ADVANCING RESEARCH & INNOVATION

IN THE BUILT ENVIRONMENT

Building and Construction Authority

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FOREWORD

Singapore's ambition to develop into a Smart Nation must include the development of smart buildings and infrastructure. Smart buildings play an essential role in supporting the vision of a more liveable, productive and environmentally sustainable built environment. The complexity of our built environment has also increased in tandem with the changing demands of businesses and people. This makes it even more imperative for our building industry to develop innovative solutions for these buildings that can meet expectations of a Smart Nation. In the BCA's 3rd Green Building Master Plan, we have envisioned a future built environment comprising of "Low Energy High-rise and Net Zero Energy Low-rise" buildings that are smarter, healthier and more occupant-centric. Investment in research and development (R&D) and innovations will accelerate the adoption of proven technologies that are ready for mass deployment to achieve this vision.

Since 2007, BCA has been working with fellow government agencies, academia and industry to roll out various R&D funding programmes to improve the resource and energy efficiency and liveability of our sustainable built environment. The launch of the Zero Energy Building in 2009 placed BCA at the helm of the research and development (R&D) arena with a platform that also supported technology test-bedding. Through the Building Energy Efficiency Technology Roadmap, green building R&D activities were subsequently streamlined along 4 key domains areas: Building Envelope and Façade Systems, Integrated Design Approach and Tools, Air-conditioning and Mechanical Ventilation Systems and Smart Building Management and Information Systems, where emerging technologies and their respective pathways are mapped out.

This publication, entitled "Advancing Research and Innovation in the Built Environment" is part of BCA's continuous efforts to disseminate knowledge and forge a stronger partnership between academia, research institutions and smart and green building industry, We hope it will be a useful reference to raise awareness, facilitate knowledge transfer and give you greater insights on the research and innovation activities for the sustainable built environment.

In this publication, exemplary building projects and technologies funded under our R&D and Innovation programmes are introduced. They are by no means exhaustive. However, we hope they will inspire both researchers and practitioners to rise to the challenges and strive to push the boundaries of building performance to create a better and greener environment for all.

Mr. Tan Tian Chong
Group Director (Research)
Building and Construction Authority

Building and Construction Authority

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EDITORIAL TEAM

Stephen Mok
Tan Li Sirh
Ma Khine Wa
Matilda W Kenanga
Sonny Andalis
Letchimi Palanisamy
Megan Chow

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ZERO ENERGY BUILDING AT BCA ACADEMY

INTEGRATED ENERGY SOURCES AND EFFICIENCY DESIGN TOWARDS A ZERO ENERGY BUILDING AT BCA ACADEMY

Supported by **MND Research Fund for the Built Environment**
Applicant: **Building and Construction Authority**

- ZEB@BCA Academy is a testbed of integrated green building technologies.
- It is Southeast Asia's first zero energy building retrofitted from an existing building.
- Despite an increase in occupancy and changes in space usage over the years, ZEB has maintained net zero energy consumption for 5-6 years of operations since its opening in October 2009.

Besides the four research projects, BCA works with technology suppliers to showcase innovative technologies in the ZEB, e.g. passive displacement ventilation and smart LED lighting system.

Passive Displacement Ventilation

Passive displacement ventilation (PDV) is an innovative air distribution system that supplies cold air at floor level and extracts warm air at ceiling level without using mechanical fans. PDV harnesses the natural convection of heat to keep air circulating. As cold air picks up heat, it rises naturally to the ceiling where it gets cooled and once again sinks down into the system cavity to re-enter the room. The cycle repeats itself, bringing cooling comfort to occupants of the space. This innovative technology has caught the attention of the international community, and received an ASEAN Energy Award under the Special Submission category in 2012. It is now being implemented on a larger scale at Nanyang Technological University (NTU).

Smart LED Lighting System

This smart LED lighting system comes with an intelligent sensor grid for each LED fitting. The sensor is able to determine lighting levels, and to sense the presence of a person by the warmth he exudes. With this technology, the corresponding light fitting turns on when a person is approaching; hence, only essential lights are turned on and at the right time, thus saving energy. Furthermore, each LED fitting's brightness can be controlled according to the preference of the individual user, allowing for greater visual comfort. In ZEB, all lights have been programmed to turn off during lunch hours on weekdays, further reducing energy use. Another feature is the low-voltage data cables used to power and control lightings. They help save wiring costs and space, and also simplify installation and maintenance. This system, ideal for open office spaces, has also been installed in a commercial building within Changi Business Park.

A. Zero Energy Building **B.** Rooftop view of Zero Energy Building **C.** Classroom installed with passive displacement ventilation **D.** Office installed with smart LED lighting system *Photo courtesy of Building and Construction Authority*

JTC CLEANTECH TWO

Supported by **GMIS Design Prototype**[1]
Applicant: **JTC Corporation**

Integrative Design Process

An Integrative Design Process allows for early inter-disciplinary collaboration and stakeholders engagement at the conceptual design stage. Collaborative efforts put in by the project team members enable them to identify cost-effective and innovative solutions that are not typically considered in the conventional design process. Solar thermal liquid desiccant system, low energy fume hoods and stratified cooling are among the identified technologies being adopted at JTC CleanTech Two @ CleanTech Park, contributing to its goal of being a low energy, high performance and sustainable building.

Solar Thermal Liquid Desiccant System

Outdoor air is de-humidified by a liquid desiccant that is regenerated by a solar thermal collector. The system treats fresh air, totalling 18,000 cubic metre per hour, which is supplied to the fitted spaces at JTC CleanTech Two. The electrical power savings is estimated to be at 92,664 kWh.

1. More information on GMIS Design Prototype can be found at the following link: http://www.bca.gov.sg/GreenMark/gmisdp.html

Low Energy Fume Hoods

Conventional fume hoods draw more electricity because they require airflow of high velocity to remove fumes. Low energy fume hoods used in fitted laboratories at JTC CleanTech Two reduce both airflow and fan power requirements, generating an estimated power savings of 24,402 kWh.

Stratified Cooling

Stratified cooling supplies treated air only to lower layers of occupied spaces instead of the entire volume, resulting in an additional two percent of energy savings. This is effective for air-conditioned industrial spaces with high ceilings.

A1 & A2. Integrative Design Process **B.** Low energy fume hood *Photo courtesy of JTC Corporation*
C1 & C2. ARTC Stratified cooling *Photo courtesy of Advanced Remanufacturing and Technology Centre, in partnership with Nanyang Technological University*

JTC CleanTech Two's Estimated Energy Savings from Selective Deployment of Innovative Technologies:

<table>
<tr><th>Cooling System</th><th>Cooling Savings</th><th>Area Implemented</th></tr>
<tr><td>Solar Themal Liquid Desiccant</td><td>45.2%</td><td rowspan="2">1500m^2</td></tr>
<tr><td>Low Energy Fume Hoods</td><td>25.0%</td></tr>
<tr><td>Stratified Cooling</td><td>15.0%</td><td>3200m^2</td></tr>
</table>

JTC CleanTech Two's Energy Efficiency Measures:

	Energy Efficiency Measure	Savings %	Incremental %
1	Concept Design (inclusive of ETTV, Passive Design, Best Efficiency Chiller Plant, L-DEC system)	22.1%	NA
2	PCM Thermal	24.6%	+2.5%
3	ARTC Stratified Cooling	25.6%	+1.0%
4	Best Practice Green Lease	28.1%	+2.5%
5	Re-baseline Lab ACMV	31.0%	+2.9%
6	Low Energy Fume Hoods	31.8%	+0.8%
7	Daylighting	32.3%	+0.5%
8	PV Generation	32.8%	+0.5%
	Total Energy Savings	32.8%	

Calculations of Potential Savings

Annual Energy Savings (kWh/yr)	3,080,680
Electricity Tariff (SGD/kWh)	0.27
Estimated Annual Energy Cost Savings (SGD/yr)	831,783.60

**At full occupation*

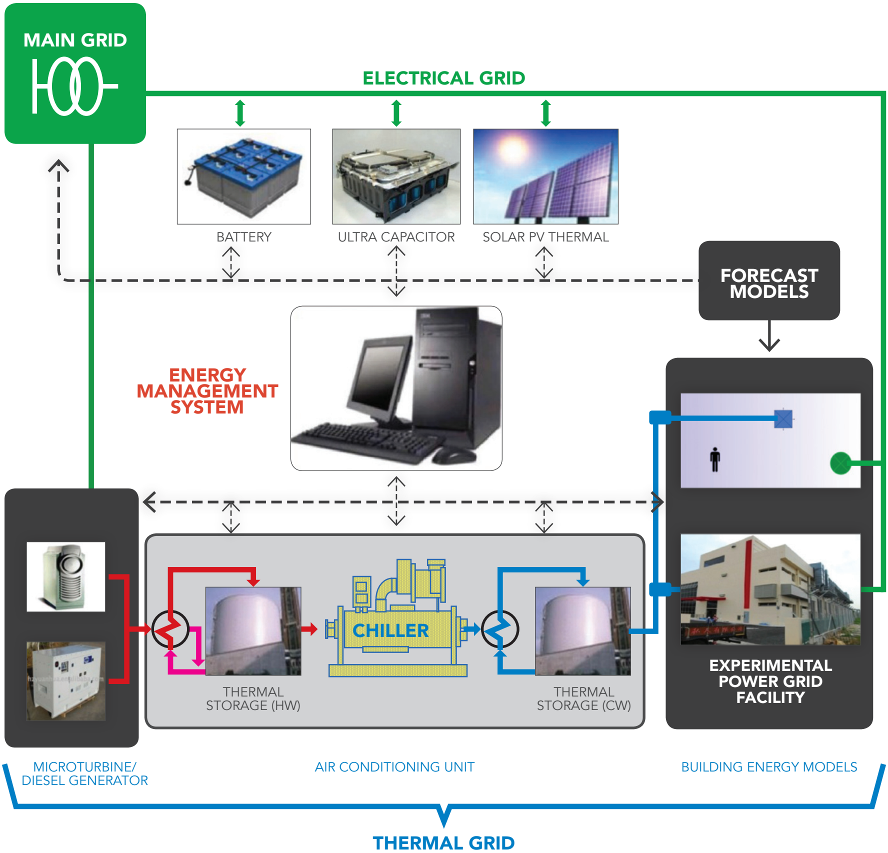
PILOT PLANT FACILITY

DEVELOPMENT OF PILOT PLANT FACILITY TO DEMONSTRATE THE ENERGY SAVINGS AND COST BENEFITS BY COUPLING ELECTRICAL AND THERMAL GRIDS IN THE BUILDING SYSTEM

Supported by **A*STAR-MND Green Buildings Grant**
Applicant: **Experimental Power Grid Centre**

In Singapore, buildings contribute up to 16% of total green house gas emissions and thus offer significant potential for reduction of energy consumption. A good building design and system optimisation are keys to reducing building energy consumption. In Japan, Hitachi Ltd, the industry partner of this project, has achieved 20% energy reduction by optimising building air-conditioning systems. Traditionally, building electrical systems and thermal systems are designed and controlled independently. However, in reality, the two systems are coupled. Thus, traditional approaches separating them are not able to achieve optimal design and operation for maximum cost and energy savings.

The project aims to design and develop a pilot plant to demonstrate the performance improvement in building energy efficiency by coupling and optimising both electrical and thermal systems. The pilot plant has solar photovoltaics (PV), diesel generators, battery, thermal storage and heating, ventilation and air conditioning (HVAC). A multi-physics model based on coupled thermal and electrical systems is required to reach the optimal design and operation of building energy systems. This project aims to demonstrate the performance improvement in such systems based on this model.

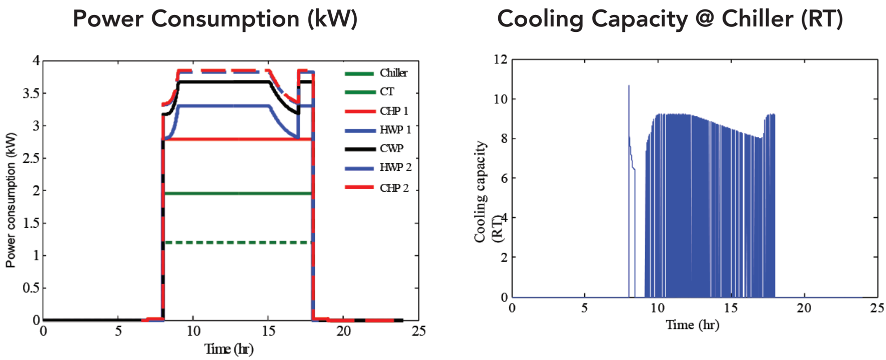


A. System configuration for the pilot plant in EPGF at Jurong Island, Singapore

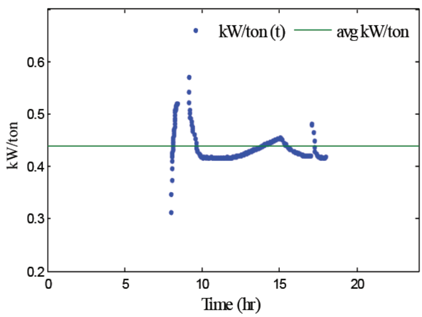
The overall integrated model is developed by integrating all the standalone models developed for the building's thermal and electrical systems. The integrated model is simulated with the user defined conditions to study the interaction between the thermal system such as mass and energy flow/balances across the systems. The basic control loops are also implemented in the integrated model as the requirement to synergize the operation of various systems to ensure proper co-ordination.

An important measure to benchmark the air conditioning system performance is kW/ton which is the ratio of power consumed by the HVAC system and the cooling capacity generated by the HVAC system. The performance of the proposed system is calculated by simulating the integrated model at rated condition with necessary control loops. The kW/ton values during the simulated day ranges between 0.4 –

0.5 during normal operation (excluding start-up time). This is an estimate obtained from the integrated model. This performance measure will be optimized further by updating the validated model, adapting advanced control and optimisation schemes and considering the equipment limits in the proposed system.



B. Power consumption by the HVAC equipment and cooling capacity generated by the absorption chiller



C. The variation in the kW/ton measure during the day

Photo courtesy of Experimental Power Grid Centre

VARIABLE REFRIGERANT FLOW PLANT

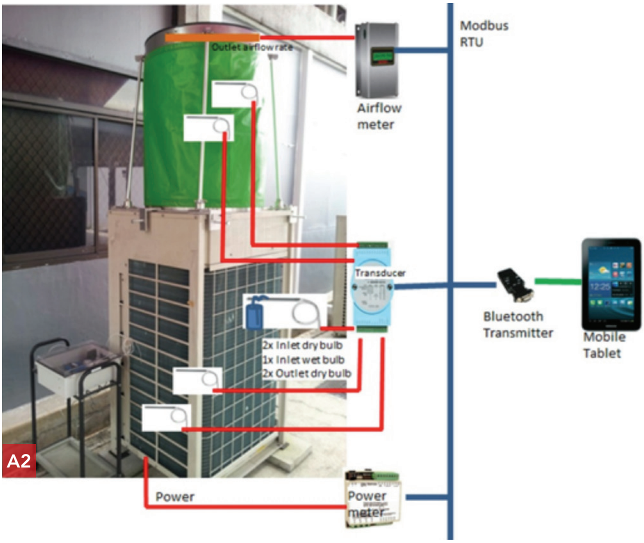
ENERGY EFFICIENCY OF VARIABLE REFRIGERANT FLOW PLANT FOR MULTI-STOREY BUILDINGS IN TROPICAL CLIMATE

Supported by **A*STAR-MND Green Buildings Grant**
Applicant: **Ngee Ann Polytechnic**

In general, Variable Refrigerant Flow (VRF) systems exhibit lower efficiency compared to water-cooled chilled water plants, and are normally perceived as consuming more energy. They are categorised under unitary package systems, with all components factory designed, assembled and supplied by a single manufacturer. Their energy performances are based on manufacturers' publications, which are in turn based on factory test data. Measurement & Verification (M&V) methodology for field-installed VRF systems are not available. This project, a collaboration among BCA, Daikin Airconditioning (Singapore) Pte Ltd and Mitsubishi Electric Asia Pte Ltd, was intended to develop appropriate solutions so that professionals can have more avenues to assess the energy performance of this type of air conditioning system.

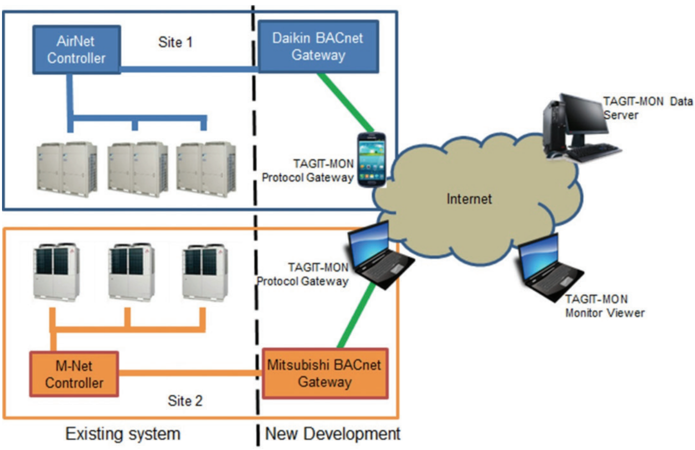
An "Outdoor Air Enthalpy Measurement Equipment (OAEME)" was developed. It is a portable device to measure the energy efficiency of site-installed VRF systems. The accuracy of this equipment was verified against the performance of the refrigeration circuit to an acceptable level.


A1



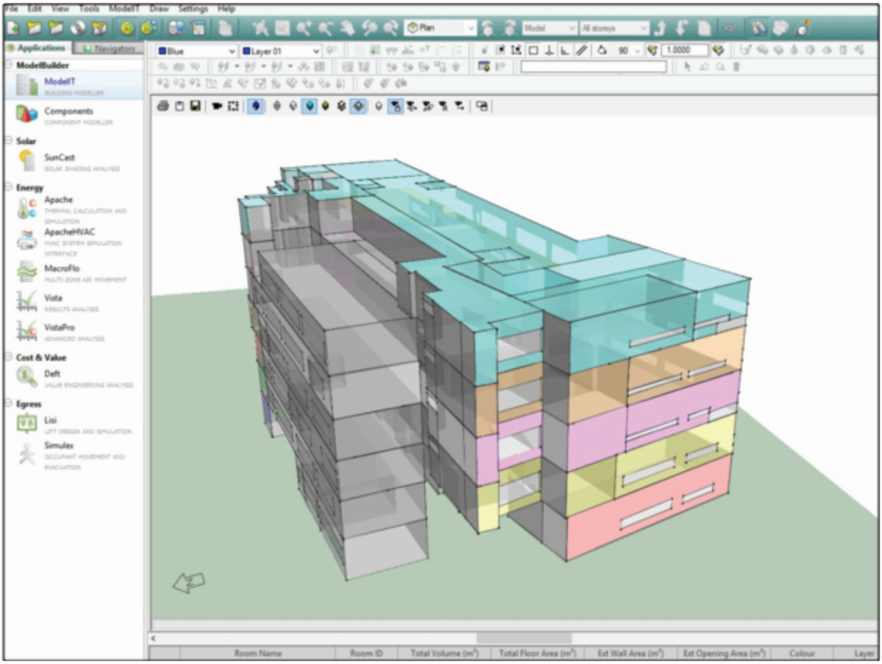
A1 & A2. OAEME mounted on Outdoor Condensing Unit

An inter-operable software package (IVMS), which consists of user interface, data base, and open protocol gateways were developed. It completed the collection of performance data of two VRF plants, at Block 18 of Ngee Ann Polytechnic and Mitsubishi Electric Building @ Alexandra Road. The custom made software has the features to analyse and report energy consumption and efficiency of VRF plants dynamically.



B. The architecture of IVMS

Energy simulation of an actual building was conducted to identify energy usage at the different components of two types air-conditioning systems, namely VRF and water-cooled chilled water systems, that contribute to the overall energy consumption.



C. 3D Model of SIT Building

Photo courtesy of Ngee Ann Polytechnic

CHAPTER 2

FACADE SOLUTIONS

PHOTOCATALYTIC COATING

ENHANCEMENT OF PHOTOCATALYTIC PRODUCT DEVELOPMENT AND COATING SYSTEMS, AND THEIR APPLICATION METHODS

Supported by **MND Research Fund for the Built Environment**
Applicant: **Haruna Paint Pte Ltd**

Advancements in materials science and nanotechnology have enabled titanium dioxide (TiO_2) photocatalytic coating to function as a catalyst that is able to undergo strong oxidation. Being environmentally friendly, it breaks down harmful bacteria and other micro-organisms upon exposure to UV rays. It also converts organic gases and tobacco smoke into less harmful by-products. As an effective self-cleaning layer requiring only sunlight and water for activation, the by-products are loosely repelled by electrostatic interaction which can be easily blown away or washed off due to its super hydrophilic film layer. This gives rise to cleaner air quality, thus raising the quality of our living environment.

Haruna Paint has successfully developed and commercialised this made-in-Singapore photocatalytic coating product, priced at less than half of its imported counterparts. The coating can be applied effectively on different substrates such as painted surfaces, tiles, granites, marbles, glass and metal cladding etc. The company has also established an effective and quality-consistent on-site application methodology which greatly reduces wastage by half. The coating has low level of volatile organic compounds in compliance with Green Label requirements.

A. Coating applied to facade of Tokyo Marine Building **B.** Surface coated with (right side) and without (left side) photocatalytic coating
Photo courtesy of Haruna Paint Pte Ltd

SMART MULTI-FUNCTIONAL COATINGS

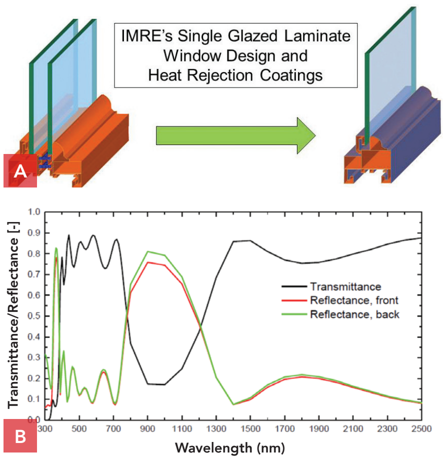
FOR FENESTRATIONS TO REDUCE THERMAL LOAD OF BUILDINGS

Supported by **A*STAR-MND Green Buildings Grant**
Applicant: **Institute of Materials Research and Engineering**

Heat transfer was reduced by depositing multi-functional oxide coatings directly onto the surfaces of laminated glass assemblies, and also developing a smart epoxy-based nanocomposite coating for window frames and other non-transparent surfaces.

The energy efficiencies of both laminated glass panels and frame components were determined. Based on actual thermal and spectral characteristics of individual components and heat load simulations, it was shown that a single pane laminated window design led to energy savings of over 40%.

The research verified a feasible solution for window systems in the tropics that can replace the use of double glazed window units.



A. Fenestration design and coatings **B.** Material properties of multi-layers coating
Photo courtesy of Institute of Materials Research and Engineering

VERTICAL GREENERY

DEVELOPMENT OF VERTICAL GREENERY SYSTEMS FOR THE TROPICS

Supported by **MND Research Fund for the Built Environment**
Applicant: **Housing & Development Board**

The VERTI.GRO Green System and VERTI.GREEN Wall System are two self-sustaining vertical greenery systems that require minimal maintenance. The scope of research includes studying, testing and building a repository of suitable plant species, as well as studying and analysing the environmental benefits of the systems.

The two systems were pilot implemented at Blk 339 Sembawang Close, producing estimated cost savings of $180,000. They were also subsequently implemented in various HDB projects such as MyWaterway@Punggol, Edgefield Plains and Jurong East Street 21.

A. Blk. 223 Jurong East St. 21
B. My Waterway @ Punggol
C. Blk. 339 Sembawang Close
Photo courtesy of Housing & Development Board

CHAPTER 3

SUSTAINABLE CONSTRUCTION

SAMWOH ECO-GREEN BUILDING

FULL SCALE EVALUATION OF THE USE OF RECYCLED CONCRETE AGGREGATE IN STRUCTURAL CONCRETE APPLICATIONS

Supported by **MND Research Fund for the Built Environment**
Applicant: **Samwoh Corporation Pte Ltd**

Samwoh Eco-Green Building is the first in the region to achieve up to 100% replacement with recycled concrete aggregates (RCA) in structural concrete work, scoring a good concrete usage index (CUI) of 0.33. A full-scale study (laboratory evaluation and site monitoring of actual building) was conducted to evaluate the use of RCA in structural concrete for building structures.

Above. Samwoh Eco-Green Building
Photo courtesy of Samwoh Corporation Pte Ltd

With normal concrete serving as the basis for comparison, the experimental data showed that comparable compressive strength, flexural strength and tensile splitting strength were attainable for concrete containing up to 100% RCA. Although concrete with 100% RCA exhibited higher creep strain and initial surface absorption rate as well as lower resistance to water permeability, chloride ingress and external sulphate attack, the effects on the concrete's performance are insignificant. On the whole, the research suggests that concrete with RCA can be designed to meet the specifications for structural applications, a factor which led to the successful completion of the Samwoh Eco-Green Building.

This project has won many prestigious awards such as the ASEAN Energy Award 2014, Minister for National Development R&D Award 2013, Green Mark Platinum Award for New Non-Residential Buildings 2010 and Existing Non-Residential Buildings 2014. Results from the study have been published in two international renowned journals, namely, the US Journal of Civil Engineering Materials by the American Society of Civil Engineers and the UK Magazine of Concrete Research.

A. Construction of Samwoh Eco-Green Building
B. Structural monitoring system
C. Creep test
D. Water permeability test
Photo courtesy of Samwoh Corporation Pte Ltd

PRECAST CONCRETE PLANK

PROPOSED USE OF PRECAST CONCRETE PLANK FOR SITE ACCESS IN HDB LIFT UPGRADING PROGRAMME PROJECT

Supported by **Sustainable Construction Capability Development Fund**
Applicant: **Teambuild Engineering & Construction Pte Ltd**

Precast concrete plank (PCP) is manufactured off-site and under a controlled environment, and thus does not require skilled labour in the fabrication process. Repetition in precasting processes increases the productivity/output and also reduces labour extensively, by about 50%. Installation of PCP on-site is extremely easy and fast, requiring only two workers and a machine operator for a one-day job. The conventional methods can take up to two days due to waiting time for hardcore materials, resulting in more unproductive working hours for both equipment and labour.

Precast concrete plank used for site access construction greatly improves the efficiency of 3-R Waste Management and Waste Recovery. PCP is made of eco-concrete, which uses recycled aggregates from demolition waste to substitute for natural coarse aggregates, and washed copper slag for the natural sand component. PCP reduces the demand for hardcore and eliminates difficulty and effort in its disposal, as hardcore is not reusable. PCP can be reused as many times as desired and little maintenance is required. Damaged PCP can be crushed and recycled as aggregate to produce eco-concrete and new PCP. The steel mesh component is also a recyclable and reusable material.

A PCP access reduces the need for excessive hoardings around the site, enabling the public to move around more freely and without facing the hazards usually posed by hoardings. Natural ventilation, lighting and degree of surveillance at the void deck and stairwell areas have also improved.

Productivity increases as PCP access installation requires only 50% of the labour, machinery and work hours typically demanded by conventional hardcore-based site access construction.

Precast concrete plank products may involve a bigger initial up-front investment but once it is used for over four times, it will become virtually "zero cost" and requires only minimal maintenance. Thereafter, it contributes directly to almost 100% cost savings in materials with the construction of each new site access.

A1 & A2. Application of precast concrete panels for site access in HDB - LUP Project
Photo courtesy of Teambuild Engineering & Construction Pte Ltd

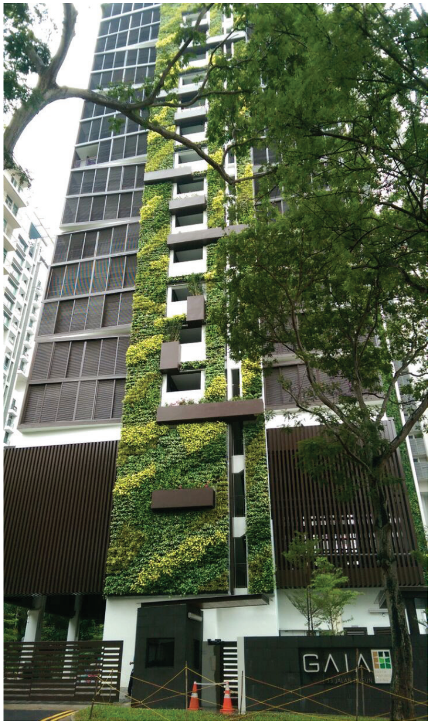
GAIA

USE OF RECYCLED MATERIALS IN THE CONSTRUCTION OF A 15-STOREY RESIDENTIAL BUILDING

Supported by **Sustainable Construction Capability Development Fund**
Applicant: **Amerald Land Pte Ltd**

Green concrete is used for all the structural members inclusive of transferred beams (except pile caps and piles) in this 15-storey residential building (GAIA). The concrete consists of 20% recycled concrete aggregates, 10% ground granulated blast furnace slag, 10% manufactured sand and 10% copper slag.

The mean strength of the green concrete is 43MPa (for Grade 35) and 63MPa (for Grade 55). The strength of green concrete is almost equivalent with that of conventional concrete, except that it strengthens at a slower though still acceptable pace. Its durability is also comparable to conventional concrete. Thus, it was concluded that green concrete is suitable for general construction activities.



Above. GAIA Building
Photo courtesy of Amerald Land Pte Ltd

HIGH STRENGTH CONCRETE

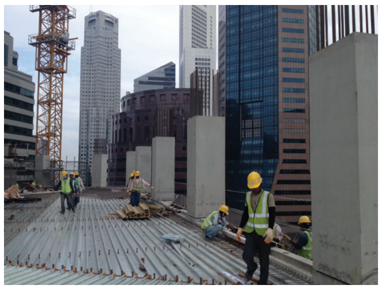
G100 HIGH STRENGTH CONCRETE FOR CAST-IN-SITU COLUMNS AND G80 HIGH STRENGTH CONCRETE FOR PRECAST COLUMN

Supported by **Sustainable Construction Capability Development Fund**
Applicant: **Takenaka Corporation**

The Market Street Tower (also known as CapitaGreen) is a Grade A office tower located at the former Market Street Carpark in the heart of Singapore's financial district.

The project has successfully used G100 high strength cast-in-situ concrete and G80 high strength precast concrete. G100 flow concrete not only benefits the environment, it reduces cost and increases productivity. This high strength concrete also promotes value engineering in which the amount of reinforcement bar or steel required is reduced by some 40%, hence bringing down the overall project cost.

With the use of flow concrete, concreting productivity is also increased as the required vibration is reduced and settlement speeded up, resulting in lesser manpower needed during the process.



Above. Construction of CapitaGreen
Photo courtesy of Takenaka Corporation

BIM FOR CUI CALCULATION

BIM ADD-ON TOOL FOR AUTOMATED CONCRETE USAGE INDEX CALCULATION

Supported by **Sustainable Construction Capability Development Fund**
Applicant: **ONG&ONG Pte Ltd**

The Concrete Usage Index (CUI) is part of Sustainable Construction scoring under Singapore's 'Green Mark' system. Computation of CUI score was previously calculated manually and using spreadsheets, making it both inaccurate and tedious. Depending on the building design, it requires design/engineering consultants to spend a week or more on the calculations.

Although CUI calculation is made more efficient with the use of Building Information Modelling (BIM) software that uses automated schedules, there are still challenges. Certain conditions need to be met in order to achieve accuracy. The concrete elements must be modelled correctly with the right material input and category, which is commonly known as object classification. Minimisation of errors become challenging due to software limitations and individual user's modelling skills.

This collaborative project explained the current challenges of calculating CUI by using specific BIM software, and experimented with a new add-on tool to address the issues which affected accuracy. The research compared the output of CUI calculation using the current 'out-of-the-box' tool versus the newly developed CUI add-on tool. The tool would help the industry to calculate CUI systematically and efficiently, with minimal user input, while promoting the adoption of BIM.

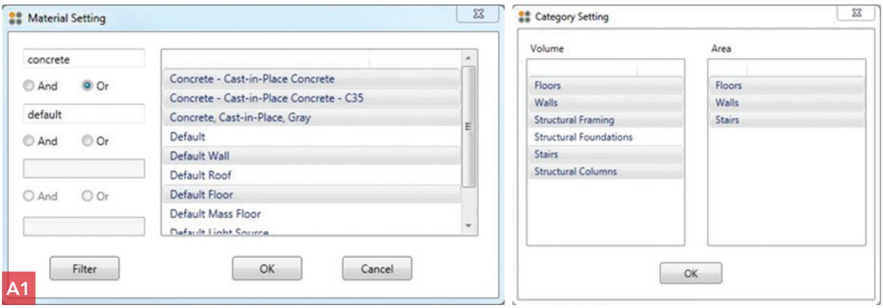
Although many types of BIM authoring software are available, this project focused only on Autodesk® Revit®. It was chosen since it is widely used in the Architecture, Engineering and Construction (AEC) industry.

The add-on tool was developed based on BCA guidelines for calculating CUI, which defines it as the "volume of concrete in cubic metres needed to cast a square metre of constructed floor area." The calculation does not include concrete used for external works, or sub-structural works such as basements and foundations.

The concept design of the add-on tool is also based on the Autodesk® Revit® workflow. The workflow involves collecting data from the model, data processing/ filtering, post-processing, and finally generating the report. All these processes are being generated within the Revit® platform by utilising the Revit® Application Programming Interface (API).

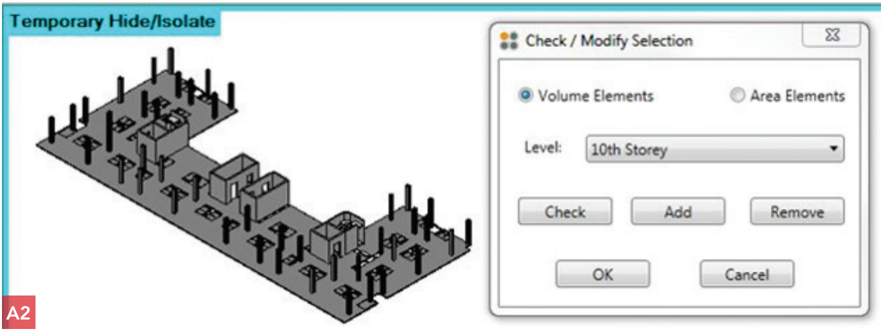
The accuracy of CUI calculation using BIM software is dependent mostly on accurate modelling at the onset. Sometimes, users model the building without considering that the same model will be used for the purpose of CUI calculation. In addition, some workarounds may be required due to software limitations. Based on sample projects tested with the average calculation time of less than five minutes, the accuracy of the add-on tool is within 5% as compared with manual calculations. This is possible if the BIM models are separated by levels, and there are no overlapping or corrupted elements.

The current version of the add-on tool calculates volume and area for all concrete regardless of the concrete grade. Specific and unique requirements, for example the inclusion of half the structural mat foundation, would need to be adjusted manually in the Excel report.



A1

Based on the concept design above, the model element selection uses Revit® material naming and is hence flexible and customisable. Modelling of precast objects including architectural objects (e.g. planter boxes, cladding & parapet) are also supported. Reports generated by the add-on are Microsoft Excel compatible and hence easy to check, customise and adjust. The add-on tool is currently compatible with the later version of Autodesk Revit® 2015.



A1 & A2. Add-on tool to automate CUI calculation
Photo courtesy of ONG&ONG Pte Ltd

CHAPTER 4

FUNDING PROGRAMMES

2-STAGE INNOVATION GRANT

The $5 million 2-Stage Innovation Grant (iGrant) was set up to encourage and support the building and construction industry to conduct fast track, Proof-of-Concept (POC) type of R&D projects for subsequent quick deployment in a fast-moving business environment. The scheme facilitates the introduction of novel tools, methodologies and technologies that have high impact in order to improve the **sustainable built environment and construction productivity**. It will also help incubate technologies and solutions with high potential for scaling-up adoption and commercialisation.

The scheme provides funding for research topics identified in the Green Building R&D Framework, with particular focus on **energy efficiency and resource efficiency**. It also supports the **adoption of innovative construction technologies and re-engineering of work processes** to improve construction productivity.

Please refer to this webpage for more details:
https://www.bca.gov.sg/ResearchInnovation/overview.html

PROJECTS SUPPORTED BY iGRANT

GREEN BUILDINGS

i. Centralised Measurement and Verification System (CEMVS) for Singapore District / Island-wide Building Energy Performance

Photo courtesy of Singapore Technologies Electronics Limited

CONSTRUCTION PRODUCTIVITY

ii. Use of Cross Laminated Timber for JTC Project - Next Development in CleanTech Park

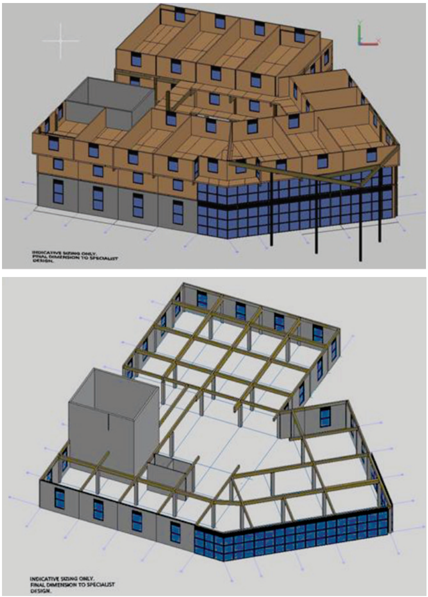


Image courtesy of Venturer Pte Ltd

iii. Tropical Hempcrete Panel

Photo courtesy of Studio Green Pte Ltd

SUSTAINABLE CONSTRUCTION CAPABILITY DEVELOPMENT FUND

As part of BCA's initiatives to drive sustainable construction, the $15 million Sustainable Construction Capability Development Fund (SC Fund) has been set up to develop capabilities of the industry in adopting sustainable construction methods and materials. It supports recycling of waste arising from the demolition of buildings and the use of recycled materials for construction. It also encourages greater adoption of recycled materials and environment-friendly construction practices. The fund has been enhanced to put a stronger focus on Training & Development and design-focused initiatives by encouraging projects to consider sustainability at the onset of design in order to achieve the multiple goals of sustainability and productivity.

Some of the key focus areas supported by the fund are:
- Sustainable construction practices or technologies
- Waste management or waste recovery
- Environment-friendly products or materials

Please refer to this webpage for more details:
http://www.bca.gov.sg/SustainableConstruction/scf_intro.html

SUSTAINABLE CONSTRUCTION

i. Recycling of Contaminated Marine Clay to Sustainable Building Materials

Photo courtesy of Boon Wee Const (S) Pte Ltd and Nanyang Technological University

Building and Construction Authority

52 Jurong Gateway Road
#11-01, Singapore 608550