The New Courtyard House and Renewable Energies – An Example of the BIRETH Design Approach

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Fig. 1 Proposal submitted for the International Solar Building Competition China 20052. The New Courtyard House and Renewable Energies

1. Introduction

High quality environmentally responsive residential buildings traditionally are designed to provide good insulation in winter and solar shading in summer. Most commonly these features are static features which do not change their positions throughout the year. Therefore good solar static shading devices often block daylight in cloudy winter days.

The most common dynamic micro-climate modulation features for buildings are the windows. We open or close them and fix them for certain percentage of openness as we want them. Also there are some retractable awnings and adjustable solar shading devices in use. Such dynamic features however do not respond in optimal ways to climate changes for the best use of green energies surrounding the buildings.

Common green energies surrounding buildings include solar energy, wind energy, rain and snow energy. Their design and use in residential buildings are commonly not well integrated. For example, windows with clear glass, double or triple glazed, allow good penetration of sunlight during day time in winter, but are not further dynamically insulated, with rock wool for example, for most part of it when the sun goes down to avoid heat loss from the building. Viewing ports with insulated hinged covers should be fitted for minimizing heat loss.

The above example shows the lack of an integrated approach to gain the best of available green energies and minimizes expenditure of energy in residential buildings. This integrated approach is discussed in this paper, illustrated in the design of a small residential building for rural Beijing [1] (Fig. 1) which was awarded Award of Merit in the International Solar Building Competition China 2005 held by The Chinese Solar Energy Society and The Chinese Society of Architecture. The design team investigated the challenge of contemporary solar architecture in China with cutting-edge ideas and eventually proposed a design titled as The New Courtyard House and Renewable Energies as an example to illustrate the ideas of the BIRETH **(Building Integrated Renewable Energy Total Harvest)** approach in which the traditional native courtyard house in the rural Beijing context was studied and integrated with multi-responding innovative green energy applications derived from first principles.

2. The New courtyard House and Renewable Energies

A new interpretation of traditional courtyard house with solar hot water system, solar PV system, solar hot air boxes and proper solar design was conveyed in the proposal of the farm house in Beijing. This Beijing farm house was designed for the said competition in 2005 [2] located in the rural area of Beijing, with requirements and schedules of a normal farming family house to be provided, added with accommodation for a few guests. The farm house must be designed to optimise its benefits with the sun.

The captioned design takes a new approach of interpreting the traditional Beijing courtyard house in the modern Beijing rural context. The design further integrates multi-responding innovative solar applications derived from first principles, and the use of innovative environmentally friendly materials for heat insulation and solar absorption/collection, and activity response.

Heliodon study of the native example of courtyard houses in the designated site reviewed that the original layout of the village and the orientation of the houses were deployed in a very sensible way in terms of solar energy utilization as a passive system (Fig. 3). It is a nice example of sustainable architecture where local material with low embodied energy and local construction technology and technique.

Instead of using all kinds of imported technology and material, it was intended to retain the local construction material,

Fig. 3 Heliodon test of native example of courtyard house in rural Beijing

Fig. 4 Heliodon test of the proposed courtyard house with renewable energies

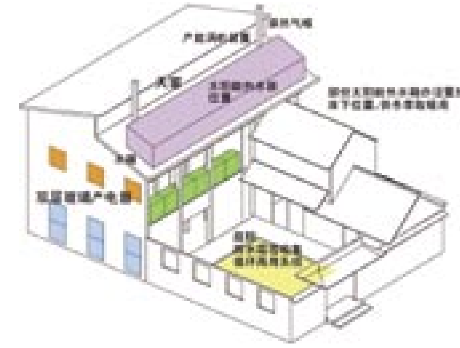

Fig. 5 The proposed solar courtyard house in Beijing with BIRETH approach

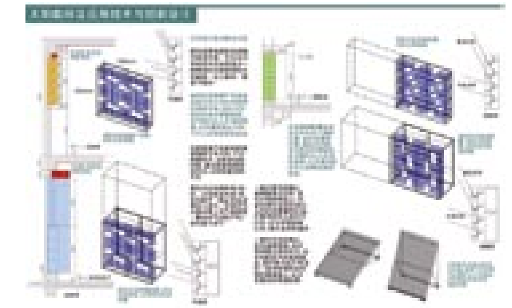

Fig. 6 The proposed solar hot box for the courtyard house

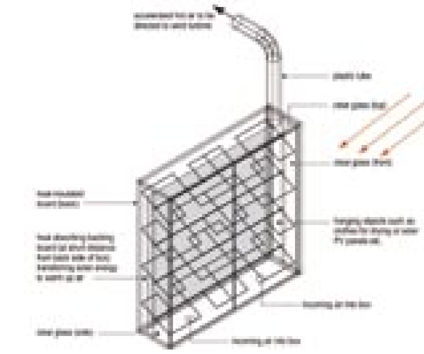

Fig. 7 The proposed solar hot box for harvesting solar energy with BIRETH approach

technology and technique as much as possible with respect to the idea of sustainability in the proposed new solar-responsive courtyard house (Fig. 4). With the introduction of the integrated active systems, the utilization of solar energy is enhanced in a large degree, it is regarded as a fusion of traditional wisdom (passive system) and the modern technology (active system). It also implies that it is interpreted as a gradual process of evolution of the traditional villages design into a new era of renewable energy incorporated autonomous houses that the ideal of zero-emission autonomous dwellings can be realized in China one the most densely populated & fast-growing country on earth.

The design flexibly and adaptably responds to collecting or rejecting solar energies in various seasons of the year, and in various hours of the day, in a dynamic manner (Fig. 5) . For instance, a glazed buffer zone is added to the front of the house in winter, but is taken away in summer. In addition, innovative thin solar energy collecting glazed boxes are proposed as addable modules on wall surface for transforming solar energy into heat storage in air or other objects, integrating architectural façade treatment with solar energy collection. Solar hot water installations are designed as basics, while solar electricity installations are optional depending on owners' economic ability due to the cost of solar devices.

Among the various solar energy systems, the popular ones such as solar hot water and photovoltaic were employed as the major means of energy collection in our design. Instead of being stand-alone generators, those systems were integrated with other features of passive energy uses and a few types of such integrated energy devices were formed.

One of such system installed on the roof is composed of a glass solar box in which solar hot water or photovoltaic is inscribed and protected against adverse weather (Fig. 6 & 7). The solar energy enters into the box is transformed into electricity or stored in the water tanks. Part of the rest of the energy that heats up the air inside the solar box can drive a small wind turbine at the end the glass chimney attached to the glass box while natural ventilation for the interior can be driven by air current. Another system which is wall-mount is composed of photovoltaic inside a glass box which also acts as a drying chamber for laundry as well as a solar-driven ventilation device.

An alternative is for solar energy collected to accelerate wind to impinge into the wind path towards the turbine thus helping move the turbine. A number of projects with used the stack effect for air movement by collecting solar energy using glazed components integrated fixed to buildings surfaces [5,6,7]. This Beijing house design, [1] are proposed with modules of solar hot air boxes to be fixed onto wall surfaces as money is available.

In addition to its basic function of solar energy collection for moving air for summer ventilation and for winter warming [8] or primarily for warming the interior [5,6] , this solar hot air box can also be used for solar drying clothes or vegetables or food, for growing green plants, for fitting micro wind turbines for power generation into its related air path.

Inspired by the macro scale prototype in Spain [9]and a related proposal in Australia [10], and reinforced in concept by a demonstration [11], this proposed micro solar hot air turbine is a subject to research and production.

3. Conclusions

While there are designs for wind generation in urban areas [12] , the proposed building integrated renewable energy total harvest approach- the BIRETH approach will benefit practically all houses in the world , or multiple storey buildings which will enable similar BIRETH features to be installed. The BIRETH approach should bring more than a zero energy home. [13]

Green energy experts are invited to work with building design professionals on integrating optimised utilization of renewable energies in buildings, primarily solar energy, say incorporating developed solar hot air techniques [14] and wind energy to fulfil building performance requirements such as making ventilation good, providing warm interiors, drying of clothes, THEN, also into collecting and storing solar and wind energies into water, and power batteries, etc., thus a building integrated renewable energy total harvest approach - the BIRETH approach.

The demand of green energy experts in building design is far more than the supply. Otherwise a lot more of buildings would have using green energies to a much large extent. And the development of the proposed micro solar hot air turbine is certainly a challenge. Moreover the ducted wind turbine [15] may also have a wide application.

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Towards Harmony – Hong Kong wetland park

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The Hong Kong Wetland Park is on a 61 hectare site on the north-eastern edge of Tin Shui Wai (TSW), New Territories, Hong Kong. The Park is envisaged as a prime example of harmony with nature, environmental practice and sustainable development; unique to Hong Kong; seeking to provide equally for the very varied and potentially conflicting functions of conservation, tourism, education and recreation. The site was originally perceived as purely a conservation and ecological mitigation initiative between the urban areas and the Inner Deep Bay RAMSAR site and Mai Po Marshes to the North-east which was required as one of the conditions of the Town Planning Board approval to the development of the TSW Reserve Zone as the major second development phase of the TSW. However, the Visitor and Tourism Study for Hong Kong, commissioned by the Hong Kong Tourism Board, recommended that new tourist attractions and facilities should be developed to sustain the long-term growth of the tourism industry. The idea for the Wetland Park arose from this vision, building upon the existing ecological mitigation plans to create a major tourism, educational and community facility based around the ecological themes of wetland conservation. Thus, the task to harmonize the man-made and the natural begins.

Building Harmony

The development is comprised of two phases. Phase 1 was completed at the end of year 2000 as a small scale exhibition gallery and garden serving as an environmental and sustainable demonstration for the things to come and further elaborated in the Phase 2 development. These include the handling of the building envelope and the adoption of screens and louvers to maximize energy efficiency; the use of natural materials including timber, stone and oyster shells; reliance on natural ventilation and lighting wherever possible; a trial geothermal heat pump air-conditioning; and the extensive use of native wetland plant species, not commonly available in the Hong Kong nursery trade. The Phase 1 building has been converted into a Ticket Office with the opening of the Phase 2 Visitor Center in May 2006. The Visitor Centre is purposely sited close to the entrance of the site and the urban area. Thereafter a series of display gardens, exhibition ponds and recreated habitats lead progressively to the Discovery Centre, and beyond via a series of fixed and floating boardwalks to Bird hides and more remote outer habitat areas, closer to the RAMSAR site. The Visitor Centre is purposely hidden within the landscape to maintain the overall environmental outlook of the development such that, when viewed from the urban area, the Visitor Centre would be seen as a green hill, without the building mass. The level of built form and intensity of usage diminishes as one move further into the site, away from the urban development and towards the RAMSAR site, and the recreated natural habitats gradually predominate.

Visitor Centre

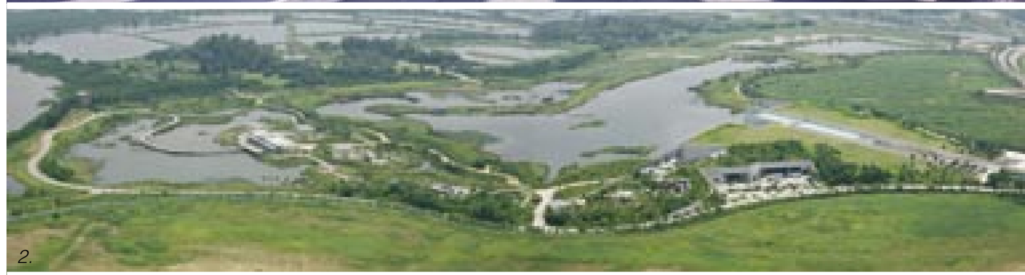
At the entrance plaza, the sound of water falling from a water feature opposite the Ticket Office rejuvenates and welcomes visitors coming by car, coach or on foot from TSW town. The original sustainable concepts at the Phase 1 Visitor was kept at the Ticket Office conversion. Leaving the Ticket office, visitors can enjoy the view of an accessible green hill and welcomed by a series of wetland habitats origami sculptures in aluminium. The green hill, hiding the Visitor Center below, as well as immediately announcing the environmental credentials of the scheme, is also instrumental in maximizing the energy efficiency of the building – the form of roof construction works with the careful orientation of the building to minimize solar gain. In addition, visitors may stroll up the gently sloping lawns of the roof to where a spectacular panorama of the surrounding wetland habitats will unfold before them. A water feature in a form of a square pond with the near 3m tall black-faced spoonbill aluminium origami sculpture begins the journey into the Visitor Centre building. The square pond feeds into a narrow stream course in the middle of the processional route. A glazed canopy and recycled Chinese brick wall on the west of the processional route link up the Ticket office and the Atrium of the Visitor Centre building mitigating the effects of solar gain on buildings.

Sustainability extends throughout the detailing of the building. Skylights are utilized to maximize natural lighting, particularly to the Atrium, through which a stream course flows connecting to the wetlands beyond, but also in some of the gallery areas and external toilets. Timber louvers are extensively employed to provide shading, particularly to the glass curtain wall façade overlooking the main lakes, where they also act as sound and visual barriers to minimize disturbance to the large numbers of water birds that are already beginning to colonize the wetland water bodies.

The Visitor Centre building requires to house extensive wetland related exhibition galleries over two storeys with a building gross floor area of approximately 10,000 square meters. Circulation ramps are adopted throughout the galleries to cater for disabled people and minimize the need for mechanical lifts.

The transition from internal gallery space to external demonstrations in the recreated wetland landscape is almost seamless, continuing the educational message of environmental concern and stewardship. As the visitor exits the building, they can visit a crocodile enclosure, purposely built for Pui-pui, a small crocodile found in the streams of Hong Kong in 2004 which caught the attention of the media and the general public. On leaving Pui-pui, a source of a rushing mountain stream, cascading over boulders down from the roof of the Visitor Centre will be found, in the first of a series of recreated habitat displays. The stream can be followed downhill through all stages of its natural life cycle until it slowly winds through the delta and empties into a freshwater pond close to the Discovery Centre.

1.



2.

3.

4.

1. Chinese brick wall extends into the Atrium of the Visitor Center
2. Bird's eye view of the Park
3. Series of aluminium origami sculptures welcomes visitors to the green lawn
4. Ticket Office behind the oyster shell gabion wall and soft landscape

SITE PLAN

Discovery Centre
The Discovery Centre functions as an outdoor classroom surrounded by interpretive zones where visitors can pond-dip to investigate the life forms commonly found in water bodies; learn how the Wetland Park is managed and the water levels manipulated by simple mechanical devices; and discover a wide range of wetland agricultural practices that have been an important way of life historically for the people of Hong Kong and China.
The building has been designed with a similar sustainable approach to the Ticket Office. In addition it relies entirely on natural ventilation by means of high ceiling and high level windows for dissipation of heat. Solar gain is also minimized by careful use of sustainable timber louvers. The flat roof has been designed to collect rain water for flushing purposes.

Bird Hides
There are three Bird Hides located at different areas of the site, each offering distinctive views to the nearby wetland areas. One overlooks the Deep Bay RAMSAR area; a second overlooks the neighboring fish ponds and another overlooking a vast tidal mud flat area.
These outlying bird hides are designed with skylights and double-skin sustainable timber louvers to maximize natural ventilation. User comfort is further enhanced by solar panel powered oscillating fans. Beyond the Discovery Centre, timber boardwalks lead out across the lakes into the 'outer zone' of increasingly natural landscape and lower key development, characterized by timber bird hides, boardwalks and nature trails.

Implemented environmental and sustainable concepts
Integrated with the natural setting of the park, the structures of the buildings are purposely designed with landscape roof, timber cladding and multiple layers of shades. The Visitor Centre has three major Galleries, Resource Centre, Office, Café, Shop, Play area and Toilets. In the external area, the Discovery Centre and three Bird Hides. All of which have their unique functions conveying wetland messages. There are also ten major green concepts embedded in the development as summarized in the following aspects.

1. Low Overall Thermal Transfer Value (OTTV)

Green Roof and orientation of the building allow the Visitor Centre envelope to achieve energy efficiency performance of approximately OTTV 16W/m^2.

2. Geothermal Heat Pump Air-conditioning System
With the sizeable land of the park, a geothermal heat pump air-conditioning system is designed for the Visitor Centre. It utilizes the mass earth of the park for heat exchange with the purpose to keep the park environment quiet and undisturbed. This system is energy efficient and environmental friendly.

3. Natural Lighting/ Ventilation and Building Services
Natural lighting by means of skylights at Atrium (north light) and external toilets. External artificial lighting is minimized to reduce power consumption. Natural ventilation is implemented by means of high level windows at the Discovery Centre, double layer of louvers and vented skylights at External Toilets for energy saving. There are other energy saving building services installations employed in this project such as a total of 220W photovoltaic panels for operating the oscillating fans in bird hides, T5 fluorescent tubes with electronic ballasts, occupancy sensors for control of office lightings, CO_2 sensors for control of fresh air supply, temperature sensors in galleries and atrium for switching to natural ventilation mode, wind sensors for control of toilet ventilation fans, photo cells control for lighting in Atrium, rain sensors for control of automatic irrigation system, VVVF drive for lift installation and variable speed drive condensing water pumps, etc.

5. Entrance Plaza extends to the lawn roofed Visitor Center

6. Discovery Center over the Lily pond

7. Sustainable timber louvers at external toilets

8. The floating boardwalk surrounded by mangrove


5.


6.


7.


8.

4. Ramp Access
Circulation ramps are built throughout G/F and 1/F galleries at the Visitor Centre to cater for disabled visitors and minimize the use of mechanical lifts.

5. Minimized Water Consumption
Low capacity, 6-liter water closets are used to reduce water consumption at all toilets. Discovery Centre has been designed to collect rainwater for flushing. Recycling of the lake water for a water feature saves water consumption. Automatic irrigation is provided to aid soft landscape establishment and maintenance but only used at night time to reduce evaporation and consumption.

6. Re-cycled Brick Wall and Fenders
Re-cycled Chinese brick from demolished traditional Chinese village houses has been used as a brick wall on the south aspect of the Visitor Centre & Ticket Office to mitigate the effects of solar gain to the building. Timber fenders collected from Victoria harbour ferry piers have been re-used in the freshwater marshes to serve as resting posts for wildlife.

7. Shading by Timber Screens
Sustainable timber from identified renewable sources is used throughout the whole project as vertical and horizontal louvers to provide shades for buildings and external landscape works.

8. Recycled Aggregates and PFA
A total of 15,300 tonnes of recycled aggregates has been used as sub-base, hardcore and fill materials in the development together with 5600 tonnes of recycled coarse aggregates in the structural concrete. The majority of the recycled aggregates are from a nearby recycling plant. The total amount of structural concrete used containing recycled aggregates or PFA as partial cement replacement amounts to about 75% of the total concrete volume.

9. Re-use of Existing Materials
Existing materials at the Phase 1 site, including aluminium wetland habitat sculptures, recycled granite paving from the Hong Kong Police Headquarter's wall, recycled Chinese bricks from demolition of old Chinese Village houses and re-used oyster shells from nearby Lau Fan Shan oyster farm would be reused in the Phase 2 works. The Phase 1 Visitor Center has been converted into a new Ticket Office. All existing trees and many other plants from the Phase 1 site have been retained or transplanted within the Phase 2 site.

10. Soft Landscape Species
Predominantly native plant species which require less maintenance and water consumption are used for landscaping work.

Conclusion
The Hong Kong Wetland Park will represent a showcase of sustainability and environmental consciousness in building harmony with nature, in terms of architectural, structural, building services and landscape design. It will satisfy its potentially conflicting objectives in order to provide a world class tourist attraction and also a major conservation, educational and recreational resource.

For any building to be truly sustainable, it relies not only on the design approach but also on the future use and management of the facility. With the education value provided by this wetland development, visitors can enjoy the park and begin to learn to be stewards, not just of this project but also of their overall environment. The Wetland Park will demonstrate the need for a sustainable lifestyle to cherish our given resources, thereby ensuring the true meaning of sustainable development can be passed on to all visitors.

9. Welcoming ducks over the recycled Chinese brickwall

10. Sustainable timber extends to the lawn roof

11. Bird hide over the quiet lake

12. Recycled granite extends to the lawn roof

Rebirth of a Building –
The New Headquarters for the Electrical and Mechanical Services Department (EMSD)

Architectural Services Department, HKSAR Government

Front Elevation from Vehicle Reception

Front Elevation

Introduction

"......most climate scientists warn us the prospect ahead is alarming unless we act soon......" (BBC News 10 Jan 2005)

The rapid developments of the World in recent years, in particular developing countries like China, have significant implications on our environment. Global warming, air pollution, flooding etc are now becoming problems which all responsible governments in the World have to deal with as a matter of urgency. For the development of the New Headquarters for the Electrical and Mechanical Services Department (EMSD HQ), the Hong Kong SAR Government decided to convert an existing building into the new HQ, rather than constructing a new building. Converting the building would compare favorably to the cost of a new development, and would also minimize demolition and construction waste. By implementing this proposal, the HACTL2 building was 'reborn' as a sustainable building to provide more effective future use, and thereby setting a good example for the continuing development of sustainability in Hong Kong.

Background

The development of the new EMSD HQ was approved by the Hong Kong Government in August 1994. The land in Caroline Hill occupied by the then EMSD HQ was considered not fully utilised and should be redeveloped. Initially, a site in Chai Wan was identified for the new EMSD HQ. In 1999, the Hong Kong SAR Government considered that the development would involve substantial capital outlay and identified the former HACTL 2 building as an alternative option for the new HQ. This alternative option was found to be feasible, and would also demonstrate the government's continuing development of sustainability in Hong Kong.

Sustainable Development- The 3'R's (Reuse, Reduce & Renew)

"......Conversion of an outdated building into new uses saves huge amount of energy and building materials......"

Since the relocation of the Hong Kong Kai Tak Airport in 1997, the former HACTL 2 building has lost its previous function. The HACTL 2 building, built in reinforced concrete, was used for air cargo handling for the former Kai Tak Airport. The Gross Floor Area of the building was around 70,000 m^2, near to the 76,000m^2 required by the new EMSD HQ. The floor-to-floor heights and the structural capacity etc all satisfy the technical requirement of the new EMSD HQ **(Fig. 1)**

However, converting this 'city remain' was no easy matter. Odd spaces, bulky structures and circulation designed for cargo handling were characteristics of the former building and required to be modified for the new uses. The Architectural Services Department of the Hong Kong SAR Government was faced with the challenging task in converting this building not only to satisfy the functional requirements of EMSD, but at the same time creating a new building which has its distinctive spatial and architectural character **(Fig. 2)**

Parts of the external walls originally used for the loading and unloading conveyance system were demolished to make way for the new entrance lobby. An additional floor (7/F) and a new metal roof were added in order to satisfy the overall floor area as required by EMSD(Fig. 4). By recycling the concrete structures, huge amount of energy and building materials in the construction process were saved, and production of huge quantity of demolition and construction waste were avoided. As calculated, the volume of demolition waste that would have been generated by demolishing the HACTL 2 building was approximately 93,400 m^3, almost equating to the volume of a 4-storey high football pitch. The volume of waste generated by the construction of a new building would equate to another 1-storey high football pitch. By converting the HACTL 2 building, the cost saving was estimated to be around HK$ 600-700 million.

Fig. 1 Old building

Fig.2 New building

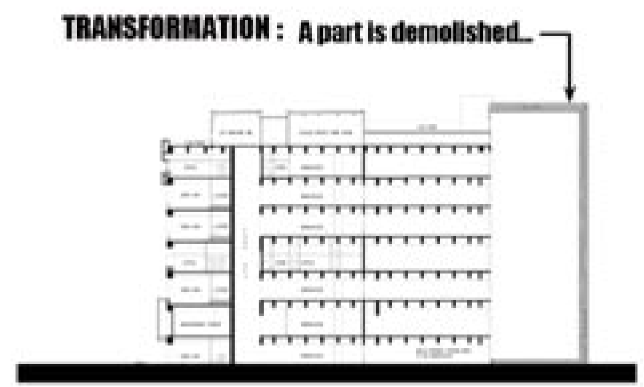


Fig. 3 A part is demolished

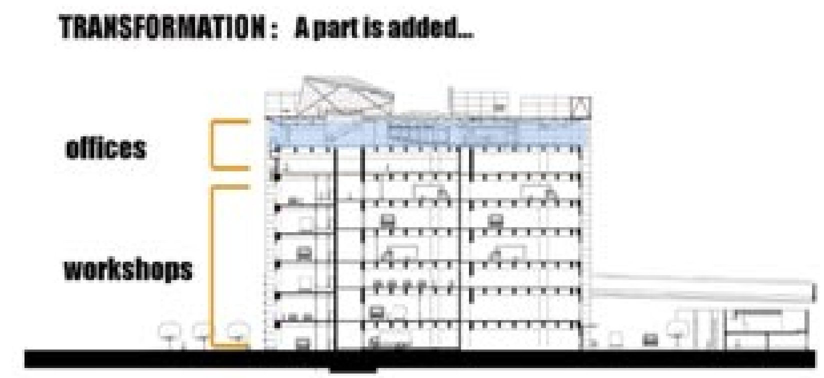


Fig. 4 A part is added

The Rebirth- Planning of the new EMSD HQ

The new building is 8-storey high, the top floor being the newly added structure (Fig. 5). The external walls which were not suitable for conversion were demolished (Fig. 3). Vehicle workshops are located at G/F to 5/F and office accommodation on 6/F & 7/F. The existing vehicular ramps at the two ends of the building are reused for vehicular access to the vehicle workshops. A new Entrance Hall and Exhibition Gallery are located on the G/F, with a well equipped Computer Data Centre on the 1/F. A new glazed Viewing Gallery, as a 'climax' to the Education Path, was built on the new roof for the viewing of the large-scale photovoltaic system.

The existing external walls of the main elevations were converted into 'Environmental Facades', with ventilated double-layered glass walls for the office floors (6/F & 7/F), metal sun shades and perforated panels for the workshop floors (G/F to 5/F). Natural ventilation and lighting to the vehicle workshops have been improved after the demolition of part of the external walls, and by creating new openings on existing blank concrete walls.

The new Entrance Hall on G/F is glazed with full storey-height glass (Fig. 6), echoing the glass walls of the offices above. The new building is designed not only to satisfy the functional requirements, but also as a good working environment for the staff. Bright colours and supergraphics are used in the interior spaces to enliven the overall environment, and provide orientation to the staff and visitors (Fig. 7).

Sustainable Architecture

Many sustainable and interesting features have been incorporated in the building design, becoming part of the architecture:

1) Photovoltaic (PV) Panels generating electricity to supplement the power input for the air conditioning system as well as the building. The building is installed with more than 2300 PV panels, currently the largest installation in Hong Kong. The total peak energy production is 350 kW. This is sufficient to drive 1 set of chiller during the peak and optimum conditions, and supplies approximately 20% of the power input for the air conditioning system. The PV installation is grid connected with China Light & Power Co., ensuring a reliable electricity

Fig. 6 Entrance Hall

Fig. 7 Vehicle Workshops

Fig. 8 Photovoltaic Panels

Fig. 9 Array of Photovoltaic Panels on the new metal roof

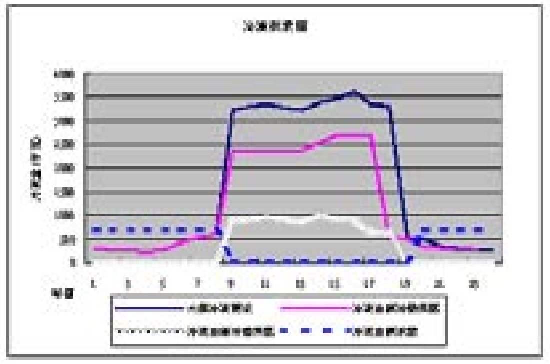


Fig. 10 Energy Consumption

Fig. 12 Metal sun shades

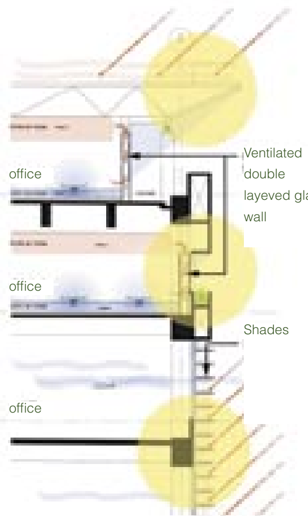


Fig. 11 Ventilated glass walls, deep canopies & sun shades

generation and supply to the building. The panels are installed facing true south at an angle of 22.5 degree to the horizontal to maximize the solar gain, enable self-cleaning of the panels and to enhance the fifth elevation of the building i.e. the roof elevation (Fig. 8 & 9).

The carbon dioxide reduced per year by using the PV system to generate electricity instead of conventional fossil fuel is estimated to be around 280 tonnes, approximately equivalent to the amount of carbon dioxide generated by a car going round the Earth 3 times.

2) Ice Maker & Tanks to produce and store up thermal energy at off-peak hours and minimise the electricity demand during peak periods. Electricity demand for air-conditioning contributes over 50% of total electricity demand in ordinary office building. Peak electrical demand dictates the scale of the transformer and the power generation plant. Ice, a good thermal storage medium, is produced during the off-peak period of energy demand and stored in the ice tanks. The ice is then used during its melting process via a heat exchanger with chilled water of the air conditioning system to offset the air conditioning and electricity demand during peak periods (Fig. 10).

The ice is made in the ice maker in the External A/C Plantroom and is stored in the 5 no. stainless steel ice tanks near the site entrance.

Comparison of Ammonia & other refrigerants

	Ammonia	'Green' Refriger-ants	Reference Refrigerants
Ozone Depletion Potential	0	0	1(Refrigerant R11)
Global Warming Potential	Negligible Quantity	1250	1(CO2)
Coefficient of Performance	5.4	4.8	4.8

Fig. 5

The graphic on the ice tanks helps to promote this sustainable feature to the public and visitors to the building.

3) Ammonia Chillers with zero ozone depletion potential and zero global warming potential, and therefore minimize global warming effect. The following table demonstrates the advantages of ammonia compared with other refrigerants (Fig. 5):

4) Ventilated Double-Layered Glass Walls & Deep Roof Canopies to control solar gain. The air space between the double-layered glass walls for the offices acts as return air duct which has the following functions (Fig. 11):

(i) as Heat Insulator- Radiant heat at the surface of the window will normally be transmitted to the inner space and perimeter zone of the office area. To enhance the thermal comfort of the occupant, the air gap between the double glazing is utilized as return air paths which effectively lower the surface temperature of glazing as well as minimize the radiant h eat transmission, and therefore minimize energy used for air-conditioning;

(ii) as Noise Insulator - This helps to reduce the noise penetration from the nearby busy Kwun Tong Bypass Highway.

5) Metal Sun Shades and Perforated Panels to control solar gain and therefore reduce cooling load. The profile of the sun shades was purposely designed as part of the architecture of the building and is considered more appropriate than proprietary system (Fig. 12)

6) Green Roofs as landscaped gardens, provide both thermal and acoustics insulation, and form pleasing environment and social hubs accessible to both EMSD's staff and visitors (Fig. 14 & 15).

7) Sunpipes and Skylights - Natural light minimizes the artificial lighting demand in a deep plan building like this one and provides a pleasing environment to the building occupants. Building occupants can also sense the changing time and weather of the day. Skylights and sunpipes made up of series of reflective tubes are located in parts of the building to serve this function (Fig. 16).

8) Motion & Daylight Sensors to control artificial lightings for energy management. Artificial lightings will be automatically switched off when motion is not detected for a given period of time or when natural lighting is sufficient (Fig. 17).

9) Social Hubs - Odd spaces in the original building have been converted to form informal 'social hubs' for staff interaction and relaxation. The building is designed not only to satisfy the functional needs, but also respond to the human needs (Fig. 18).

10) Grey Water Recycling - Grey Water from washbasins, showers and canteen kitchen are treated via microfilters, disinfected and reused as flushing water for the building. Approximately 9,500 m^3 of water can be saved per year.

11) Waste Management for recyclable papers, kitchen waste and waste oil. Recyclable papers are transferred from various floors via the recyclable refuse chutes down to G/F refuse room. The collected paper will be compacted by a baler system for easy collection by the contractor for recycling purpose. Pulping system is used to treat wet food remains from the canteen kitchen. Waste oil generated from the workshops will be collected and transferred into a 10,000 litres underground waste oil tank for central disposal by a specialised waste oil contractor.

Fig. 14 Green Roof

Fig. 15 View from Office to Green Roof

Fig. 16 Sunpipes along 7/F Corridor

Fig. 17 Motion Sensor

Fig. 18 Social Hubs

Fig. 20 Schemattic diagram of Education Path

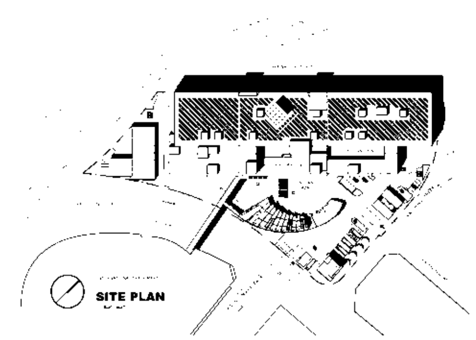
Fig. 21 Ground floor Exhibition Hall

Fig. 19 Environmental facade with cleaning gantry

12) Infra-red Systems and Electric Heater Units for Paint Booths -This is the first installation in Hong Kong for this kind of large-scale and fully automatic infra-red systems in paint booths. The system can shorten the drying time, enhance the flexibility on drying particular areas of a car body and effectively save the total energy consumption in comparing with traditional hot air type paint booths. By using electric type heater units, emission of flue gas from traditional diesel/ towngas burners can be totally eliminated and thus no air pollution is produced during the drying process.

13) Local Building Materials - Most of the building materials are manufactured or fabricated locally in the Pearl Delta and delivered to the site. Unnecessary deliveries from distant manufacturing plants are avoided, which would reduce energy for and emissions from delivery vehicles.

14) Window Cleaning Gantry - Using a conventional window cleaning gondola will unnecessarily add to the loading on the new metal roof to the building. Vertical cleaning gantries are designed for the cleaning and maintenance of the curtain walls and form part of the architecture of the building.
(Fig.19)



Education Path

An Education Path is incorporated into the building which includes the Exhibition Areas at G/F & 7/F, and the Viewing Gallery on the roof. The purpose is to introduce the public to Sustainable Design through interactive exhibits, and to showcase the innovative and advanced technology integrated into the building, and their wider and future applications in other buildings. (Fig.20 & 21)

Conclusion

"......the completion of the new headquarters for EMSD will hopefully point the way for future development for sustainable design for Hong Kong......"
- Mr. Yue Chi-hang, JP, Director of the Architectural Services Department, at the prize-giving ceremony for the 2004 Annual Awards of the Hong Kong Institute of Architects

Despite various difficulties encountered during the conversion of an outdated building into new uses, the building was completed in November 2004. The completion of the new EMSD Headquarters demonstrated the technical viability and the financial advantage of such conversion. This is in line with The Hong Kong SAR Government's continuing policy on sustainability. The success of the project will hopefully point the way for sustainable design for future developments, both private and public, in Hong Kong. In doing this, we can all make significant contribution to the improvement of our environment, before it is too late.

Awards

The project received the following awards:
* Merit Award of the Hong Kong Institute of Architects 2004
* Open Award for Technical Excellence in Architectural Technology 2005 by the Chartered Institute of Architectural Technologists UK
* Certificate of Merit for the Quality Building Award 2006 (Sustainable Building Category-Revitalization Sub-category)
* Grand Award for the Green Building Award 2006 (Newly Renovated Building Category) by the Professional Green Building Council

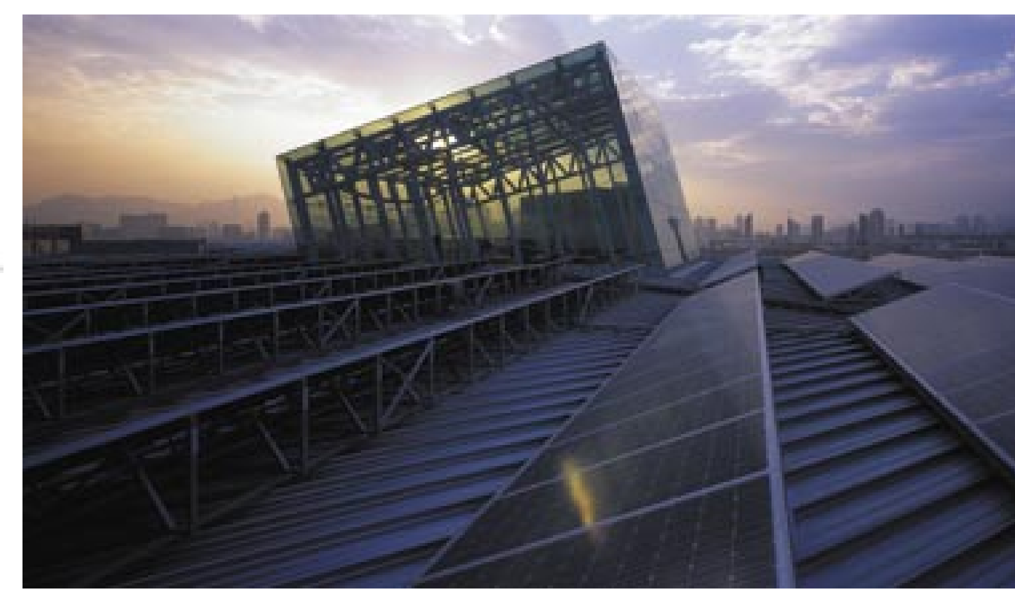


Fig. 22 Viewing Gallery & Photovoltaic Panels

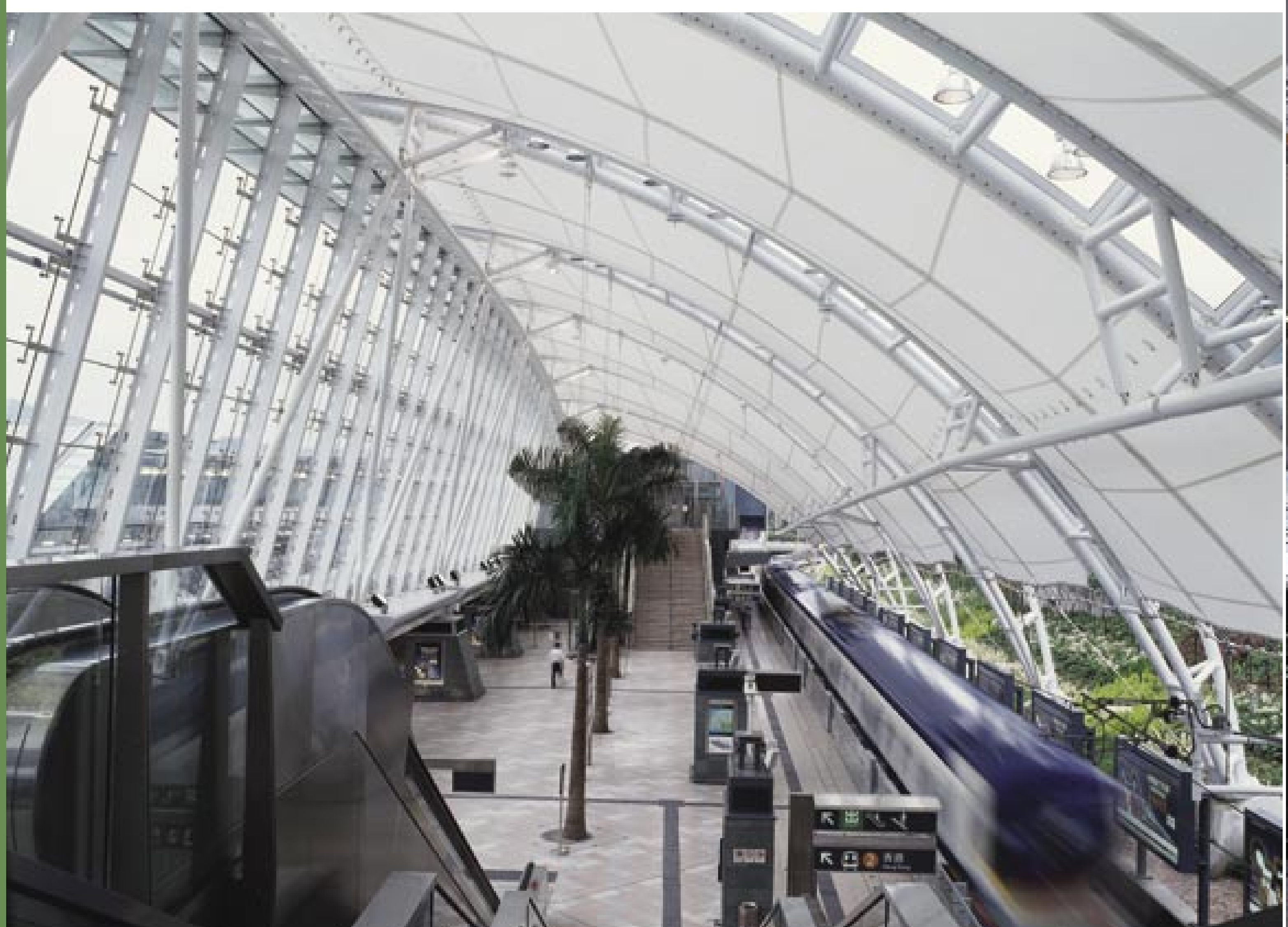
MTR SUNNY STATION

AEDAS LTD

HKIA Merit Award
Green Building Award Grand Prize

Uniquely situated as an interchange Station with the existing MTR Tung Chung Line, MTR Sunny Bay Station also has a pivotal role as a gateway, and the starting point of a unique railway journey to Hong Kong Disneyland Theme Park. The initial project brief from MTRC conceived the station as an 'open-air' project, but also having the ability of being sealed off and air-conditioned, if needed at a later date. Rigorous investigations into air-flow and passenger movement during the feasibility study set the stage for the distinctive form which while also capitalizing on the effects of natural air circulation, had to address issues of passenger protection from both typhoon rain and winds.

Sunny Bay station differentiates itself from previous transport projects, by not just having to handle large passenger flows, but by also having to provide a sense of drama and expectation for the Disneyland visitors. The design team looked back to the sense of adventure present in grand halls of the rail



stations of the 19th century, to re-create a renaissance in rail travel through the use of modern design, forms and materials.

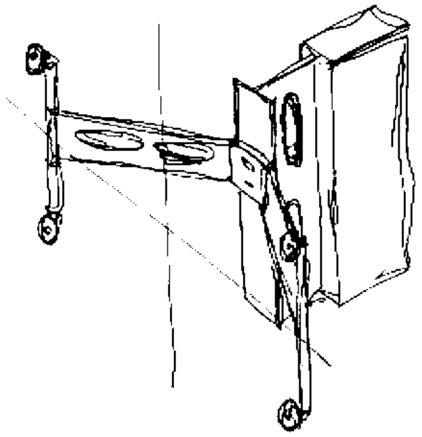
Sunny Bay Station evolved a striking identity composed of a gently curving Teflon coated (PolyTetraFlouroEthylene) fabric roof on a lightweight steel bow string truss roof structure manufactured from round hollow section steels. The fabric was chosen for its self spanning and self cleaning properties as well as its ability to transmit a gentle diffused natural light. Directly underneath the fabric roof, a clear and direct cross platform interchange has been designed to transit arriving passengers from Hong Kong onto the Disneyland train. As the fabric roof negates the need for a suspended ceiling below, all lighting and necessary services have been carefully and thoroughly considered to compliment the design.

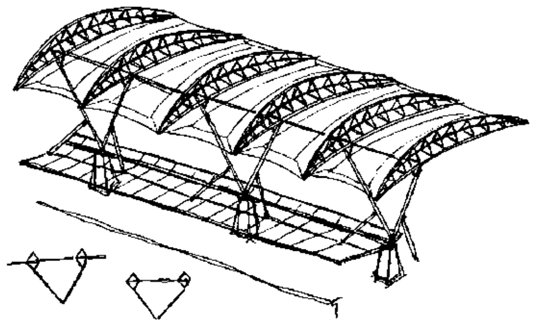
Deceptively simple, the organization of the plan is very clean and efficient. The large Interchange Hall has two electrical, mechanical and back of house facility buildings, clad in stone, at either end forming 'bookends' to the Grand hall. Escalators at the ends of the Hall lead passengers returning from Disneyland Station over the rail tracks to the platform for trains back to Hong Kong. The design of the opposite platform takes the metal low blade canopies as its reference and provides a harmonious counterpoint to the Grand interchange hall.

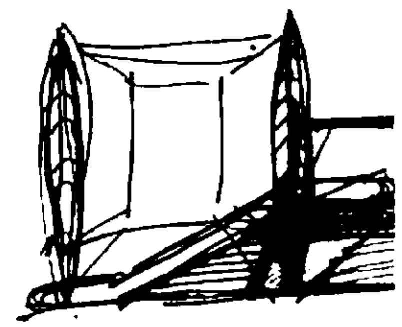
The impact of the large curved fabric roof, supported from sculptured arched bow string trusses, is complemented by the dynamic curve of the partially louvred, inclined glazed 'windscreen'. An overall feeling of lightness and spaciousness floods the Interchange Hall. It is clearly an outdoor space that benefits from the effects of the roof form and the natural breezes.

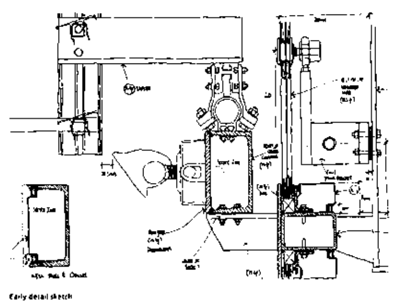
A clean language of machined materials has been used throughout the station. The Electrical, mechanical and back of house 'bookends', and the stone clad air-intakes on which the roof support steels sit, provide a solid anchor and complement the lightness and delicacy of both the fabric roof and the curved windscreen.

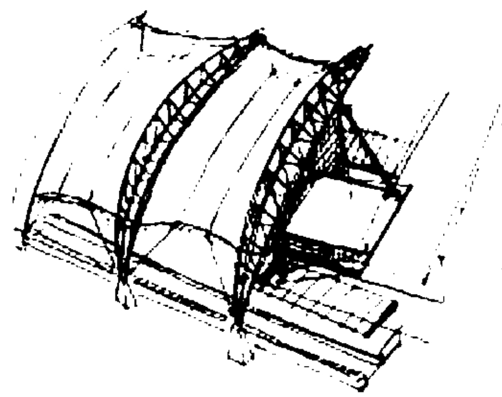
In the evening, architectural lighting further enhances the unique experience of traveling to the theme park by rail, illuminating the fabric roof from within and with the steel and glass, turning the station into a crystalline beacon for all those who use and see the station.

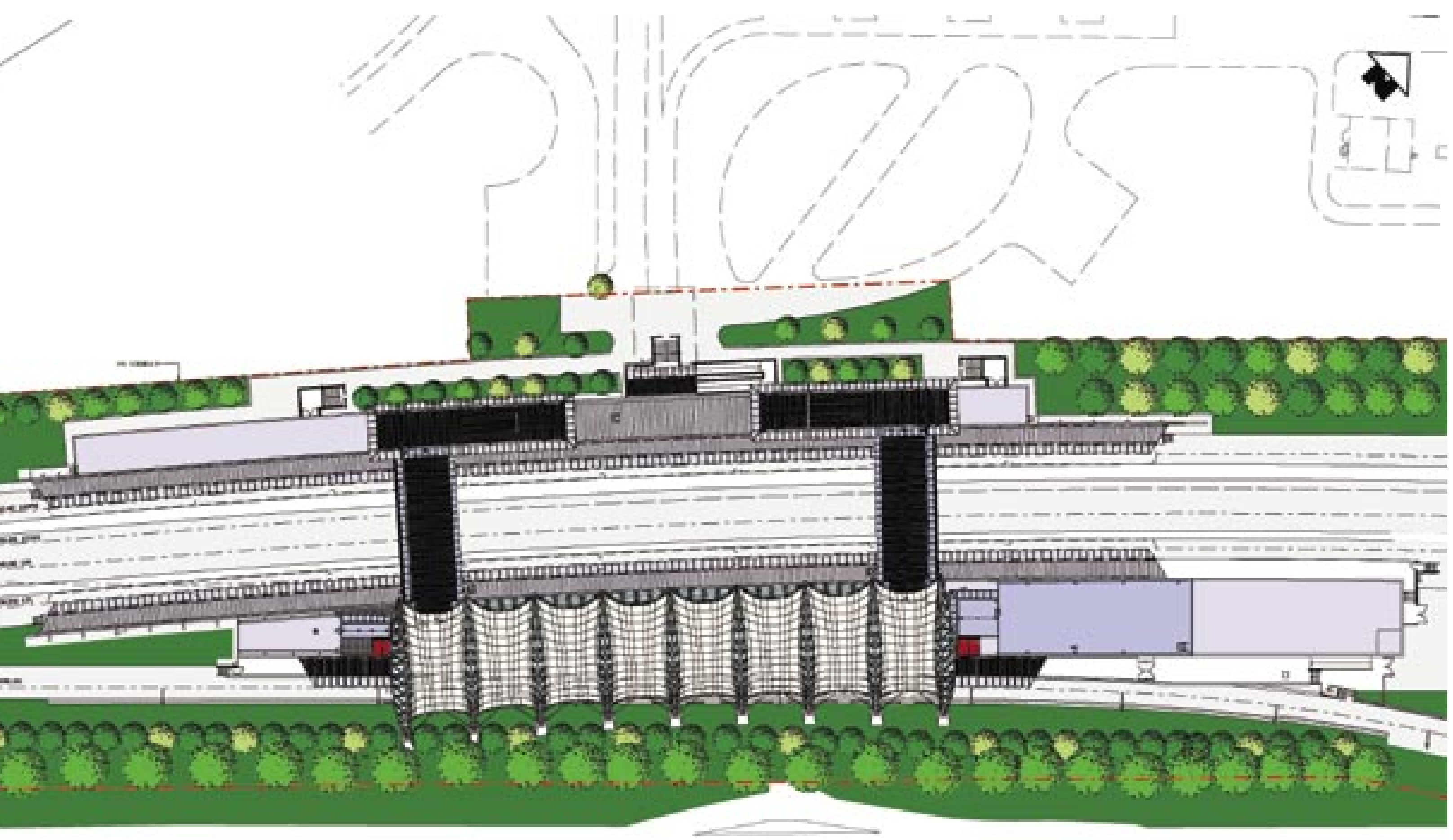










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