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# PREFAB architecture

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## Buildable systems to achieve higher labour efficiency

More and more developers and designers are now favouring prefabrication over conventional cast in-situ construction to achieve better aesthetics and faster construction. Contractors are also making a concerted effort to use buildable system such as precast components to benefit from higher labour efficiency. This issue of PREFAB Architecture features two such examples, a high-rise residential development, Casablanca Condominium and a landed residential development, The Chancery Residence.

Casablanca Condominium was originally designed and tendered as a conventional cast in-situ construction project. The contractor then decided to redesign the project to adopt a more buildable approach by using high

levels of prefabrication. This article reveals several advantages in using of prefabrication to create a Mediterranean haven and overturns several misconceptions on the limitations of using precast components.

The Chancery Residence presents an opportunity as well as a challenge to the architect and the contractor to create a coveted and cherished residential landmark on a sloping profile. A clustered housing development comprising 34 units of unique cluster houses, the designer demonstrates the benefits of using combination of prefabrication and cast-in-situ concrete to achieve the desired result.

The last article illustrates how the designer employs the concept of sky

gardens and the use of unitised curtain wall system in One George Street to redefine the Central Business District's skyline with a refreshing look. One George Street is also one of the first commercial developments to introduce the concept of sky gardens at various floors. Bounded by the congested site and limited road access, the designer overcomes the constraints by harnessing the benefits of using prefabrication and cast in-situ concrete in tandem. One of the solutions includes the unitised curtain wall system comprising full height glazing integrated with sun screen louvers prefabricated and assembled overseas.

By William Lim

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# Living the *Mediterranean dream*

By Lawrence Foong  
DP Architects Pte Ltd

Drop-off porch at Towers with precast elements on wall

## Project Team

Client	Far East Organization
Architect	DP Architects Pte Ltd
Structural Engineer	KTP Consultants Pte Ltd
M&E Engineer:	Mega Trends Consulting Engineers
Main Contractor	Chiu Teng Enterprises Pte Ltd
Quantity surveyor	KPK Quantity Surveyors
Landscape Designer	OTLA Design Partnership

# Casablanca Condo



**Casablanca Condominium - A Mediterranean lifestyle**



**Two-storey high precast arches at multi-storey carpark facade**

The white-washed facade of the Casablanca Condominium provides a perfect backdrop for its Mediterranean theme. This new development located at Rosewood Drive in Woodlands comprises three blocks of 16-storey and another three blocks of 17-storey apartments with a selection of 478 units, ranging from 2- to 4-room units, and all set in an ideal North-South orientation. The resort-style facilities include one of the longest swimming pools in Singapore complemented by colourful water features, a lavish landscaped surrounding, children's play area, BBQ pavilions, clubhouse, tennis courts and multi-purpose court.

## Redesign

This project was not originally designed to use prefabrication because of the common misconception that adopting precast design may be restrictive as compared to conventional cast-in-situ design. Considering that massive Mediterranean architectural forms would be designed for Casablanca, it was decided in the early stages that the conventional cast-in-situ method was more appropriate than the use of prefabrication.

However, upon the award of contract, the contractor Chiu Teng Enterprise Pte Ltd decided to redesign the structural system adopting a more buildable approach using prefabrication for the construction of almost the whole structural system.

Even though the Casablanca project was not subjected to buildability legislation, the whole redesign process leveraged on the high buildability achieved by the wide use of structural

and the architectural precast elements.

The horizontal precast elements included different sizes of panels of concrete slab. Concrete pour strips of 300 mm width were used to lock the precast slabs in place. The vertical precast elements consisted of the parapet walls, the load-bearing and non-load-bearing internal walls, the external façade walls which were integrated with precast planter ledges, the two-storey high precast arches at the multi-storey carpark facade and the precast boundary walls at the secondary entrance to the condominium.

Other buildable design features such as the perforated and non-perforated staircases, the air-conditioning ledges, other reinforced concrete ledges and the precast refuse chutes were also included in the building system. In addition, the apartment blocks were founded on precast piles instead of conventional bored piles.



**Precast boundary walls at secondary entrance**



**Erection of facade wall with integrated air-con ledge**



**Installation of precast refuse chute**



**Prefabricated staircase structure**

## Pleasant Surprises

The outcome of extensive prefabrication work adopted after the redesign process satisfied the original design intent of creating a Mediterranean resort while at the same time simplifying the construction details. Several other distinct advantages are:

1. Prefabrication did away with the need for external scaffoldings. Gondolas were used to carry out external works on the façade finishes. This resulted in a clean and neat working environment and also enabled better visual quality check and control during the installation of the precast components. With better quality control, there was a marked increase in site productivity as minimal or no touch up work was required;

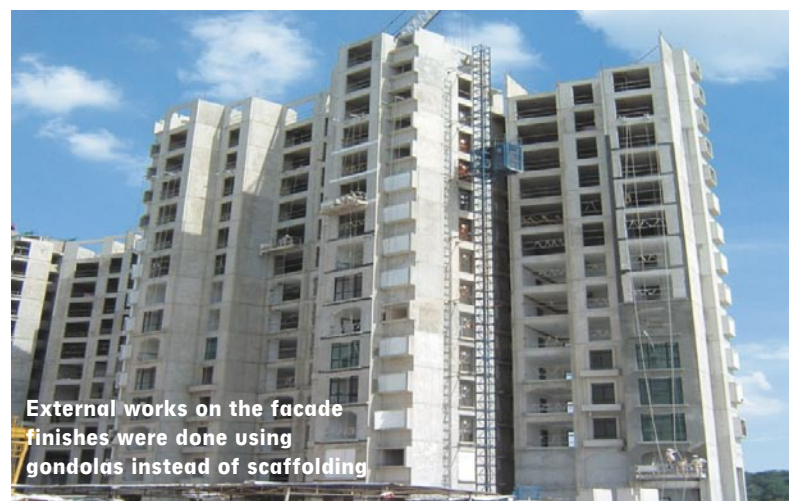
2. Prefabrication reduced the amount of on-site construction activities considerably and minimised disturbances and inconveniences to neighbouring residents. In addition, removal of waste materials from the construction site as a result of in-situ operations was reduced considerably;

3. The use of solid precast concrete walls had effectively reduced, if not, eliminated the possibility of any efflorescence, which were common in plastered brick walls. Consequently, the lifespan of the paint was also extended;

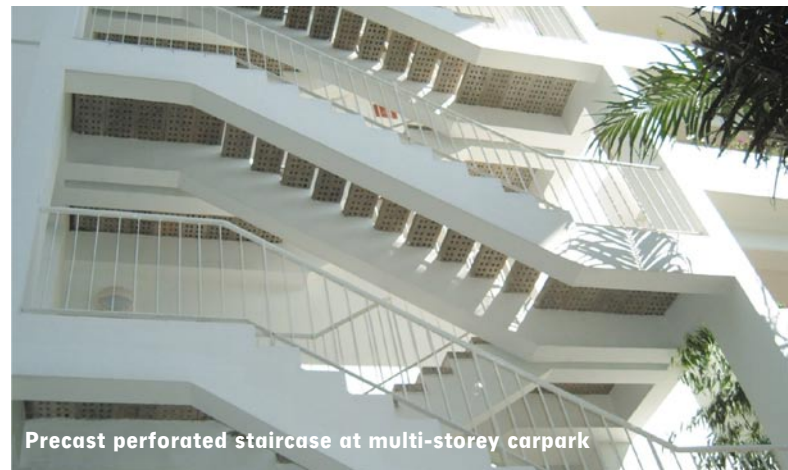
4. Precast option offered unparalleled straightness of the walls. As the precast walls did not require thick cement plaster as the brick walls did, good and consistent quality of the finishes were achieved;

5. Choosing precast load-bearing walls in place of cast in-situ columns and beams increased the interior floor space and provided more flexibility for laying out;

6. Besides reducing the construction time, prefabrication minimised the effects of weather on the construction progress. Much of the labour-intensive work such as the setting up of formwork, the fixing of the rebars and the casting of critical components were done off-site under shelter. The workers involved in the installation of the precast components experienced less fatigue as a result. This helped to improve their productivity on site.



**External works on the facade finishes were done using gondolas instead of scaffolding**



**Precast perforated staircase at multi-storey carpark**



**Private enclosed space with preformed metal decorative balusters**

# Casablanca Condo



**Landscaped garden, swimming pools, water features and BBQ pits**

## The Method

Switching to prefabrication still allowed the contractor to satisfy the original design criteria and meet the time frame for completion despite the fact that the redesign was only made after award of tender.

Realising that additional time might be required for the redesign process to be switched to prefabrication, the first-storey structure was carried out using cast in-situ construction. Simultaneously, the precast drawings for the construction of the subsequent floors were being prepared and approved. This minimised the impact of the redesign and its disruption on the construction progress.

Furthermore, many architectural elements that were time-consuming to construct were in fact expedited by the adoption of prefabrication. These included the repetitive arches, planter ledges and balconies designed to cater to the Mediterranean theme of the project. The arches, planter ledges and balconies

were as a matter of fact ideal for prefabrication. This way, the project team reduced the construction time and achieved consistency in looks and the quality of construction and finishes including excellent watertightness of the architectural elements.

Copings and corbels, which are common building features in Mediterranean architecture, could also be easily prefabricated by integrating them with the façade and parapet walls. Even the large curvilinear boundary walls did not pose much difficulty during the prefabrication and installation stages.

## Conclusion

Contrary to commonly misunderstood belief, prefabrication did not necessarily restrict the architectural expression as this project clearly illustrates. Instead, it complemented the articulation of the Mediterranean architectural styles with high quality finishes, achieving ultimate customer satisfaction.

## *Cherished* residential landmark

By Tang Sau Kit  
Liu & Wo Architects Pte Ltd

Courtyard enclosed by  
full height glass panels

### Project Team

Client	WAREES Land Pte Ltd
Project Manager	WAREES Investments Pte Ltd
Architect	Liu & Wo Architects Pte Ltd
C&S Engineer	Azfa-ATC JV
M&E Engineer	Squire Mech Pte Ltd
Quantity Surveyor	Barton Associates Pte Ltd
Interior Designer	Cu Fua Associates
Landscape Designer	DLQ Design Pte Ltd
Main Contractor	Kim Seng Heng Engineering Construction (Pte) Ltd
Precaster	Excel Precast Pte Ltd

# The Chancery Residence



Extensive use of glass panels in dining & living areas

The Chancery Residence – a recently completed housing development nestled in the heart of an exclusive enclave of the Chancery area, comprises 34 units of unique cluster houses. Located on a sloping site just below the Chancery Hill, the development offers a panoramic view of the city skyline in the midst of a quiet neighbourhood. Added to its splendour are the sparkling swimming pool, luxurious spa pool, fun children's pool, reflective pond and beautifully landscaped gardens. The Chancery Residence is one of the last few major developments in this exclusive neighbourhood.



Side elevation of a corner unit

Featuring a site area of approximately 6,600 sq m, the sloping site profile of approximately 11 m (from the highest point to the lowest point of the site) presents an opportunity for the architect to create a coveted and cherished residential landmark. The development comprises 33 units of 2-storey terrace houses and an exclusive single unit of a 2-storey strata bungalow, crowned with the attic cum roof terrace and a private carpark at the basement.

## Design Concept

The design concept for the units revolves around the use of the courtyard/

airwell to spill natural light and provide ventilation to the interior of the units. The party wall offers a perfect backdrop for the courtyard/ airwell to be enclosed by full height glass partitions at the other three sides. There are generally only two types of unit layout in the development, one with an internal courtyard at the basement level and the other with the courtyard located at the 1st storey level. This is to maximise standardisation and repetition for structural and architectural components and hence, enhance the buildability for the development while allowing some differentiation and choice for the consumers. Both types of layout are generally rectilinear in nature, with the public realm spaces such as the living and dining rooms located at the 1st storey, and the private bedrooms located at the basement, 2nd storey and attic level.



Precast planks at 2nd storey

# The Chancery Residence



**Full height glass panels allowing views out of the bathroom**

The full height glass panel windows at the courtyards, the living and dining areas and the hallways, in addition to allowing uninterrupted views to the lush landscaped area and distant city skylines, create a well-lit interior. Coupled with the prefabricated steel staircases with teak tread finish and open risers from the 1st storey to the attic, the whole environment emits a sense of 'lightness' and spaciousness albeit within the standard unit width of 6 m generally found in terrace units.

Precast panels are also widely utilised in this development to form the building facades. Used in a layered manner, it helps to articulate the front, rear and side facades with its clean and strong linear edges. However, the hilly terrain and staggering site layout of the units pose challenges to the main contractor especially in the launch and erection of the larger panels. Exercising meticulous site planning and control was very important despite the fact that the usage of precast panels actually helps to alleviate excessive site congestion.

## Floor Slabs and Walls

Although the original structural design allowed for cast in-situ floor slab, the main contractor prefers to use precast planks for the 2nd storey floor slabs. This speeds up the project and at the



**Launch of precast panels in progress**



**Prefabricated steel staircases with teak tread finish**

same time reduces and minimises the noise disturbances that would be generated from the stripping of the metal formworks that were used at the casting site to achieve better and smoother concrete surfaces.

The internal walls of all the units were constructed using standard size lightweight concrete panels finished with skim coat only to reduce the dependency on on-site manpower. These lightweight concrete walls with hollow core also make it possible to conceal the various M&E pipes and trunkings within the wall. It eliminates the risk of the workers 'over-hacking' the walls during the process of creating voids to house the M&E services. Unnecessary manpower loss due to rework and material wastage are also avoided.

The use of brickwalls as the external walls are minimised through the extensive adoption of the precast panels and large floor-to-ceiling glass window panels. These brighten up each room and induce a sense of life and comfort to the occupants.



# The Chancery Residence

## Conclusion

The combined use of the precast and cast-in-situ construction incorporating several buildable design features has successfully enhanced the buildability of The Chancery Residence development, while minimising the disturbance to the quiescence of this exclusive neighbourhood.



Front elevation of precast panels, large windows and timber trellis

## Series of precast panels on the facade



# Office tower *flaunts* its sky gardens

By Vincent Koo Tin Chew & Khoo Poh Bin  
DCA Architects Pte Ltd

## Project Team

Client	George Street Pte Ltd
Architect	DCA Architects Pte Ltd
Collaborating Consultant	Skidmore Owings & Merrill LLP (NY)
Structural Engineer	TY Lin International Pte Ltd
M&E Engineer	Squire Mech Pte Ltd
Main Contractor	Kajima Overseas Asia Pte Ltd
Quantity Surveyor	Davis Langdon & Seah Singapore Pte Ltd
Landscape Architect	Sitetectonix Pte Ltd
Lighting Consultant	Lighting Planners Associates Inc.
Façade Consultant	Arup Façade
Curtain Wall Consultant	Permasteelisa Pacific Holdings Ltd

Illuminating the city nightscape

# One George Street

**O**ne George Street is one of the first commercial developments in Singapore to introduce the concept of sky gardens at various floors. The 23-storey Class A office building development is located at the prominent gateway in the Central Business District. Situated close to major transport networks such as Raffles Place and Clarke Quay MRT stations, it offers easy accessibility to a selection of shopping and dining facilities within walking distance.

## Restricted Working Space

Being located within the busy business district meant the project team had to contend with several challenges. The restricted working space is just adequate for loading and unloading works and is not enough for prefabrication and assembly works to be carried out. Site access is possible only through George Street as other roads such as South Bridge Road, Pickering Street and North Canal Road are often inaccessible with heavy vehicular flow. Several precautions need to be taken to avoid causing unnecessary inconveniences or disturbances to neighbouring residents.

A typical office floor in One George Street consists of an area approximately 2,800 sq m and is designed to be virtually column-free. By off-setting the building core, clear spans of 13.5 m and 18 m are created for the typical office floor, providing the flexibility in sub-division of tenanted areas to accommodate changing market demands. The use of post-tensioned reinforced



**Extension of sun shade louvers offer screening to roof top**

concrete superstructure and 4.5 m floor-to-floor height enable an expansive interior with a 3 m clear ceiling height.

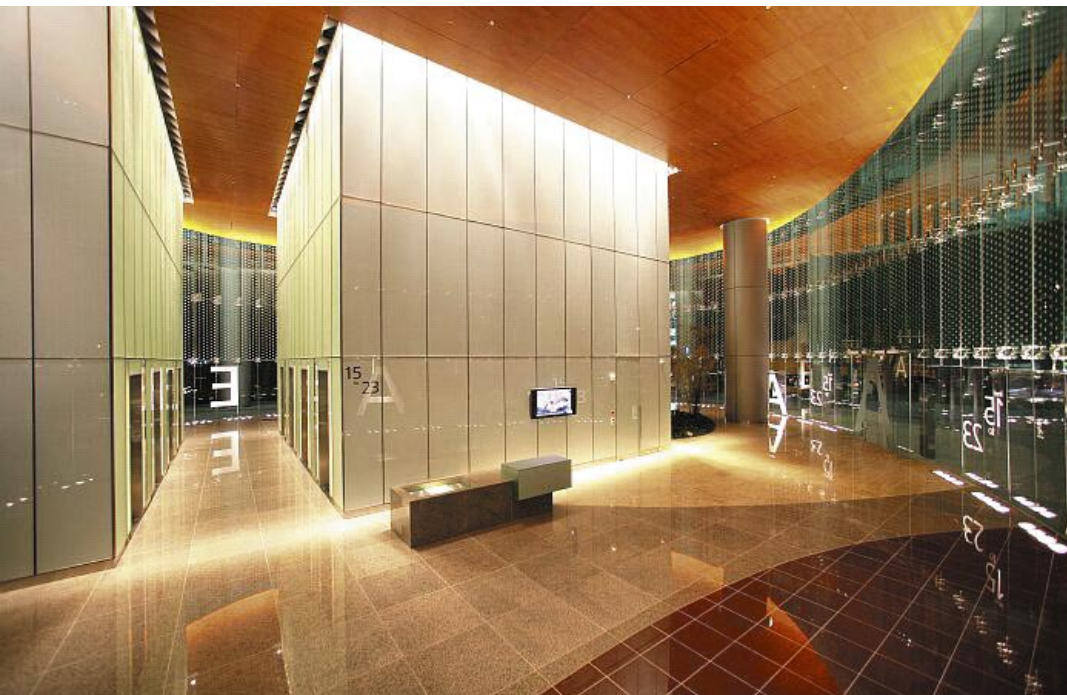
## Standard Grids

To facilitate the construction of the building, the office floors were designed based on standard grids and the common areas such as the lift lobbies and toilets were designed as modular units with standard details and finishes.

The typical floor structural system consists of one-way post-tensioned beams spanning from the corewall to the perimeter edge of the building. To reduce the number of beams required, a typical centre-to-centre beam spacing of 6.0 m was used with 170 mm thick reinforced concrete slab. Reinforced concrete slabs were constructed using welded wire mesh to expedite the construction. Standardisation of the beam sizes and spacing at every floor allows the same table formworks to be used repetitively. This reduces the floor-to-floor cycle time to nine days for a typical floor area of 3,063 sq m.

## Sun Screen Louvers

The North-South building orientation was determined by site constraints. A central core design and full height glazing has been adopted to ensure tenants can enjoy panoramic views of Hong Lim Park and the Singapore River, with a distant view of the Padang. A layer of sun shading louvers has been introduced to address energy conservation issues of full height glazing in the tropics.



**Back painted glass cladded on the core wall**

# One George Street



**Fabrication of unitised curtain wall in overseas factory**



**Fully assembled curtain wall system**

The architect has adopted the unitised curtain wall system comprising full height glazing with integrated sun screen louvers. The curtain wall components were prefabricated and assembled overseas and delivered to site for installation. The fixed sun screen louvers added to the aesthetics of the building as well as to meet the OTTV requirements. There were approximately 5,210 pieces of curtain wall components to cover the entire building envelope. This choice of unitised system has averted a 2-stage installation process of the curtain wall, followed by the sun screen louvers.

The aluminium louvers with yin-yang shaped profile are designed with discreet variations in tilt angle and spacing to create a rhythmic effect on the façade. The louvers are closely spaced and tilted at an almost vertical angle initially at the car park floors, but gradually opens up at the office levels to offer a panoramic view of the surroundings. The sun shading louvers also extends to the roof top and screens the M&E services.

## High Cantilever Roof Screen

Vertical cantilevered steel trusses were proposed as the structural system for the 25.5 m high cantilever roof screens above the roof. The side facing North Bridge Road consists of glass whilst the remaining three sides consist of open louvers. The steel trusses are light and prefabricated off-site. They can be assembled and installed easily using bolts without the need to weld.

## 1st Storey Public Plaza

The 1st storey landscaped public plaza provides repose in an otherwise built-up surrounding. A path leads pedestrians through the landscape on a relaxed walk pass water columns set amongst planting mounds, and connects to surrounding road junctions. Colour-coordinated granite paving patterns serve as a welcome gesture to visitors and tenants.



**Extensive use of glass panels at the lift lobby**

# One George Street



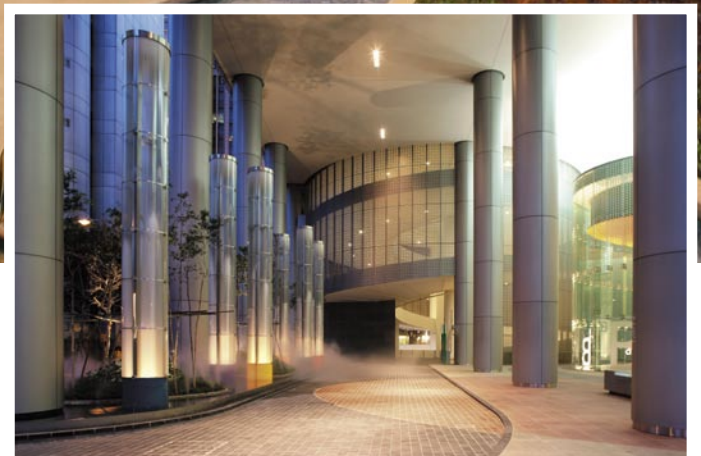
Meandering water feature at the the Skygarden



**Unobstructed night view from the sky garden**

The transparent organic forms of the 12 m high glazed lift lobbies allow the extensive landscaping to permeate through, infusing a park-like atmosphere. The sub-divisible design offers key tenants the possibility of private lift lobbies. Each panel of the segmented laminated tempered glazing is 3 m high by 0.9 m wide and prefabricated off-site. The modular glass panels are hung from the top of the 2 m deep cantilevered RC structure spanning up to 10 m. Clad in vertical aluminium panels, it is tapered at the edges to create a sleeker profile. Graduating frit pattern on the glazing reflects the glow of up-lights recessed along the perimeter, accentuating the distinctive silhouettes of the glass lobbies. The use of natural lace-wood veneer on the ceiling provides a warm contrast to the glossy back painted glass of the core wall. Interior finishes such as the use of back painted glass reduces the wet works and facilitates construction covering large surface areas with minimal material wastage.

External lighting design is simple but effective, creating dynamic contrast between night and day. Rather than a static



**Prefabricated glass water columns at public concourse**

time operation, the lighting schedule is programmed for gradual, subtle changes simulating natural phenomena.

## Sky Gardens

The 12th, 15th and 22nd storey sky gardens, conceived as voids in the building mass, serve as breakout areas for tenants to contemplate and relax. At the 5th Storey, mature rainforest trees and colourful shrubs create a lively elevated tropical environment. It has a meandering water feature culminating in a heated 25 m infinity-edge lap pool overlooking the Singapore River.

# One George Street



**Preparing for the installation of the unitised curtain wall**



**Installation of the unitised curtain wall**



**Redefining the CBD skyline**

In the design of the landscape deck at the 5th storey, proper coordination with the landscape architect is essential to simplify the floor construction. Post-tensioned beams at regular centre-to-centre spacing of 4.5 m and depth of 1,100 mm are used. Upstanding beams over the planting area are designed with a constant beam depth without sacrificing landscape intent for ease of construction. The required planter pits are provided within the clear width in between beams and contained within the beam depth to simplify the erection of formworks.

To increase the buildability of the floor construction of the landscape deck, a flat base level is provided and designed with minimal structural drops. This permits the undulating landscape levels to be constructed in shorter duration without sacrificing the overall progress of the project. The undulating landscape deck is to be constructed using a built-up slab system at a later time.

## Other Prefabricated Components

To go along with the buildability scheme, One George Street has adopted several other prefabricated components

### 1. Permanent Metal Staircase Formwork

This formwork is to simplify and expedite the stair construction.

### 2. Pre-insulated Chilled Water Piping System

This system is fabricated in the factory using polyurethane foam as thermal insulation and galvanised steel as jacketing which ensures better quality control and require less manpower to install.

### 3. Prefabricated Electrical Busbars

These are used for vertical power distribution instead of conventional cable risers. Busbars are modular copper sections suitably rated for the usage and enclosed in sheet steel metal.

Each section of the busbar is jointed at site which enables easier handling and manpower savings as opposed to using bulky cables.

### 4. Prefabricated Panel Type Water Tank

Instead of using cast in-situ concrete tank which is labour intensive to construct, the domestic water tanks at the roof top are made from Fibre Reinforced Polymer (FRP) panel tanks while the fire services tanks use pressed steel tanks. These are prefabricated off-site and delivered to site in modular panels which allow easy assembling at site.

### 5. Integrated Air/Light Troffer Ceiling

Integrated air/light troffer ceiling consists of both linear air diffusers and fluorescence lights in the same modular ceiling panel. The modular design reduces the need for individual brackets for three systems, namely the air-conditioning system, lighting system and false ceiling. It improves buildability with better quality control and performance.

## Conclusion

One George Street, distinct with its sleek, elegant and contemporary aesthetics, will redefine the Central Business District's skyline with a refreshing look.

## Apologies

In the article "Rejuvenating a World Class Airport" published in the 2005 Issue No 2 of Prefab Architecture, a member of the project team was inadvertently left out. We apologise for that and list the additional consultant for the upgrading of the Changi Airport below:

Facade Consultant : Hugh Dutton Associés



Incorporated in Singapore since 1990 and listed in the Singapore Exchange Securities Trading Limited's Mainboard in 1997, Permasteelisa Pacific Holdings Ltd focus its business on design, fabrication, Supply and installation of architectural exterior facades (curtain wall) and Internal Partition systems for both commercial and residential buildings.

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