建築

BUILDING JOURNAL
HONGKONG • CHINA • NOVEMBER • 2010

Also in this issue
Hysan Place
Henderson Land Development
Guangzhou Building Development
Kitchen design

World Financial Centre, Beijing

Quality Transcends Time

World Financial Centre, Beijing

Quality Transcends Time

The developer, Henderson Land Group's vision was to create the first environmentally sustainable international Grade A office building in Beijing. A world class project team was assembled consisting of design, construction and building management professionals from Hong Kong, Mainland China and other parts of the world to make this vision a reality. Clear project requirements were established at an early stage in design, based on the target customer's needs. The aim of the project team, which was based in the Beijing Site Project Office, was to create a quality building that would transcend time and would be a benchmark for commercial buildings in Mainland China for years to come.

Environmental considerations were given high priority in all aspects of design, construction and operation of the building, through choice of environmentally friendly materials, energy efficient systems and controls. WFC is a "green building" as demonstrated by the project achieving the highest possible rating of "Platinum§ under the globally recognized Leadership in Energy and Environmental Design (LEED) and Hong Kong Building Environmental Assessment Method (HK BEAM).

“As a developer, our vision was to create the first environmentally sustainable, Grade A office building in Beijing. It was the objective of the Project Team to create the most technologically advanced, energy efficient and sustainable building in the region.”

David Dumigan
General Manager, Project Management 1
Henderson Land Group

Plannning and engineering achievements

The site abuts Chaoyang Road on the north and East Third Ring Road on the east. There is a 50 metre and 100 metre landscape buffer zone to the east and north respectively to screen off traffic dust and noise, and to provide spatial relief. To the west and south are local district streets for vehicular access.

The building is adjacent to the metro station Jintaixizhao of Subway Line No 10, which has direct transfer to the airport railway. An underground link from the basement level also provides direct access through a tunnel to be completed in 2012 to the concourse of the metro station.

To fulfill an international Grade-A office standard, the project takes the form of two moderate-height towers, with large floor plates with a gross floor area of about 4400 square metres allowing for single-floor operations for large companies. Keeping the towers within 100m height also dispenses with the requirement for a refuge floor, and improves the usable efficiency of the building.

Special trading floors for financial institutions, with 3.3m headroom and 300mm high raised floor and additional reliable electrical and air conditioning capacity, satisfies the needs of international financial services companies. WFC is the first office building in Beijing to provide this type of facility.

In addition to 10m high independent lobbies with crystal chandeliers and crystal wall artwork at the cores for each tower, the first two levels and the first basement level provide space for retail and food and beverage outlets. Basement parking accommodates over 1200 vehicles and 2,000 bicycles, with the lowest of car-park floors doubling as the national defense air-raid shelter. The major electrical and mechanical equipment is also located in the basement.

The orientation of the twin towers is optimized for the best wind flow and comfort at pedestrian level. Also, the orientation of building grids respect the overall east-west planning grids of the CBD area and the historic city of Beijing.

Extensive landscaped open space with an area of approximately 12,000 square metres was designed for the enjoyment of the occupants and general public.

Perspective of WFC at the heart of the CBD

Roof design

Because these buildings are lower than some of the surrounding structures, extraordinary effort was given to the roof design in consideration for the views from surrounding structures. The roof was treated as the 5th elevation. The glass walls are extended past the highest occupied level to screen the mechanical equipment on the roof, then folded back to complete the jewel like crystalline effect of the dual cubic form. An intricate frit pattern helps to obscure the equipment, and also creates the illusion of dematerialization as the tower meets the sky.

Curtain wall

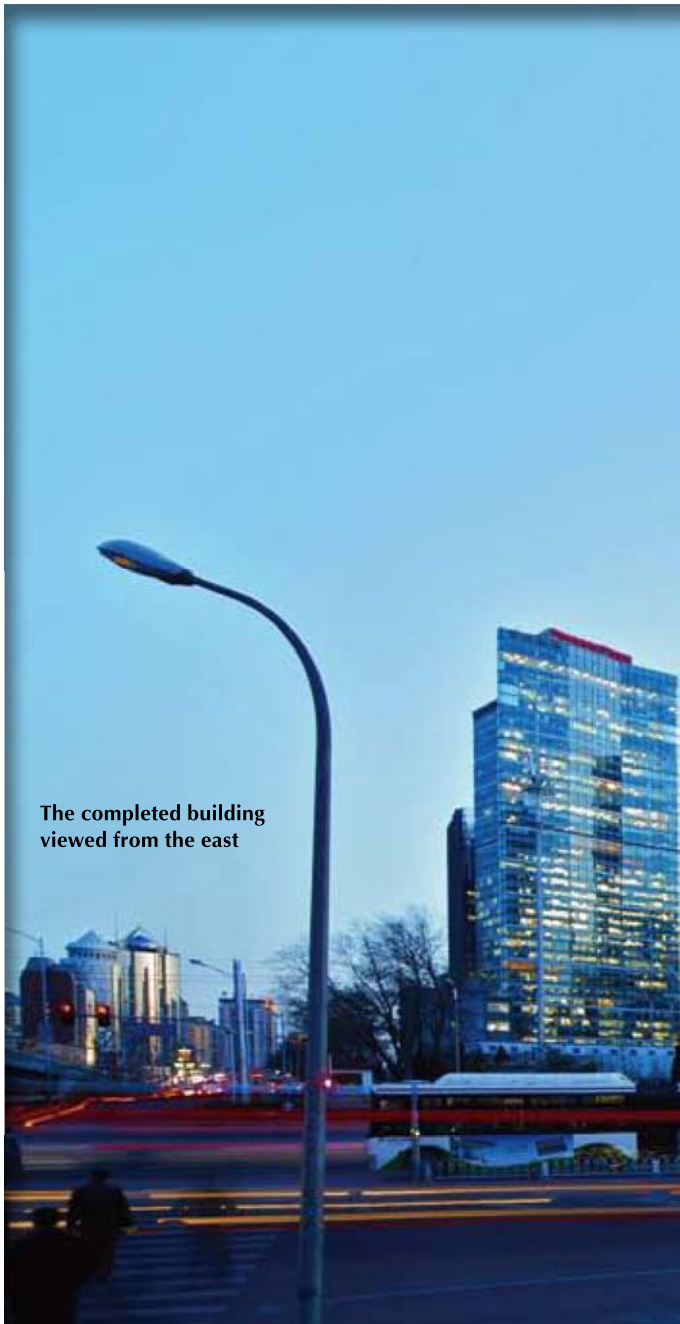
The exterior wall is designed and constructed with the most advanced curtain wall technology available. The modular unitized system is not only the most effective rain screen against moisture penetration, but also the most efficient to manufacture, transport and install. The insulated glass unites ensure maximum thermal performance by the use of Low-e coating and argon gas in the airspace. The glass specification was carefully selected for the optimum balance between thermal efficiency and visual characteristics.

Structural design

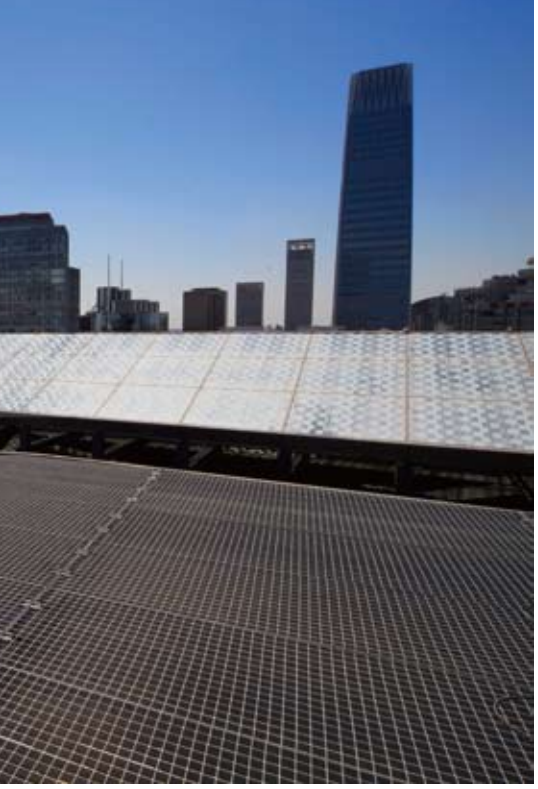
Large open plan column-free office space is achieved by using over 18 metre long span steel beam and reinforced concrete composite floor system. The facade columns are at 12 metre centres to provide less obstruction to natural light and facilitate open views thus resulting in a more comfortable environment for the occupants and reducing energy costs.

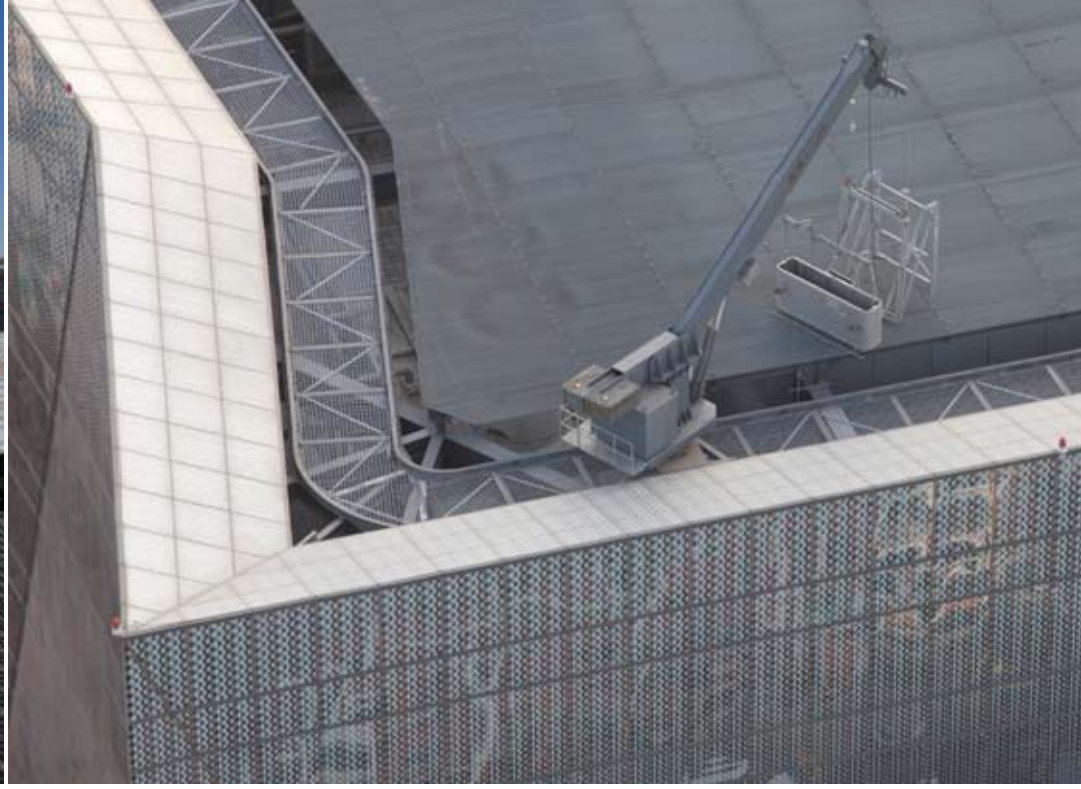
A dual structural stability system made up of composite perimeter frame together with a central reinforced concrete corewall has been adopted for each of the towers. The dual system ensures enough stiffness while maintaining adequate ductility under earthquake loads. Although the building is only 100 metres tall and about 65 metres wide having large lateral stiffness, the long span from building edge to core wall results in the building's rotational mode becoming very critical under earthquake behavior. Hence the ring of edge beams has adopted composite construction to increase the building's rotational stiffness while

Completed roof top with all mechanical equipment hidden



The completed building viewed from the east

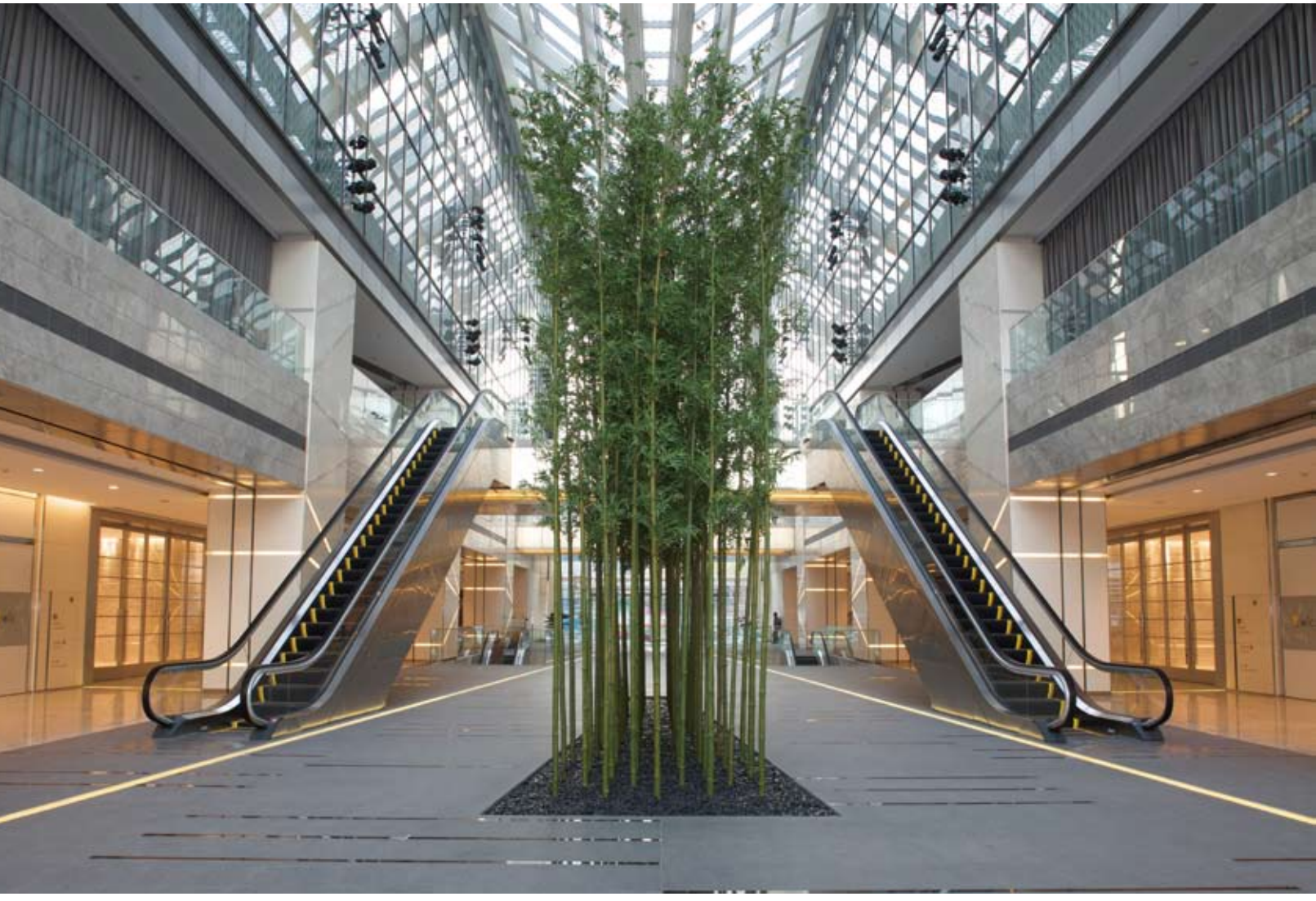




Building Maintenance Unit (BMU) at roof top (two on each tower)

Column and wall free floors offering maximum flexibility

Five storey high Winter Garden



maintaining 12 metre column spacing along the facade and column free corners. The use of long span structure may introduce vibration problems. Detailed footfall vibration analysis was carried out to ensure that there was no comfort problem during occupancy.

Building services

A total of 34, 21-persons high-speed lifts are divided into three zones in each tower, achieving less than 30-second waiting time and more than 12% handling capacity. One further VIP lift is provided for each tower for the exclusive use by top executives. There are also two service/fireman's lifts and two car park shuttle lifts for each tower.

Absorption chillers using steam supplied through the municipal network are employed in the chiller group to reduce the use of refrigerant and also give higher reliability to the chilled water system. Steam is also used for humidity control of the ventilation system, humidity being a critical design concern in the dry winter climate of Beijing. Steam is a reused form of energy being waste from power stations.City heating is provided through radiators located along the perimeter of the building integrated within the raised floor system. This is contrary to normal practice in Beijing with exposed radiators which take up useful wall or floor space. The perimeter ducts of air handling units in the same compartment of the office floors are interlinked, allowing supplementary cold air supply to accommodate the high peak demand of air-conditioning in summer, improving summer performance with no extra energy usage.

A unique three-feed dual electrical power supply system with back up generators was installed to give a very reliable electricity supply. This is the first time such a system has been installed in Beijing.

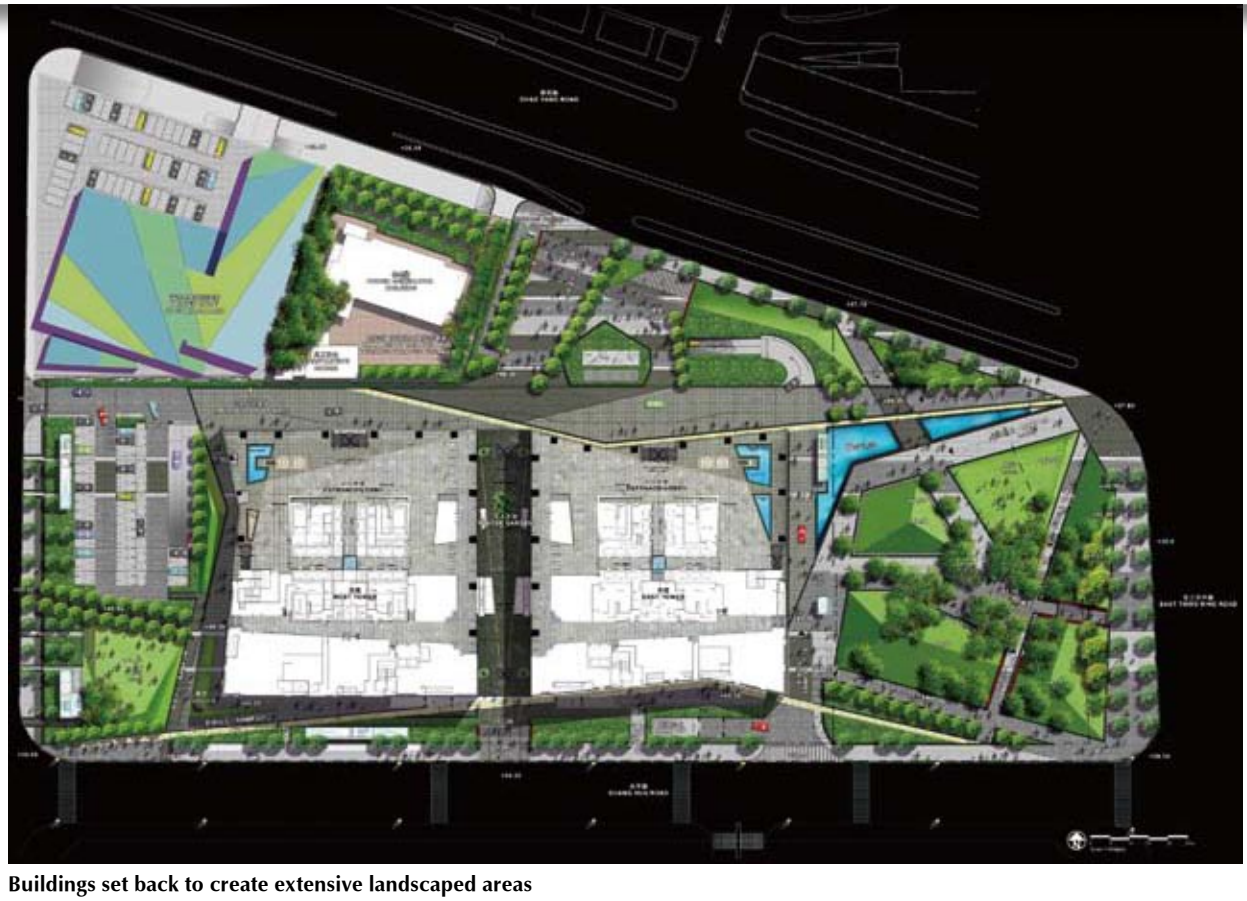
Between the towers is a fully enclosed atrium to connect the lower two floors of the towers and provide expansive exhibition

Low radon emission stone in Winter Garden

"WFC has successfully integrated architectural and environmental considerations into a modern, green working environment for the future. As a Bank we are committed to minimizing the impact of our operations on the environment; and we are honoured to support WFC in contributing towards China's transformation into a low carbon-emission economy."

Southern facade of building with landscape

Typical floor showing column free space and 1.5m planning grid



Buildings set back to create extensive landscaped areas

Crystal Walls in main lobby of east and west towers

Main Lobby of East Tower

Installation of Crystal Wall under artist Michael Hammers' supervision

Crystal walls construction

The success of the crystal walls in the main lobbies presents the best example of showcase workmanship. Assembled from 1200 glass pyramid-shaped boxes, each with different dimensions, the crystal wall was designed in Germany with full construction details worked out. The artist Michael Hammers first directed a part-prototype mock-up to be manufactured in China, using local technicians under the supervision of the artist. Then full scale production was carried out in China and installed on site under Michael Hammer's direction. The precision of engineering and workmanship achieved has made this art piece a reality which is admired by tenants and visitors alike.

spaces and amenities to the complex. The roof is supported by corbel beams fixed to adjacent tower columns leaving the atrium floor free of structure. Use of fritted glass reduces direct solar exposure that helps improve mechanical efficiency and occupant comfort. On the north and south ends, the glass atrium projects past the tower edge, signifying the main entrance along with the 3 dimensional canopies. Natural smoke relief is justified through rigorous study using computational fluid dynamics.

Other structures

The sub-grade functions such as the metro station, car park and national defense facilities added to numerous site structures outside of the main towers. The design of these elements was as intense as the main building. The canopy to the metro station and the screens around the air vents complement the tower design, and enhance the overall aesthetics of the entire complex.

Lighting

The lighting design was fully integrated with the architecture as well as the site and landscape elements. The building facade is animated with programmable lights embedded in the curtain wall. Flood lights reflected from suspended screens highlight the tower tops. Both use LED sources that combine energy efficiency, longevity with unlimited flexibility. Lights embedded in the landscape and site structures further enhances the overall composition of the complex.

Interior design

The crystal theme was also carried into the interior design of the building which achieves a warm and comfortable feel. Common areas, lobbies and washrooms are all designed with luxurious materials with warm tones creating a hotel like atmosphere.

Artwork

The crystal wall artwork is located along the corewall in the ground floor lobbies. The prominent German artist Michael Hammers was employed to design and direct the construction of the crystal wall. This 4 metre by 46 metre long crystal wall plus the crystal chandeliers at the entrance to each tower have become the jewels within the jewel boxes.

Installation of modular double glazed, low-e, argon filled curtain wall system

Self climbing formwork for central core walls and structural steel erection for floor plates

Typical floors and unitized curtain wall under construction

Basement and piling under construction in shoring free excavation

Areal view of site showing mechanized construction methods

Superstructure construction

Hydraulic self climbing formwork was used for the construction of the corewall. The same reusable formwork was used for the whole core, minimizing waste and ensuring quality. The system also allowed a four day floor cycle to be achieved.

The symmetric arrangement of the structure facilitated standardization and prefabrication of structural steel members. Standard steel formwork was used for ring beams on each floor.

A prefabricated steel truss deck is adopted in the composite floor construction, rather than the conventional ribbed steel deck. Reinforcement bars are prefixed to the steel deck to form a truss in the factory, thus providing enough stiffness for the steel deck to support the working load and concrete self weight, and no formwork, falsework or propping is required during concreting. The concrete and steel bars in the deck act as the slab structure to take up final floor loads.

Hydraulic self climbing formwork and prefabricated structural steel

The use of jump-lifts enabled the curtain wall of complex geometry to be completed at the earliest possible time, due to early removal of external hoists. This arrangement saved about one month in the overall construction programme.

WFC is an architectural icon with functional and flexible space

Facts and Figures

Volume of excavation	200,000 cubic metres (50,000 truck loads)
Weight of structural steel	17,000 tonnes
Volume of concrete	126,000 cubic metres
Number of curtain wall units	10,000
Number of raised floor panels	350,000
Number of Chillers	12
Number of Lifts	44
Number of digital CCTV cameras	600
Number of trees planted	200
Number of bicycle parks	2,000
Number of car parks	1,278
Number of construction workers	2,500

Awards and honours

- Intelligent Building of the Year 2009 – by AIIB
- HK-BEAM Platinum Certificate
- LEED Platinum Certificate
- Quality Building Award 2010
- Outstanding contribution to the development of Capital Financial industry in Beijing

Excellent air quality inside Winter Garden

Overcoming cultural differences

The project management team had recognized from the beginning that overcoming the cultural differences between the Hong Kong, Mainland and international designers and the local contractors and suppliers was paramount to the success of WFC in Beijing. The local contractors' experience and knowledge is invaluable, and in order for them to deliver a building of international Grade-A quality, which had not existed before in Beijing, the project management team and designers took full account of local experience and capability, and developed suitable details to achieve the design intent.

To enable the contractors to understand the quality expected for WFC, the Developer at the very beginning of the project arranged for major contractors of all disciplines to visit Two IFC in Hong Kong. The contractors also showcased their past work to the project management team, who could then appreciate their abilities and limitations. Through mutual respect and understanding the integration of international design with local resources and experience was successful in pushing for and achieving the desired high quality building.

Site project office

The project had to be completed within a very challenging programme, from commencement of the project scheme design in October 2005 and start of construction in May 2006 to occupation in January 2009. This required very close teamwork and quick decisions from the Developer. It should be noted that the construction time overlapped with the 2008 Beijing Olympics. In order to cope with the challenging programme, tight budgetary constraints and location of this project, the Developer established a Site Project Office with the project management team resident full time in Beijing.

Proactive construction management

The particular challenges of fast-tracking, with construction in advance of completion of design, necessitated close coordination between contractors and designers. This was facilitated by a strong and proactive project and construction management team with a positive attitude which established a partnering ambiance.

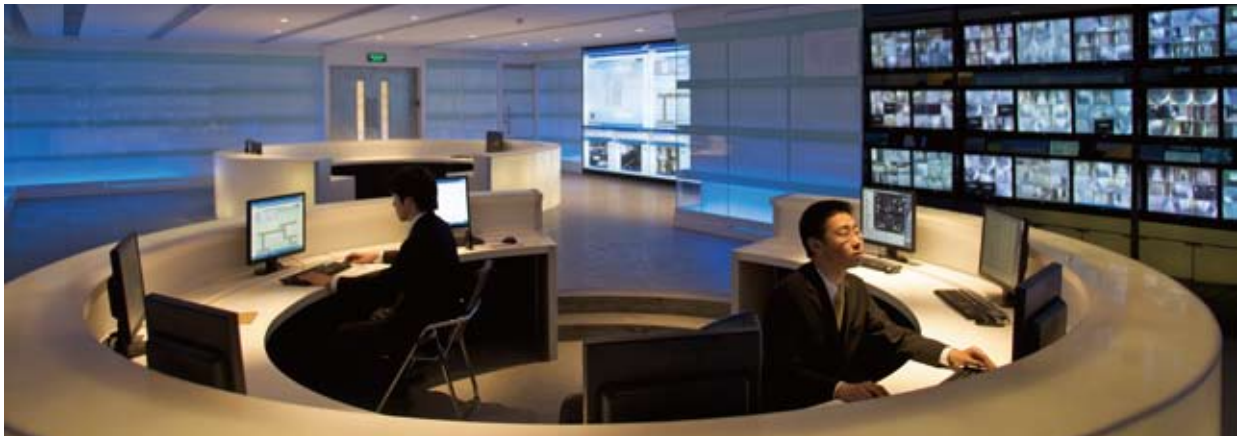
Programme monitoring

A Master Programme was drawn up with Critical Paths identified as the basic tool for monitoring the design, tendering and construction process. The programme revealed clear constraints on key dates for statutory procedures, and for tender award of various construction and supply packages, which in turn controlled key dates for completion of design packages.

Short-term programmes then addressed site activities in 2-week "timeboxes", and reflected actual progress on site. Any particular problems could be brought up and resolved on site by the Project Team. This was monitored on a day-to-day basis by the construction management team, at weekly site meetings, and reported to the Developer's senior management monthly.

Exterior design

The design of the building takes full advantage of the pair of cubic forms. While single tall towers have become the norm in office building design, the conception of the twin towers is a unique opportunity. The articulation of the folds follows the rigorous rules of rotational symmetry. Adapting the concept of paired entities that occur naturally in the realm of particle physics, the symmetry of the two buildings is resolved at a higher level. At the same time, the folds on the facade are inherently comprehensible and logical, creating a subtle but sophisticated composition.



Building Management System (BMS) central control room for operation and monitoring of building services and security systems

Typical lift lobby

Choice of materials

Sustainability was a major consideration in the choice of materials. The following environmentally friendly materials were used in the construction of WFC :

- Volatile Organic Compound (VOC)-free paint and coatings;
- low VOC emission adhesives and sealants;
- VOC-free carpet system;
- low radon emission stone finishes;
- locally sourced materials to reduce the environmental impacts resulting from transportation;
- materials such as steel bar, masonry block, curtain wall, wood purchased within 800 km of the project site;
- building products with recycled content are beneficial to the environment as they reduce impact from extraction and processing of virgin materials and reduce generation of waste volumes; in this project, contractors demonstrated preference in sourcing materials with recycled content such as steel, fire doors and glass.

Energy efficiency and life-cycle analysis

Low-e double glazing with argon gas is used for the curtain wall system improving insulation properties and reducing energy consumption for heating or cooling of the building to an absolute minimum, while maintaining an indoor temperature of 21oC and a humidity of 40% during summer. The heating and cooling control is further automated through the intelligent building central control with variable air volume (VAV). Optimal lighting layout design also achieved the necessary lumination level of 500 lux for an international Grade-A office while keeping the power consumption down to just 10W/m^2.

A Life Cycle Assessment (LCA) was carried out for WFC and ten environmental impacts were assessed from the whole life-cycle perspective, including (a) raw-material extraction, (b) building material manufacturing, (c) transportation, (d) construction, (e) building operation, (f) repair and maintenance, and (g) disposal:

The proposed design of WFC reduces the operational environmental impacts of

the basecase by 42%, with the 50-year operational environmental impact reduced from 2.98 Hong-Kong Eco-point per construction floor area to 1.72 Hong Kong Eco-point per construction floor area. Some examples of energy-saving measures are:

- window to wall ratio: 69%;
- external wall U-value: 0.6 W/m2-K;
- dual-panel metal-frame low-e glass windows with thermal break;
- fenestration U-Value: 2.7 W/m2-K;
- fenestration shading coefficient: 0.29;
- fenestration visual light transmittance: 0.36;
- HVAC System: variable air volume (VAV) plus baseboard radiation for office;
- outside air quantity based on demand control ventilation (DCV) sensors;
- airside heat recovery: 70% efficiency energy wheel;
- chillers type: variable speed electrical centrifugal chillers.

Indoor air quality plan

An Indoor Air Quality (IAQ) Management Plan was developed and implemented for the construction and pre-occupancy phases of the development.

Low Volatile Organic Compound (VOC) adhesives, sealants and paints are used for the project. The use of these materials reduces indoor air contaminants that have odour and are irritating and/or harmful to the comfort and well-being of both the workers during construction and the occupants of the building.

Indoor air quality measurement

The results of IAQ analysis indicated that all IAQ measurements comply with Good Class (Level 2) of the HKSAR Indoor Air Quality Objectives (IAQOs) for evaluating indoor air quality of office and public places, as well as satisfying Chinese Standards. The results of the IAQ testing were shared with tenants.

Renewable energy

To encourage the development and use of renewable energy technologies, the developer has purchased a two-year Renewable Energy Certificate (REC) with a US green provider, Windcurrent. For WFC, the contract between the developer and the REC provider includes a purchase of RECs equal to 35% of the predicted annual electrical consumption over a two-year period.

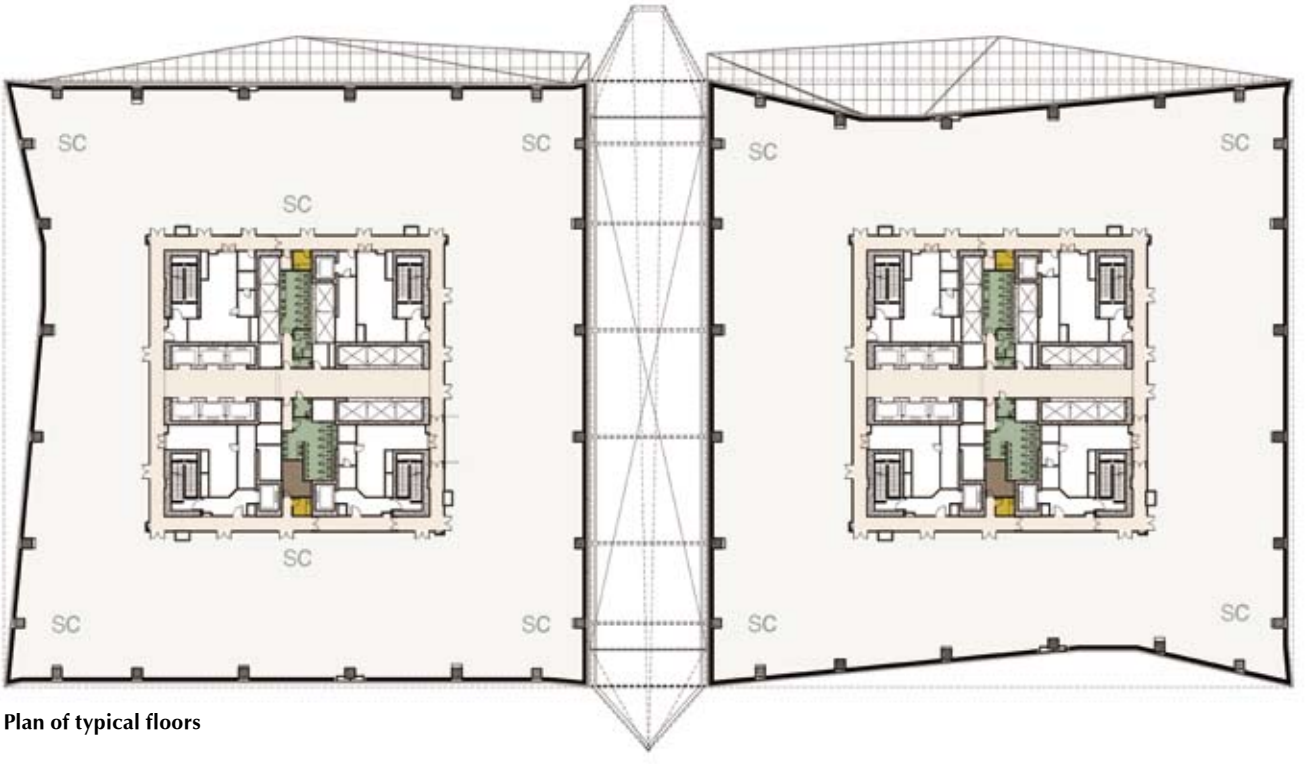
VOC-free carpet, paint and wall coverings

Environmentally friendly choice of materials for washrooms

Conclusion

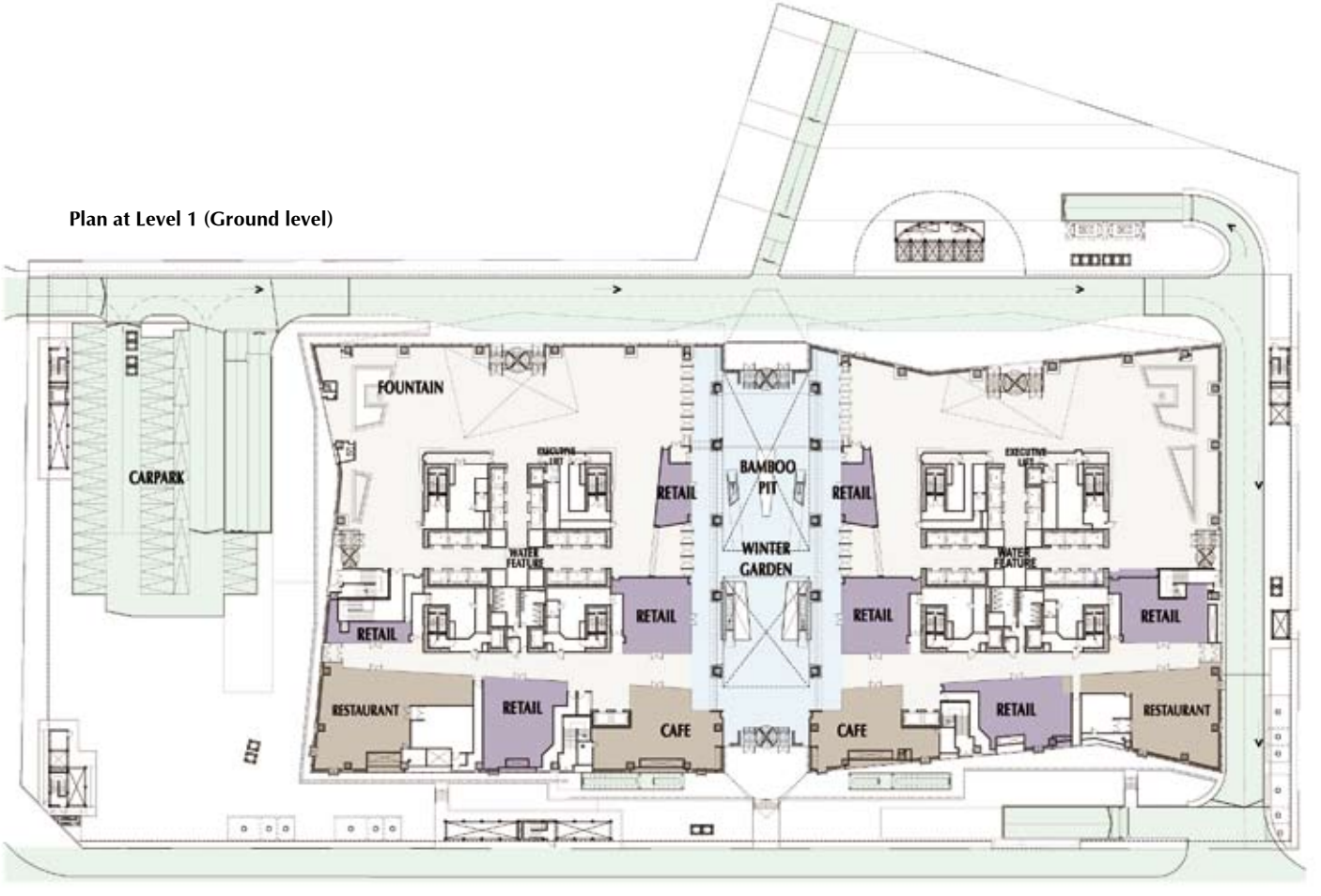
WFC, Beijing, is one of the most technologically advanced, energy efficient and sustainable commercial buildings in the world.

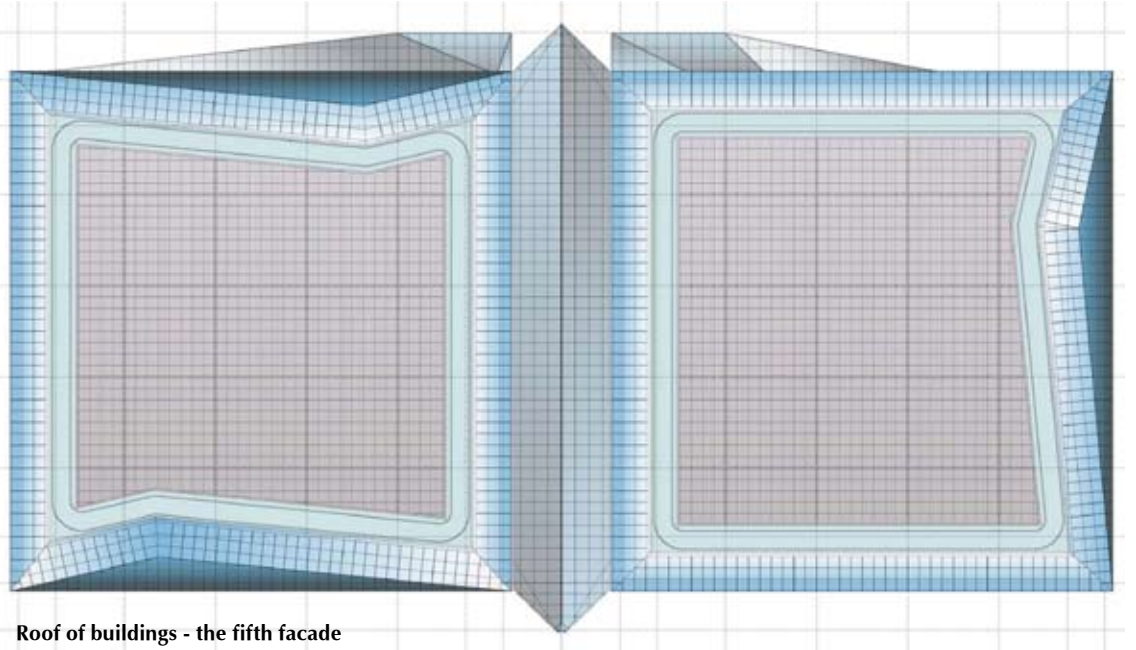
World Financial Centre, Beijing
Electronic version of this story is available on www.building.hk



Plan of typical floors

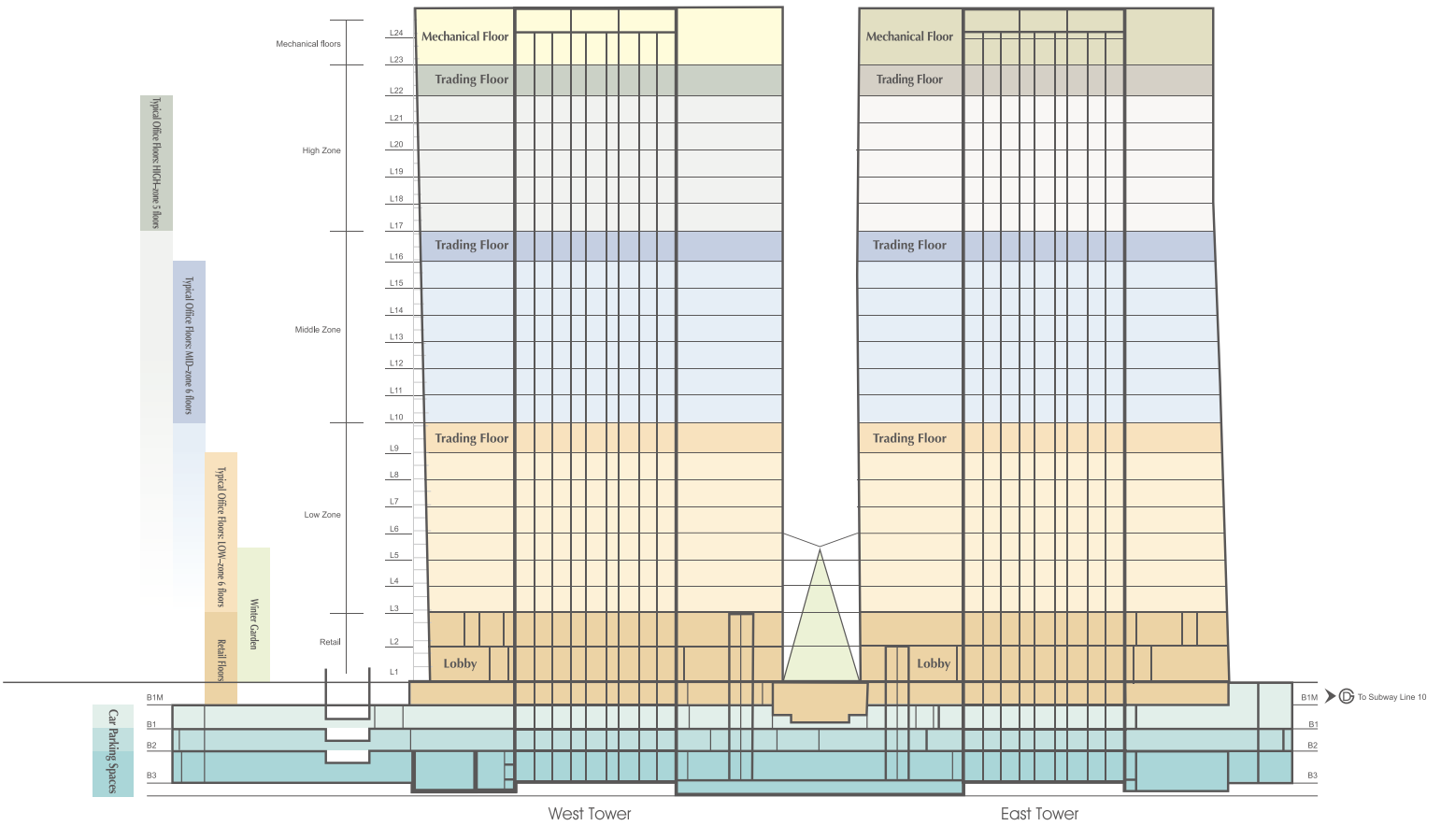
Plan at Level 1 (Ground level)





Roof of buildings - the fifth facade

Section showing trading floors and lift zones



中國建築一局(集團)有限公司

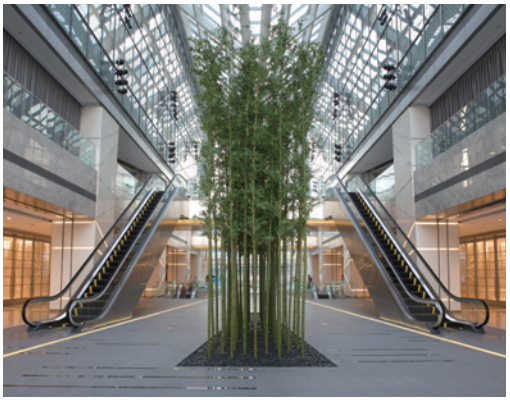
CHINA CONSTRUCTION FIRST BUILDING (GROUP) CORPORATION LIMITED

MAIN CONTRACTOR

of

WORLD FINANCIAL CENTRE

The First LEED Platinum Project in Beijing



北京環球金融中心

北京市首幢榮獲LEED白金認證項目

總承建商

中國建築一局(集團)有限公司

北京市豐台區西四環南路52號　　電話：010－83982099　　網址：www.cscec1b.net

Pelli Clarke Pelli Architects

NEW HAVEN

NEW YORK

SHANGHAI

WWW.PCPARCH.COM

ACLA 傲林國際
A Member of Hyder Consulting

wfc World Financial Centre
Beijing, China

Award winning Landscape Architecture, Master Planning and Urban Design, for over 30 years in Asia.

- Hong Kong
- Beijing
- Shanghai
- Hanoi

Worldwide offices in the United Kingdom, Europe, Middle East, Australia and Asia.

www.acla.com.hk | www.hyderconsulting.com

FAC·LEEDership

Sustainability, Green Building and Energy Management Consultants

FAC LEEDership warmly congratulates Henderson Land on the completion of their World Financial Centre development, and their success in making WFC the first LEED Platinum project in Beijing.

Our company was honoured to be entrusted with the role of LEED Commissioning Authority for this project.

As the region's foremost provider of commissioning services for LEED, FAC LEEDership offers clients a full spectrum of environmentally-friendly activities. Our core competencies are as follows:

Green Building Certification Consultancy Services

Energy Auditing, Benchmarking, Measurement And Verification (M+V)

Energy Reduction Programmes (New And Existing Buildings)

Carbon Auditing

Indoor Air Quality (IAQ) Testing

Building Energy Modelling

Testing And Commissioning (T+C) Management Services

Hands-On Commissioning Of Major Building Energy Systems

Third-Party Witnessing Of T+C Data and Energy Performance

Preparation Of Operation And Maintenance (O+M) Manuals

Facilities Analysis and Control Ltd / LEEDership Ltd

E-mail: info@fac-ltd.com Web: www.fac-ltd.com / Email: info@leedership.com Web: www.leedership.com

19/F, Fook Lee Commercial Centre, 33 Lockhart Road, Wanchai, Hong Kong Tel: (+852) 2529 2128 Fax: (+852) 2529 2198

90 Circular Road #02-00, Singapore 049441 Tel: (+65) 6534 5740 Fax: (+65) 6534 5741

EM Macau, Alameda Dr., Carlos D'Assumpcao, No.181-187, Jardim Brilhantismo A9, 3rd Floor Room Q. Tel: (+853) 2857 5595 Fax: (+853) 2857 5596

P.O.Box 99739, Dubai, UAE Tel: (+97)1 4 2654077 Fax: (+97)1 4 2654088

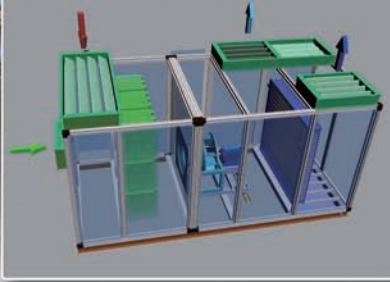
SAIVER®
SINCE 1959

Air Handling Unit

EUROVENT CERTIFIED PERFORMANCE
AHU N° 03-05-043
Range A1

- Integrated Design with built-in controls,VFD,valves and piping
- Thermobreak Construction
- 60 or 88mm Thick Panel
- 2,000~200,000 CMH
- IAQ Option
- Energy Saving Option

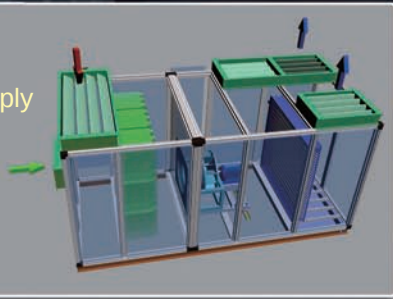
北京環球金融中心
Beijing World Financial Centre



Multi Zone Design

One AHU serves different zone with different supply temperatures

- Compact design and Space Saving
- Cost Saving
- Energy saving for exterior zone during winter



Service is Our Business

偉基空調有限公司
WELCOME AIR-TECH LTD.
Unit B300, 3/Fl., Block B, Sea View Estate, No. 2-8 Watson Road, North Point, Hong Kong.
Tel: (852) 2806 8316 Fax: (852) 2806 2426
E-mail: sales@saiver-welaire.com.hk Website: www.saiver-welaire.com.hk