerated, with one condensing unit connected to one evaporator or product cooler. Semi-hermetic compressors were selected over hermetics because of their greater reliability, better power consumption and the possibility of repairs in case of a breakdown. Even though, water was available at the site, it was considered prudent to opt for aircooled condensers since water shortages do occur, after poor

monsoon rains, water quality needs to be monitored constantly, and cooling towers with connecting piping and circulating pumps come with their own set of maintenance problems. On the other hand, air is available in abundance and aircooled condensers are relatively trouble-free – enough advantages to overcome the higher operating cost of air-cooled vs water-cooled units.

All unit coolers selected were airdefrost type except the two units for the –20°C freezer storage room which were electric defrost. Two unit coolers were selected for this freezer, in order to reduce their height, thus providing more headroom for the pallets. Both coolers were piped to one condensing unit.

Strategic Placement of Equipment

The large condensing units for the Pre-staging, Weighment workstation and Ball Mat areas were located on an open terrace with plenty of space and cool ambient air available at all times. The smaller condensing units for the nine storage rooms, were placed on a steel platform right behind the refrigerated rooms and slightly above the ceiling of the rooms, at a height of approximately 5m. The mounting platform was constructed inside the vast volume of the building structure housing the 4.5m high insulated panel structure of the Cargo Centre. Even though the condensing units were placed “indoors”, the large air volume of the space and its “open” connection to the outdoor air on both ends was considered adequate for good performance.

The six unit coolers for the Prestaging, and Weighment workstation area were suspended from the new steel structure erected over the ceiling, in the centre of the 25 m wide refrigerated store. Alternate units discharged cold air in opposite directions thus providing uniform cooling in the entire area.

Refrigerant Piping

Locating the nine large condensing units on the terrace of the adjoining building (six units for the Pre-staging and Weighment workstation area and three for the Ball Mat area) resulted in a long length of refrigerant piping of 60 m including a vertical lift of 8 m. The suction lines were selected to limit the pressure drop within 2 psi. The vertical suction lift was a potential problem area, because of the possibility of poor oil return to the compressor crankcase. This was overcome by installing a U-trap after intervals of 4 m rise (a total of two traps for the 8 m lift) and ensuring a gas velocity of 12 m/sec in the vertical riser, by correct pipe sizing.

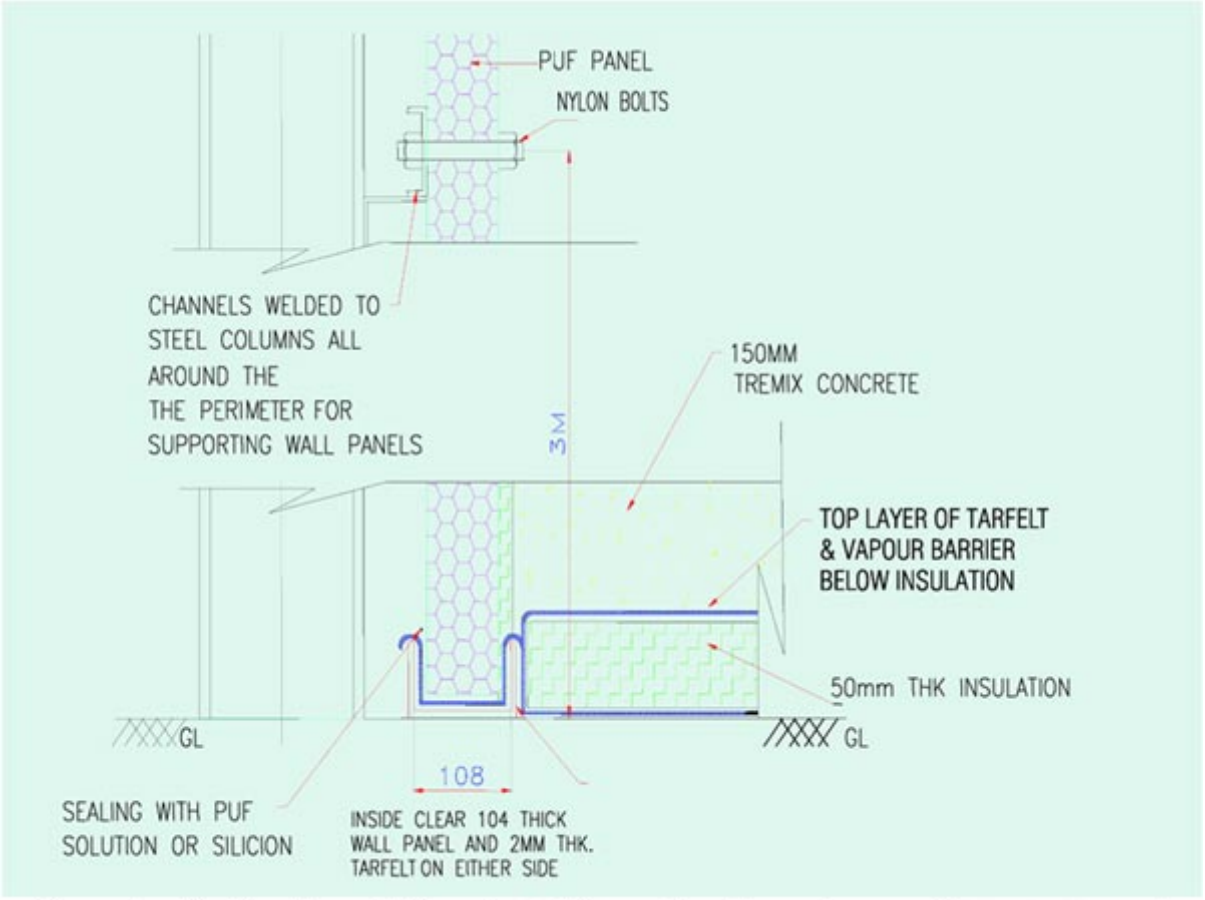

Figure 1 : Section through floor insulation and wall panel supporting arrangement

Installing the Insulated Panel Structure

The refrigerated Cargo Center measures 90m x 27m x 4.5m high and is built inside an existing shed of the Sahar Airport Cargo Complex, Since the existing steel trusses were not capable of carrying the load of the insulated ceiling panels and the unit coolers, an independent steel structure comprising columns and trusses was designed and erected to support the wall and ceiling insulated panels, unit coolers, refrigerant piping, sprinkler system and electrical light fixtures with cabling. The new trusses had a span of 27m and the total steel consumed is around 100 tonnes.

The existing concrete floor formed the base on which 50mm heavy-density expanded Polystyrene insulation was laid with waterproofing material laid prior to the insulation, to form a vapour barrier.

The wall panels were erected on the existing concrete floor, inside a steel U-channel covered with tarfelt which overlapped the tarfelt vapour barrier on the base floor. See **Figure 1**. The gaps between the wall panels and the tarfelt are filled with silicon sealant to prevent any ingress of water vapour to the refrigerated area.

Before the “Tremix” RCC finished flooring was poured, another layer of waterproofing material was laid over the insulation, to avoid any water from the concrete damaging the insulation. A vacuum dehydration technique was used to cure the concrete finished floor, thereby achieving a top surface level uniformity of ± 3mm

One of nine Bitzer air-cooled condensing units mounted on the terrace. Notice the suctiontrap and vibration eliminator installed in the insulated suction line

The wall panels are laterally supported by steel channels, using nylon studs and nuts to prevent condensation and reduce heat gain. Refer **Figure 1** for clarity.

All ceiling panels are supported by steel “hat” channels, which in turn are suspended from the trusses with the help of galvanised threaded rods. See **Figure 2**.

All adjacent wall and ceiling panels are joined together by means of foamed-in-place camlocks and joints sealed with silicon. Corners and ‘T’ sections are specially formed and foam insulated in purpose-built moulds thus providing a clean, neat appearance.

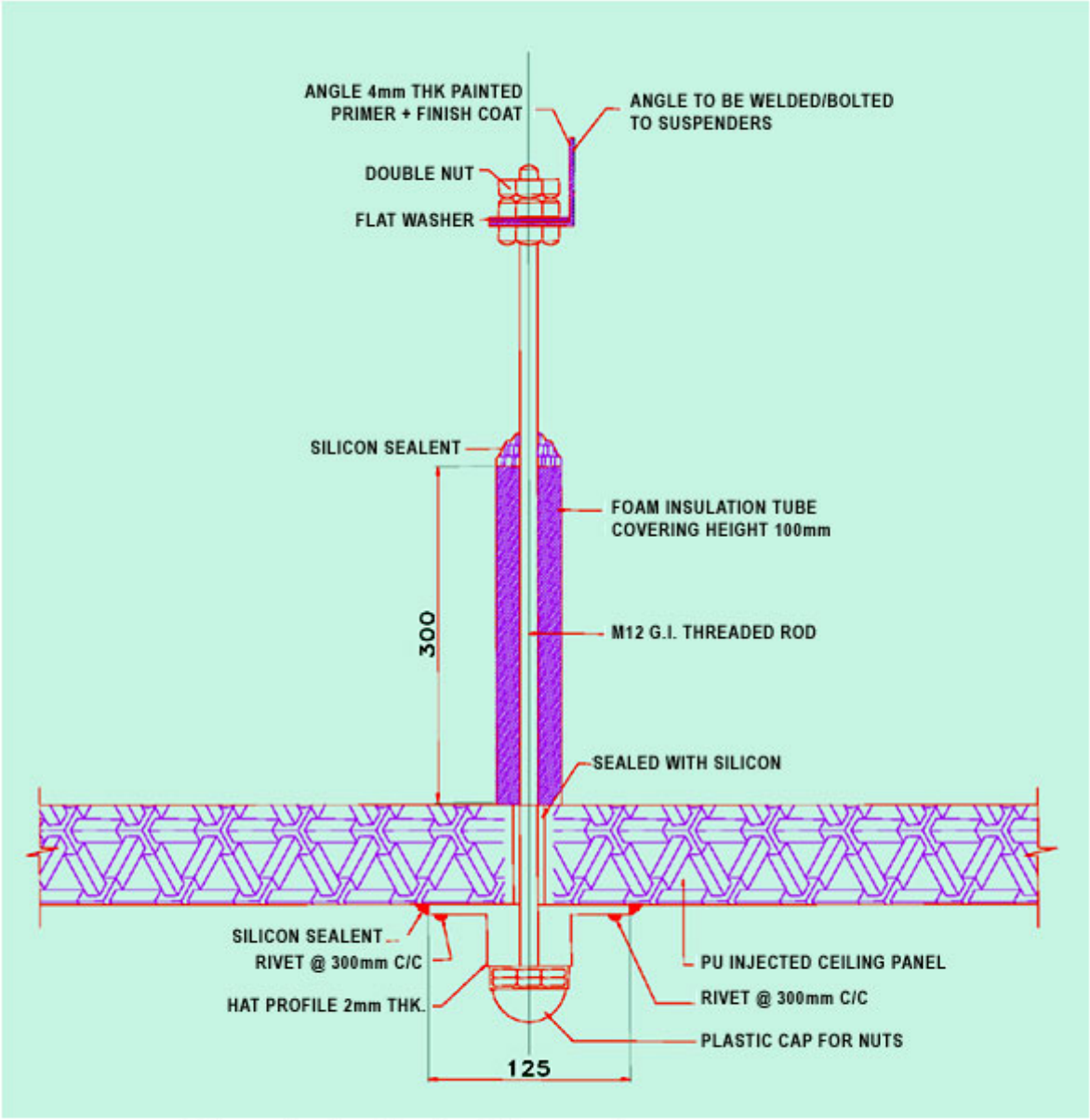

Figure 2 : Insulated ceiling panel support arrangement

Ventilation Air

To dilute and flush out Ethylene gas given off by the ripening process of fruits stored in the space, a fresh air ventilation system was provided for completely changing the air in the centre every six hours. The fresh air is pulled in, by an in-line centrifugal fan connected to a duct system, that delivers the air to the suction side of fans of the unit cooler, cooled, and discharged over the entire area of the centre.

Electrically Operated Doors

To the segregate the various areas, electrically operated, overhead sectional type doors (28 nos) were provided. For maintaining continuity of the cold chain on the truck dockside Dock Shelters were provided to minimize the loss of refrigeration. On the air-side,

imported pallet covers were provided to cover the pallets during transit between the Cargo Centre and the aircraft.

Actual Performance vs Design

The facility has been under trial runs for a couple of months and we find that we are achieving all the design parameters. We have been able to maintain the desired temperature in general areas with a temperature variance of ±1°C and RH between 75 and 90%. We also find that in spite of very long refrigerant piping lengths, oil has been circulating properly through the system.