Retrofit Project of Shanghai Hongqiao International Airport T1 Terminal

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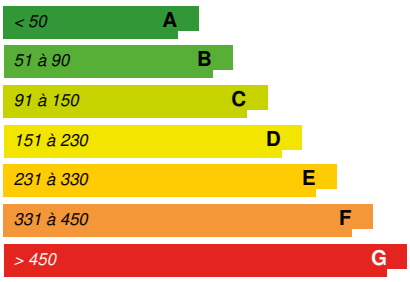

Building Type : Airport, train, subway station
Construction Year : 2014
Delivery year : 2017
Address 1 - street : 200335 ,
Climate zone : [Cfa] Humid Subtropical - Mild with no dry season, hot summer.

Net Floor Area : 131 845 m^2
Construction/refurbishment cost : 1 022 320 000 ¥
Number of Passenger/year : 10 000 000 Passenger/year
Cost/m2 : 7753.95 ¥/ m^2

General information

This project includes the renovation and expansion of the Shanghai Hongqiao Airport Terminal 1 for enhancing its aerodrome capacity and service level. The whole retrofit project will integrate the original Building A, Building B and the Honggang land block into a complete terminal. The whole retrofit project will be implemented under the green building concept and relative technical measures.

1. Passive energy-saving designs:
Natural ventilation: Set the ventilation tower to improve the current poor ventilation situation of the Joint Inspection Hall and the Ticket Hall caused by large depth. Form the ventilation tower by pulling up the height of the original skylight over the inspection area. In order to get good ventilation circuit loop more easily, the body shape of the Entrance Hall will be optimized while the height of the entrance hall and the height difference between the open windows being increased.
Natural lighting: Design sloping roof on the side of Building A, the internal inclined roof surface is furnished with reflective material with high light scattering property. Through the optimization of the lighting reflection angles, the introduction of natural light can be achieved throughout the year; the Joint Inspection Hall is installed with skylights so that to increase lighting area for effectively improving the indoor natural lighting.
External shading: The interior surface of the entrance hall is equipped with perforated aluminum board. The perforated aluminum external shadings are installed on the west side facade and under the north skylights of the departure lounge of Building A in the process of the facade transformation.
2.Facilities and equipment energy-saving measures

Apply high efficient air conditioning units. The cold source is applied with water cold storage system, with the storage rate being 30.5%.The air conditioning system is subdivided according to the function of the service area, the building orientation, and the inner area or the outer area, and different systems are controlled separately. General air system can achieve variable fresh air volume control to reduce the energy consumption of the air conditioning system.
Utilize high-efficiency lighting fixtures. The lighting system of the public areas is under the unified control of the BA system while the VIP areas utilize the intelligent lighting control system for achieving the real-time and effective lighting control based on the time-sharing control, timing-control, sub-regional control and according to the open channel area ,the external lighting conditions and the passenger volume. Apply the building automation management system and the energy management system to monitor and measure the mechanical and electrical equipment in the building.
Utilize solar water heating system for hot water use in the VIP areas. Select vacuum tube heat collector and apply centralized hot water supply. The collector has the area of 450m^2, reaching 50% guarantee of hot water. Utilize indirect heating mode and the gas water heater as auxiliary heat source.
3.Water-saving design
High-efficiency water appliances: Sanitary wares are all equipped with Level 1 water-saving appliances. Apply the 3 liters / 4.5 liters flushing volume two-stage water-saving toilets. Utilize ceramic sealed inflatable faucets of which the water flow is less than 0.1 L/s under the 0.1 ± 0.01MPa condition.Urinal flush is not greater than 2L /time.
Water metering device: Set water meters at the total domestic water pipes, fire water pipes, air conditioning rooms, freezing chambers, boiler rooms, cooling towers, kitchens, water tanks and other water supply pipes.Water meters are equipped with remote communication interface so that the measured data can be uploaded to the energy monitoring center. These measurements meet the Technical Code of Energy Consumption Monitoring Systems for Public Buildings of Shanghai (DG/TJ08-2068).
Water-saving circulating cooling water system: Utilize the cooling towers with high cooling performance and water collecting performance. The cooling water system contains water quality stabilizing treatment facilities. Set water tray connected to the cooling tower drain pan to ensure water flow balance. Set water meters on the supplement water pipes.
Water-saving irrigation system: Outdoor greening irrigation applies sprinkler irrigation, micro-irrigation and other water-saving irrigation methods to save irrigation water.
4. Saving-material design
High-performance and high-strength materials: In the reinforced concrete structures of the transformation parts of the buildings, the amount of ordinary steel bars with HRB400 and above force grade should account for no less than 50% of the total amount of steel bars. In the steel structures of the transformation parts of the buildings, the amount of steel high-strength with Q345 and above strength grade should account for no less than 50% of the total amount of steel used.
Prefabricated components: The roof and parts of the top floor area of the transformed terminal use steel structure.
5. Indoor environmental quality guarantee
In this project, the introduction volume of fresh air in the air conditioning season is adjusted according to the indoor CO2 concentration controlled target so as to minimize the energy consumption of the system. Indoor air quality monitoring systems are installed in the main function rooms in which the occupant densities are high and change substantially with time to monitor and analyze the indoor carbon dioxide concentration, with the ventilation system linkage.

Data reliability

Self-declared

Stakeholders

Stakeholders

Function : Thermal consultancy agency

600 18

http://www.arcplus.com.cn/cn/
Green design advisory unit

Contracting method

General Contractor

Owner approach of sustainability

Eco-sustainable ideas will be integrated into the design at the beginning of the transformation. First of all, make full use of the original building through the assessment and evaluation to achieve functional upgrading and structural reuse; At the same time for both the airport environment and architectural characteristics put forward the update strategy to minimize the cost to create efficient and comfortable space quality while making full use of the original building so as to achieve low cost building operation and refine the formation of the airport green transformation evaluation system for providing effect evaluation and design reference to other airport green renovation project. This is based on the considerate optimizations of environment quality, envelope, indoor natural ventilation, natural lighting and shading and other passive climate adaption designs of the mechanical and electrical equipment under non-stop operation conditions.

Architectural description

1. natural lighting and ventilation design combined with project features and requirements
Because the airport terminal has a huge volume, there are large local areas which have no natural lighting and ventilation conditions. In this retrofit design project, the design of ventilation tower integrated with skylight is proposed innovatively to improve the current poor ventilation situation of the Joint Inspection Hall and the Ticket Hall caused by large depth. Form the ventilation tower by pulling up the height of the original skylight over the inspection area, which greatly enhance the indoor environmental quality of these regions.
2.The envelope and exterior shading design combined with the local climate characteristics.
Taking into account that Shanghai is located in hot-summer and cold-winter zone, the transformation design utilize the design strategy of envelope thermo insulation structure combined with external shading to minimize the heating and cooling energy load. The interior surface of the entrance hall is equipped with perforated aluminum board. The perforated aluminum external shadings are installed on the west side facade and under the north skylights of the departure lounge of Building A in the process of the facade transformation. What is especially innovative is that external shading boards are set up at the boarding bridge which greatly improves the thermal environment of the boarding bridge. Curtain walls and skylights are integrated with aluminum alloy frames of which glass material is mainly 8LOW-E+12A+8+1.52PVB+8 hollow laminated glass and 8+1.52PVB+8 laminated glass. These measures aim to enhance the thermal performance of the building envelope.
3. Green energy-saving retrofit takes full account of the existing architectural characteristics, reduces engineering quantities and improves the economy
Design not only concerns about the performance of the building after the transformation, but also controls the cost of transformation and quantities. Feasible measures are proposed as far as possible making full use of the characteristics of existing terminals considering the economy and material and equipment conservation. For instance, retrofit the reserved parts of the structure the original skylights to the ventilation towers. Set up high side windows using the height differences between the openings of the original building blocks. Improve the building performance such as the effect of indoor ventilation with minimal transformation to ensure the economy.

If you had to do it again?

Difficulty:
The original terminal building is relatively small and the functional layout is compacted; Transformation and expansion will lead to that part of the building volume is surrounded in the center, so it is difficult to obtain natural lighting and ventilation. The ticket hall, inspection hall and the boarding lounge should be clearly separated according to the security requirements of the terminal. The transformation of the original space will change the layout and separate the original space, resulting in disadvantages in ventilation and lighting. The original small space scale and low height also impede the indoor air circulation.

The original facade is retained, which results in that the wall and the windows are difficult to change and shading is not easy to set and it is hard to implement the envelope insulation renovation.

Solution:
Take into account the balance of green performance and the investment of the retrofit project, introducing moderate green targets and achieving local improvements. Feasible measures are proposed as far as possible making full use of the characteristics of existing terminals focusing on natural ventilation, natural lighting and shading and other passive design to obtain higher energy efficiency and environmental space quality at a lower cost. For instance, retrofit the reserved parts of the structure the original skylights to the ventilation towers. Set up high side windows using the height differences between the openings of the original building blocks.
The transformation strategy is: Make full use of existing buildings based on the original architectural features; Adapt to the climate; Create synchronization of the architectural design and the functional quality; Improve energy efficiency by combining design with operational management measures.

Building users opinion

The overall lighting effect of the ticket hall is excellent and the lighting effect near under the skylight is the best. Due to the diffuse reflection of the inclined roof, even the lighting effect of the deep depth of the ticket hall has also achieved the desired.
The International Joint Inspection Hall was originally surrounded in the center and there was no natural light. The natural lighting effect is improved obviously through the skylight set combined with the ventilation tower. A district high level of the terminal, near the top of the curtain with skylights, making the surrounding area lighting is good, most of the central terminal area to achieve the desired results. B District Office lighting effect is very good, although part of the set sun shade, still meet the lighting requirements. The C-district is very close to the curtain wall and has a good lighting. The building overall temperature and humidity is controlled at appropriate level with average distribution, no temperature and wind speed mutation and somatosensory comfort.

Energy

Energy consumption

Primary energy need : 457,05 kWhpe/m^2.
Primary energy need for standard building : 634,00 kWhpe/m^2.
Calculation method : Field measurement method (China)
Final Energy : 138,50 kWhfe/m^2.
Breakdown for energy consumption :
HVAC: 41%
General Lighting Socket Equipment: 38%
General Power Equipment: 8%
Others: 13%

Initial consumption : 457,05 kWhpe/m^2.

Envelope performance

Envelope U-Value : 0,54 $W.m^{-2}.K^{-1}$
Building Compactness Coefficient : 0,15
Indicator : GB/T 7106-2008
Air Tightness Value : 3,00

Real final energy consumption

Real final energy consumption/m2 : 136,80 kWhfe/m^2.
Year of the real energy consumption : 2 017

Renewables & systems

Systems

Heating system :
- Gas boiler

Hot water system :
- Gas boiler
- Solar Thermal

Cooling system :
- Water chiller

Ventilation system :
- Natural ventilation
- Double flow heat exchanger

Renewable systems :
- Solar Thermal

Renewable energy production : 0,60
Solutions enhancing nature free gains :
Natural ventilation,natural lighting, exterior shading

Smart Building

BMS :
Utilize construction equipment monitoring system to monitor and control air conditioning equipment, water supply and drainage equipment, electrical equipment and other electrical equipment to reduce energy consumption.The building automation management and energy management system is used to monitor and measure various mechanical and electrical equipment in the building. The energy management system manages the cooling and heating amount, water resources system, gas system and electric energy to achieve the separated metering of the lighting socket electricity, air conditioning electricity, power consumption and special electricity.

Users' opinion on the Smart Building functions : Automatic control system is running well which can ensure the indoor air conditioning system, lighting system operate well.

Environment

Urban environment

Terminal 1 retrofit is part of the transformation of the Terminal 1 area. The Terminal 1 area renovation is planned terminal-centered, including the Terminal 1, the transportation center, the integrated development on the south side and the integrated development on the north side. Terminal 1 can carry on 10 million passengers annually after completion. The traffic of the terminal and the passenger traffic and parking facilities are solved by transportation center on the eastern side of the terminal including the passenger boarding hall, underground park, ground overall and front overhead. The construction area is 72,000 square meters and it can provide 1250 parking spaces; The comprehensive development of the South and North block positioning is terminal supporting office and business services.

Land plot area

Land plot area : 4 471 730,00 m^2

Green space

Green space : 900,00

Parking spaces

Terminal traffic center undertakes passenger transfer and parking which is consisted of passenger transfer hall, underground parking with a total area of 72,000 square meters that can provide 1250 parking spaces.

Products

Product

Water storage air conditioning system

2115 11 A

http://www.poweru.cn/index.asp

Product category :

Water storage technology refers to that when the power load is low at night, the cold amount produced by the electric refrigerator is stored in the form of cold water. At the peak time during the day, do not open or partly open the refrigerator to make full use of the cold amount stored at night for air conditioning so as to achieve the purpose of power peak load shifting.

As the implementation of time-sharing price by the power sector, the operating cost of the chilled water storage air conditioning technology is less than conventional air conditioning system. The greater the difference between the time-sharing prices is, the more benefit the users get.Water storage technology mainly take use of the physical properties of water. For water at 1 atm, the density is the largest at 4 °C (1000 Kg / M3). With the increase of water temperature, its density is decreasing. If there is no external disturbance, it is generally easy to form the natural stratified state that the cold water is under the hot water. But when water is below 4℃, there is obvious irregularity condition that with the decrease of the water temperature, its density is decreasing. So the cold water temperature in chilled water storage should be no less than 4℃. The temperature is generally 4-14℃ in the cold storage process, and it is generally 40-95℃ in the heat storage process. Water storage utilizes the significant thermal capacity change of water (water specific heat capacity is 1.0Kcal/kg•℃).

Take advantage of the country's time-sharing tariff policy to greatly save operating costs. The night environment temperature is lower and the cooling effect is good. The system runs at full load at most of time so as to improve the working efficiency of the chilling units. It saves maintenance costs as well. Water storage can also reduce the installed capacity and electricity capacity of refrigeration equipment thus reduce the electricity investment (including electricity subsidies and transformers, power distribution cabinets and other power facilities). In addition, as a backup cold source, it increases the reliability of air conditioning system and it can also be combined with low temperature water supply and low temperature air supply to reduce the capacity of equipment and the noise. Storage tanks can be integrated with the fire pool, or put underground, not taking up the places for commercial use so as to reduce the occupied area of the chilling unit room and reduce initial investment. As the operation time of the chilling units during the day is less, the noise is very small and it is clean and easy to operate.

External shading

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http://www.lingyun.com/

Product category : Opere di finitura / Elementi esterni - Porte e Finestre

Perforated aluminum board is divided into facade shading aluminum and sunroof shading aluminum. Perforated aluminum plate is 3mm thick with surface fluorocarbon spray and the perforation rate and aperture are determined according to the site model. Outdoor shading aluminum board is mainly located on the outside curtain wall of the corridor lounge of terminal building B including perforated aluminum, steel skeleton, connectors and other components. Perforated aluminum section is of the "L" type and the plate division details is in the drawings. The perforated aluminum plate folding is 150mm length and the folding covers the edge of the steel keel with no holes on the folding. Steel frame will be fixed in the original aluminum concrete structure, steel structure, the curtain wall contractor shall calculate out and determine the size of steel skeleton according to force requirements for the sake of security. Steel skeletons are all processed and fixed by mechanical method to avoid the impact of welding on the appearance. Steel frame surface is sprayed on fluorocarbon layer which shares the specifications with the curtain wall. The color of the fluorocarbon layer has not been confirmed. Avoid the destruction of the original building facades on the junction of the steel skeleton and the original structure. Aluminum connectors should be small and installed at concealed location in uniform spaces and with fluorocarbon layer on the surface.
Skylight aluminum shadings are mainly located at the skylights of the departure buildings of Terminal A and Terminal B, the Joint Inspection Hall, the new lounge corridor of Terminal A, D section of Terminal A and the lounge corridor of Terminal B. Skylight aluminum shading mainly consists of perforated aluminum board, steel keel, boom and other components. Perforated aluminum board is basically divided the same with the skylights and the plate patchwork details are in drawings. Plate folding is 100mm length and the folding part is not perforated. The sizes of the steel keel are determined by the curtain wall contractor. The surface of the steel keel has fluorocarbon coating which shares the specifications with the curtain wall. The color of the fluorocarbon coating has not been confirmed. The sunshade board must be installed together with the mechanical, electrical equipment and lighting devices.

Large number of glass curtain walls are used in the terminal buildings, which easily causes the increase on the heat load in summer and the glare impact, resulting in discomfort of the staff and increase on the energy consumption of cooling equipment. In addition, in Building B of Terminal 1, there is a huge contradiction between its west orientation and the vision requirements.
Adjustable external shading: The perforated aluminum boards are set at the inside surface of Terminal A entrance hall. Perforated aluminum external shadings are set on the west facade and the skylights on the north side in the lounge of the Terminal A. Shading architecture and the facade are of integration design which can resist most of the solar radiation while making the indoor lighting more gentle and not affecting the vision and natural lighting.
Exterior shading on the west facade: Perforated aluminum shadings are set on the empty side of the facade according to the structure transformation and facade retrofit and fixed on the facade by steel structure with about 1.5m distance over the facade. Shadings can resist most of the solar radiation while making the indoor lighting more gentle and not affecting the vision and natural lighting. The exterior shadings of the boarding bridges are set according to the different orientations. Vertical blinds in different angles are set on the west and southwest orientation of the boarding bridges according to the sunshine characteristics.

Solar hot water system

199

http://www.sunrain.com/

Product category : HVAC / Riscaldamento, Acqua calda sanitaria

The VIP area utilizes solar hot water system for the living hot water in the mode of centralized hot water supply. The solar collector is arranged on the roof of the VIP area. The heat collector adopts vacuum tube heat collector which is installed horizontally. The collector surface should be polishing treated. The auxiliary heat source of solar hot water system is gas water heater. The hot water storage tank of the solar water heating system, the gas water heater, the hot water circulating pump and water tank are set up in the heat exchanger room of the VIP room. Hot water system adopts mechanical cycle to ensure the hot water temperature.
Design parameters: Average daily solar radiation of Shanghai level is 12.3MJ/.m2.d. Hot water guarantee rate is 50%, by indirect heating. The heat collector adopts vacuum tube heat collector with the heat collecting efficiency not less than 74% and the collector area is about 450 m2 by calculating.

The solar water heating system works well and effectively reduces the gas consumption for hot water.
Environmental benefits: Reduce pollution and carbon dioxide production relative to using fossil fuels to produce hot water.
Save energy: Solar energy is a source for everyone. As long as there are sites and equipment, anyone can use it for free.
Safety: Avoid the risk of explosion or poisoning by using gas water heater or boilers. Avoid the risk of leakage of electricity.
Space free: The system can automatically works. In addition, the solar collector is installed on the roof and does not occupy any indoor space.
Economic efficiency: Normal solar water heater is not easy to damage with the life time at least ten years and even twenty years. Because the basic heat source is for free, so it is in line with the economic benefits.

Costs

Construction and exploitation costs

Renewable energy systems cost : 1 352 900,00 ¥
Cost of studies : 1 680 000 ¥
Total cost of the building : 1 022 328 300 ¥

Energy bill

Forecasted energy bill/year : 28 100 000,00 ¥
Real energy cost/m2 : 213.13
Real energy cost/Passenger/year : 2.81

Building Environnemental Quality

Building Environmental Quality

- waste management (related to activity)
- water management
- energy efficiency
- maintenance
- building end of life management
- integration in the land

Health and comfort

Water management

Consumption from water network : 382 213,00 m^3
Water Consumption/m2 : 2.9
Water Consumption/Passenger/year : 0.04

Carbon

GHG emissions

GHG in use : 98,50 $KgCO_2/m^2/$
GHG before use : 136,94 $KgCO_2/m^2$
Building lifetime : 50,00
, ie xx in use years : 1.39

Date Export : 20231013134255