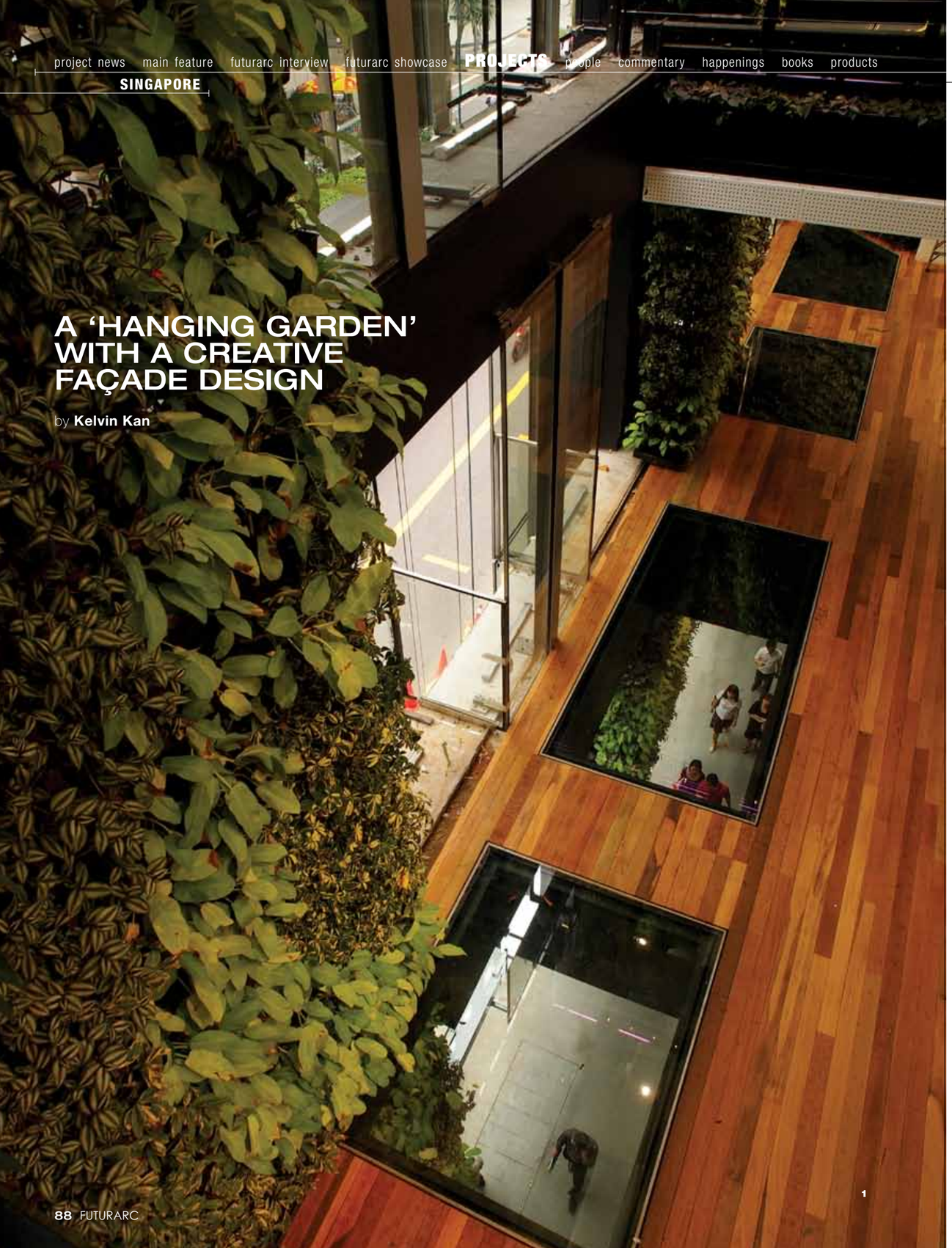
A 'HANGING GARDEN' WITH A CREATIVE FAÇADE DESIGN

by **Kelvin Kan**



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Kelvin is a Chartered Architect in the UK and Singapore with an MSc in Construction Management from Kingston University. With an architectural background, he ventured into structural glass design and the curtain wall industries, and has successfully designed and completed various glass/façade projects around the region. With a unique 'hybrid' expertise in architecture, glass, façade and design capabilities, and 'green' technologies, Kelvin formed AgFacadesign (AgFd) in 2009. The AgFd approach is to redefine how architecture is conceived by taking it from 'first principles' through a critical and analytical process while pushing the boundaries of design to maximise value and create a joyful experience for the building.

PROJECT DATA
Project Name
158 Cecil Street
Location
Singapore
Completion Date
25 February 2011
Client
Alpha Investment Partners Limited, Singapore
Architecture Firm
AgFacadesign, Singapore
Principal Architect & Façade Consultant
Kelvin Kan
Landscape Architect
Tierra Design (S) Pte Ltd, Singapore
Quantity Surveyor
Northcroft Lim Consultants Pte Ltd, Singapore
Structural Engineer
KKLim & Associates Pte Ltd, Singapore
Mechanical & Electrical Engineer
EMPlus Pte Ltd, Singapore
Main Contractor
Lai Yew Seng (LYS) Pte Ltd, Singapore
Green Wall Contractor
LYS; Consis Engineering Pte Ltd, Singapore
Lighting Contractor
LYS; Illum-tec Pte Ltd (Fabulux), Singapore
Images/Photos
Faradilla Zakaria; Ben Kan; Kelvin Kan

1 Glass floor panels visually link the atrium to the pedestrian space below 2 Full-height 'layered' façade allows for the required ventilation 3 The atrium transforms into a 'glowing' green space at night

BACKGROUND

Located within the prime area of Singapore's Central Business District (CBD), the 10-storey high 158 Cecil Street (the original building completed in 1984) was designed to be environmentally responsive. With floors receding inwards approximately 1.5 metres at each floor, shading was naturally provided. External RC planters spanning across 24 metres wide on levels four to nine provided further shading to the building façade.

DEVELOPMENT

Through commercial activities over the years, changes in the form of amendments and alterations were made to maximise the site's developmental potential (within permissible limits). Meeting the latest planning guidelines, the latest A&A work sought to maximise the allowable Gross Floor Area (GFA) by adding 37,000 square feet of floor space. These new floors on levels 11 to 14 are supported by a new 1.5-storey high transfer-floor structure extending over 40 metres across the building's floor plate. A new façade (on Cecil Street) was created within the boundary line forming a recessed but external 'atrium' juxtaposed neatly with the existing receding floor plates within.

To avoid the need for sprinklers, fire fighting or smoke extraction system provisions, the 'external' atrium space needs to be naturally ventilated to meet the stringent fire, smoke and ventilation requirements of the local authorities. Although the existing open metal mesh satisfies the fire department's guidelines, it did not meet the new owner's aesthetic requirement.

PROJECT REQUIREMENTS

As an A&A project, the challenge for the design team was to create a meaningful space for the 'external' atrium. In order to achieve that, they came up with two main criteria: to design a façade treatment that looks contemporary and attractive, and to transform the atrium into a lively and pleasant environment for tenants.

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APPROACH

The Façade

The primary objective is to maintain the 'atrium' as an 'external space' without the need for any fire-fighting provisions such as sprinklers, smoke detectors or fans etc. To meet that requirement, the façade must allow sufficient ventilation and enable natural smoke dispersal in the event of a fire. With this in mind, the architect created a design that used alternating glass panels spaced widely apart. A 'layered façade' was created where voids between the staggered full-height 900-millimetre-wide glass sheets (clipped onto the sides of steel mullions) provided the free area needed. The gaps are left permanently 'opened', allowing air and light to penetrate deep into the atrium. Smoke control studies by fire specialist IGnesis Consultants were conducted to demonstrate that such a layout would provide the required free area for fire emergencies.

The 'Atrium'

The former 'mesh façade' appeared cell-like and aesthetically unappealing. The planters were also topped up with concrete that made them look like heavy RC beams blocking out views. The entire atrium space, painted in dark brown, created an uninviting appearance. Thus, the architect's main task was to transform it into a lively and stimulating space.

It was thought that a 'hanging garden' concept with additional 'visually interactive' elements could enliven the space. This also provided refreshing views from every floor overlooking the atrium. Existing planters were 'reinstated' with money plants draping over the edges—the plants droop from the newly created 'walkway planters' along either sides of the beams.

Furthermore, the design team incorporated vertical greening to the existing end wall and columns. From the second to the ninth storey, both ends of the building and the back of each existing structural columns are also covered with green walls—a vertical garden with a festoon of potted plants. The green walls combined landscape elements with building technologies to create walls of bold architectural landscape visible both during the day and at night.

The atrium space faces east, thus it has limited daylighting. A specially designed lighting system offers not only display lighting effects but also practical lighting to sustain the green walls. The engineered light-framed structural system for the potted plants house all plumbing lines for irrigation and runoff from the drip irrigation system. Catwalks are camouflaged with more tray planters to allow ease of maintenance and to also add to the enhancement of the entire green indoor environment.

Reinforcing the concept of vertical greening, the planting on the green columns were extended down onto the pavement walkway at level two, so that plants appear to penetrate through the glass floor panels strategically placed on level three.

INTEGRATING GREENERY INTO THE EXISTING BUILDING

Architectural Planning

Within the atrium's confined space, the aim was not to add elements that would make the space appear even smaller or more cluttered. Existing elements that seemed 'hard and uninviting' were transformed into 'soft and attractive' features:

- Uneven end-wall converted to a seven-storey green wall feature
- Obtrusive columns to green columns
- RC planters reinstated to create 'hanging garden'
- RC beams converted to 'walkway planters' for maintenance and to reinforce 'hanging garden' concept
- Inclined green wall (facing external elevation) introduced (replacing RC protruding wall) to conceal visible M&E services from street level

Space Planning Design

Juxtaposing the following features with the existing elements provides 'spatial connectivity" to the seven-storey atrium:

- Walkway planters extending out towards façade (on existing RC beams) as 'sky walkways' on alternate levels
- Existing platforms extended with end-planter (added for maintenance access) provides perspective views across the atrium

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- Glass floor on the third floor terrace creates visual connectivity to the pavement and street level below

Designing the Layered Façade

The concept of the façade was conceived based on the need to provide voids to achieve natural ventilation and for smoke discharge. With a strong knowledge in glass technology and façade design, the architect created a façade system where two glass panels are simply 'clipped' onto a centre mullion. Like a pair of 'transparent wings' each module is placed in an 'in/out' arrangement, alternating each module to provide a 'void' between them.

The following elements form the 'layered façade' assembly:

- 150x150 millimetre steel mullion fixed to edge of RC beams or welded onto RHS beams
- 16.52 laminated clear glass full height panels with steel angles to protect the exposed edges
- Structural sealant used where glass panels are concealed within the recessed space of mullion with steel channel bolted onto the steel mullion
- Dead load support is provided at the base of glass via a cantilevered bracket with steel clamps and dead load ledge within steel mullion
- Live load is achieved from the steel clamp plates at the top and bottom edges of glass panels
- Movements in X, Y and Z directions have been designed into the system to ease installation

By day with reflections, the 'layered façade' appears as a semi-transparent/ translucent 'screen' but by night with lighting, its total transparency transforms the seven-storey atrium into a 'glowing lantern' of greenery.

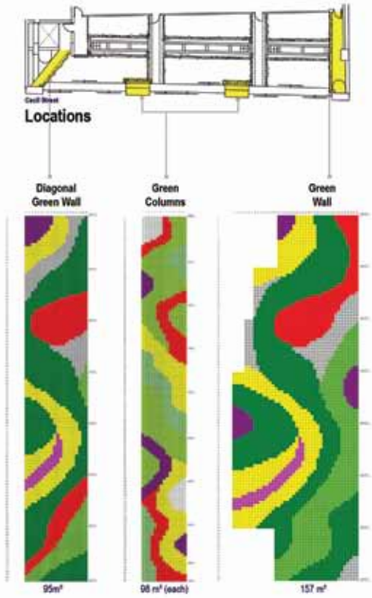
Construction Methods and Planning

Working on a tight four-month construction schedule the following was adopted to meet project requirements:

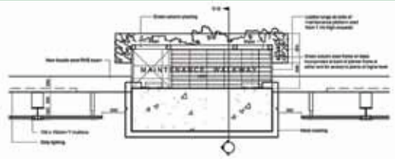
- Demolition of the seven-storey RC wall – power saw cut was used to minimise noise and dust as the building was tenanted within a built-up downtown area
- Pre-fabrication works were used for steel members with minimal site welding for speed, quality control and site constraint
- Finishes to steel were sand blasted and pre-finished with epoxy paint to reduce site painting
- Façade glasses were pre-assembled in a factory for better quality control, and then delivered in batches and sequenced for immediate installation
- Glass façade brackets and framings were redeveloped based on the architect's concept and then pre-fabricated

4 Beams converted into planters **5** 'Hanging garden' **6** Façade before redevelopment **7** Before, planter troughs filled with concrete appeared as unsightly 'beams' blocking views **8** Specially designed lighting system to sustain the green walls

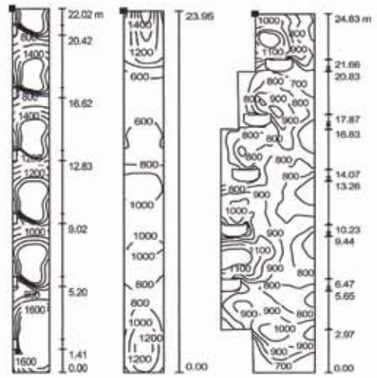
Technical Details - Green Columns & Green Walls



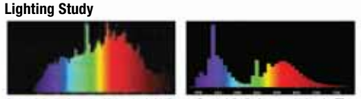
Landscape Design
Existing walls and columns were "cladded" with potted plants of different species. Plants were organised to create "vertical visual movements" connecting the 7-storey space. With strategically located "growth" and accent lights, the plants are able to sustain themselves indoors during the day and "glow" at night.

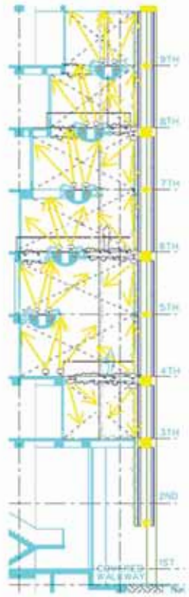


Green Column Maintenance Walkway Part Plain

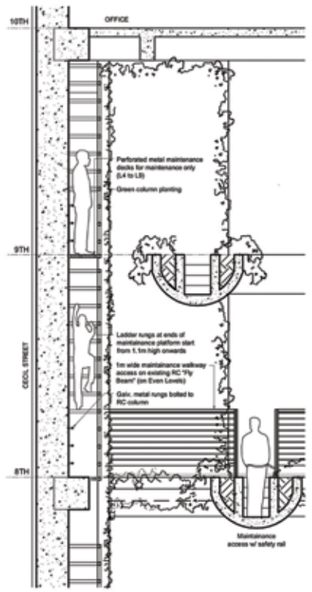


Lighting Study

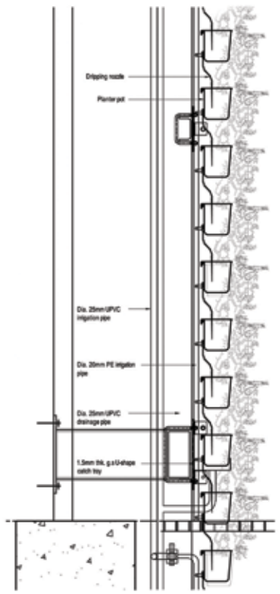


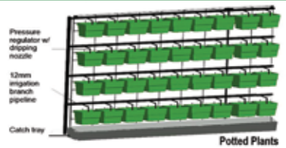


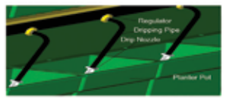
Green Wall "Growth" Lights
Lighting studies were done to ensure that all areas of the green columns and walls receive the required lighing levels of 700-1000 lux; growth lights for columns and walls were strategically located on every level.

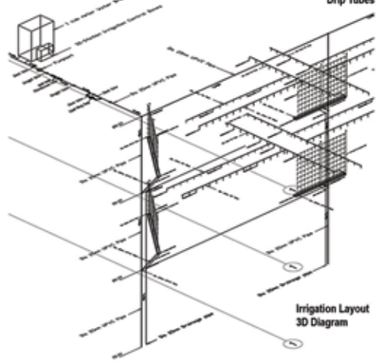


Maintenance
Green Columns' plantings were offset from the existing columns by 500mm to allow for maintenance. Ladder rungs at the ends of maintenance platform behind the existing columns were added to allow access to plants on every level.



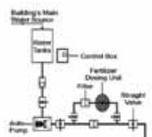




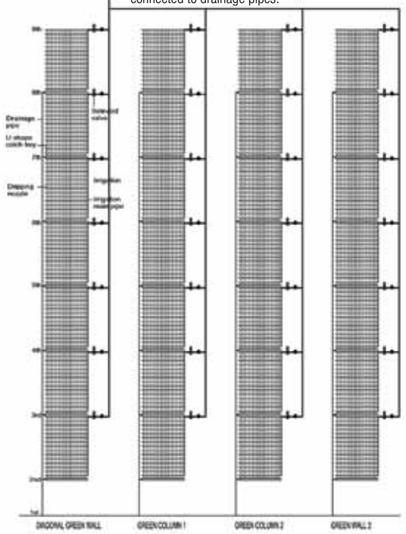


Landscape Structure
The engineered light frame for potted plants neatly house all plumbing lines for irrigation and runoff from the drip irrigation system. The vertical greening system comprises of modular individual planter pots, mesh frame, mounting brackets, irrigation and drainage system. The pots can be individually removed and assembled onto interconnecting modular panels bolted onto the steel structure. Hooks at the back of each pot allow it to be mounted and removed from the mesh frame. The pots have good resistance to petroleum-based chemicals and naturally occurring soil chemicals. The thickness of the system is 130mm overall and weighs 15kg/m² (system only) and 65 kg/m² (when saturated with vegetation).

Technical Details - Green Columns & Green Walls

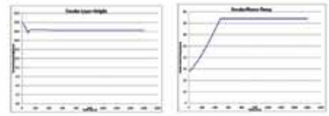


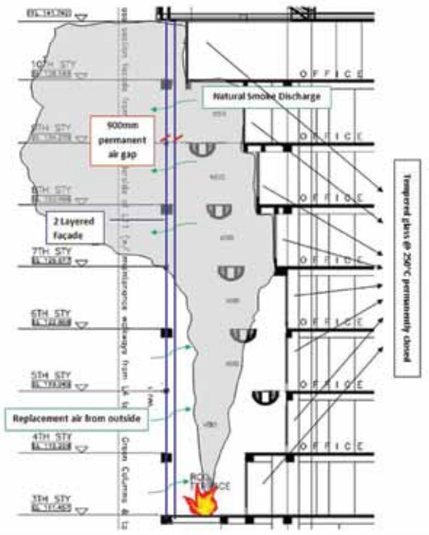
Irrigation & Drainage
The system is a multi-level drip system consisting of a fertiliser mixing pump, computerised irrigation controller (timer), valve, main irrigation pipe, branch line, regulator and drip nozzles.The vertical greenery system receives its irrigation water from two 1-cubic-metre water tanks located on Level 10. With a modular irrigation controller integrated , irrigation of plants are done on alternate days of the week. For indoor plants, they do not consume much water. There are U-shape stainless steel catch tray fixed at the bottom of each greenery panel with outlets connected to drainage pipes.



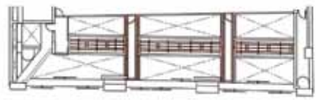
Technical Details - Smoke Ventilation

Fire & Smoke Design Study
Design calculations provided in support of the natural smoke ventilation provisions in the void area of the 'layered façade'. The axi-symmetrical plume model below represents the smoke movement for the typical fire scenarios in the atrium's void area.

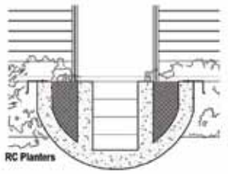




Technical Details - RC Planters (reinstated) & Planter Walkways

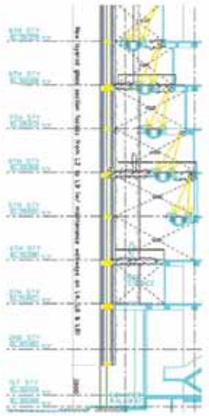


Irrigation & Drainage



Existng RC planter troughs were reinstated to become "hanging gardens". Maintenance walkways and fall arrest system were added to provide safe maintenance access.

Existng RC beams towards the columns have gratings placed above them creating maintenance walkways for the green columns. These beams were camouflaged with side planters with openable gratings that allowss for easy maintenance of lights and plants.



RC Planters Day "Growth" Lights
Floodlights installed one level above every RC planter troughs help ensure all plantings receive sufficient "daylight" for photosynthesis.

Day "Growth" Lights

3D Light Modelling for Plants in Atrium
Lights were selected to provide a daylighting effect that is effective for the plants' optimum growth. Combinations of 150W ceramic discharge metal halide lamps with full colour spectrum and 18W fluorescent lamps with mostly blue and red spectrum were used. The metal halide lamps were housed within highly efficient floodlights to deliver an average lighting level of 1,000 lux to the plants. Fluorescent lamps were also placed underneath planter walkways for their optimum growth.