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Aurecon is developing and implementing sustainability strategies to improve the financial and environmental performance of new mixed-use development in Shanghai, Mapletree Minhang Development Project.

Roger Manho, Aurecon’s technical director, Buildings Shanghai said, “Through smart engineering we can achieve energy savings equivalent to powering 1,875 homes, reduce CO$_2$ emissions equivalent to planting 200 trees as well as saving water to the equivalent of 15 Olympic size swimming pools over a year.”

Aurecon’s team of experts is providing electrical and mechanical engineering systems to deliver best practice in sustainability so that the structures within the development perform efficiently, economically, safely and sustainably.
In response to China’s emerging demand for high quality and cost-effective facilities for the working population outside Shanghai central business district (CBD), the large-scale commercial and retail mixed-use development will provide a new form of liveability for China.

Designed to deliver a Grade-A office alternative, the development will target new benchmarks in sustainability for office and public spaces and ultimately provide a lifestyle and entertainment destination to over 300,000 residents within a 3 km radius.

“Through our collaborative model, we are bringing the best methods, technologies and innovations in environmental management techniques from around the world, to deliver practical solutions for saving energy and water that remains flexible and suitable for the people that work there and live locally,” said Mr Manho.

The project, designed to accommodate 20,000 people, will incorporate a host of quality facilities including VivoCity, a shopping centre, a cinema, an open-air rooftop garden, children’s playground and amphitheatre.

Mr Manho added, “Aurecon’s approach is focused on delivering safe, comfortable and environment-friendly modern buildings that best suit client needs, budget and the surrounding environment.”

Images: The Mapletree Minhang Development Project in Shanghai will target new benchmarks in sustainability for office and public spaces, and ultimately provide a lifestyle and entertainment destination to over 300,000 residents within a 3 km radius.
Sinotech Research & Development Building is believed to be the first total Building Information Modelling (BIM) project from design to construction in Taiwan. Located in Neihu District, Taipei City, the facility occupies a plot of 3,845.2 sq m and has a total floor area of 15,285 sq m. It includes an office, a classroom, three research centres and two large laboratories. Sinotech Engineering Consultants Ltd relied on Tekla software for design, after which the company passed the Tekla model to Chien-Kuo Construction Co Ltd and Chun Yuan Steel Industry Co Ltd for construction.

Earthquake resistance

The multi-function building integrates cutting-edge technologies of sustainability, intelligent systems and earthquake resistance. Its earthquake resistant structure rests on special moment-resisting frame (SMRF) designed for 25 percent capacity of the seismic demands on the structure with bracing system. In addition, the structure uses fluid viscous damping (FVD) with energy dissipation system, the patent for which is owned by Sinotech Inc. These are mounted on the steel structure to enhance the seismic resistance of the building. It is a way to add energy dissipation to the lateral system of a building structure.

The earthquake resistance systems usually affect the space planning. A 3D visualisation can help engineer to know what kind of influence they make, and find a solution to drop down the impact. The systems are also assembled by various kinds of parts.
and conform to the required precision of installation. To avoid installation errors, the location and the size of each part should be designed accurately. Tekla Structures can help to do this, and it let Sinotech provide high precision design.

**SRC structure**

The superstructure of Sinotech R&D Building is of steel and the basement is a reinforced concrete (RC) structure. The basement’s first floor is the transfer floor for transferring the steel into the reinforced concrete structure. As a typical column at this floor is developed as steel reinforced concrete structure (SRC), the steel column is terminated at the B1 floor while the reinforcing bars continue through to the foundation.

Furthermore, as the SRC column design combined structures of steel and reinforced concrete, it is a challenge to place longitude and stirrup reinforcement bars in fixed size concrete and to avoid collision of reinforcement bars at RC beam-SRC column joint. Tekla can aid the user to achieve more detailed design, including reinforcement bars and steel coupler design. Reinforcement bars groups can be created and modified quickly and smoothly in Tekla. Besides, automated clash check can find collided reinforcement bars immediately. There are benefits of reducing collision problems and increasing design quality.

Above: Fluid Viscous Dampers, the patent for which is owned by Sinotech Inc.

**Continued overleaf**
Safety analysis

In order to avoid structural failures during construction, engineers conduct structural safety assessment and analysis for each construction stage. Engineers conducting structural analysis read the construction scheduling plan in advance. Due to use of construction simulation, the plan is effective enough to express the whole construction process, and therefore the engineers can easily find potential structural risks.

When the engineers need to analyse the building structure, they do not rebuild analytical models from 2D shop drawings. A 3D model can directly be sent from Tekla environment to structure analysis & design software, such as SAP2000. Analysis model rebuilding time can be reduced and information can be transferred more consistently, thereby increasing safety analysis accuracy during construction.

Above and right: Sinotech R&D Building integrates cutting-edge technologies of sustainability, intelligent systems and earthquake resistance. The superstructure of the building is of steel while the basement is a reinforced concrete structure.

SINOTECH

Sinotech was established in January 1993. The engineering services provided include study, investigation, planning, design, inspection, construction supervision, project management and turnkey contracts on electric power, hydraulic, urban development, industrial and agricultural development, as well as environmental, civil, architectural, mechanical, transportation and electrical engineering projects. The company currently employs over 1,300 technical personnel and has successfully completed more than 3,400 domestic assignments.

Sinotech has worked in Indonesia, the Philippines, Vietnam, Malaysia, Saudi Arabia, the Dominican Republic, El Salvador, Honduras, Fiji, Georgia, São Tomé and Príncipe, Swaziland and mainland China. To date, it has successfully completed some 140 overseas assignments.
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XCMG ‘RISING ABOVE’ YANTAI

XCMG’s 4,000 t crawler crane was recently used for the lifting of a propylene tower at the Wanhua Industrial Park in Yantai, China. The propane dehydrogenation equipment was said to be the heaviest and the hardest to lift in the project. The propylene tower has a lifting height of 118 m, diameter of 14.4 m and total weight of 1,680 t.

The XCMG XGC88000 crawler crane features a maximum lifting moment of 88,000 tm - ranked the first in the world in terms of lifting capacity, according to XCMG. For this project, the crane was fitted with a 108 m heavy boom and 33 m fixed jib, plus a 30 m operating radius. A 1,000 t XGW1100 tailing dragging equipment was also used to work with the XGC88000. The XGW1100 was jointly developed by Sinopec and XCMG for heavy lifting projects. The erection of the propane dehydrogenation equipment took about four hours to complete.

Above and below: XCMG working at the Wanhua Industrial Park, Yantai.
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The city of Wuxi, in the east of China near Shanghai, is investing heavily in the construction and extension of efficient public transport systems. At least five metro lines are to cross the city in the future. The first two metro lines, with a total length of 58.5 km, are currently under construction and expected to start operation by the end of 2014. Line 1 will cross the city from north to south while Line 2 from east to west. Herrenknecht received orders for five Earth Pressure Balance (EPB) Shields for the construction of Line 1 and three for the Line 2. The machines were assembled by the local branch Herrenknecht (Wuxi) Tunnelling Equipment Co Ltd.

The eight EPB Shields, with diameters of 6,370 to 6,390 mm, have tunnelled through the underground since July 2011. They excavated a total of almost 16 km. On 3 March 2013, they completed their mission with the final breakthrough of the S-730. With excellent performances of more than 33 m a day and 164 m a week, the TBM made its way through the ground excavating a diameter of 6.39 m. It built 2,508 m of tunnel for the Line 2 in only 10 months.

Before that the machines also mastered challenging tasks when constructing the metro tunnels for Line 1. The S-663, a compact EPB Shield with a diameter of 6.37 m, drove only a few meters beneath...
Herrenknecht TBMs play a key role on the project.

residential and commercial buildings. On 7 December 2012, the machine achieved its final breakthrough. At the start of tunnelling, on 24 May, only 7 m of soil was above the machine and the distance to the foundation pillars of the building above was only 3.7 m. Therefore, the ground, consisting of strongly aquiferous clay, was treated with a special frost procedure. Following a smooth start, the machine quickly crossed beneath the building.

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Hong Kong’s public transportation network is constantly being extended. One of the ongoing projects is the South Island Line (East), a new medium-capacity railway that is 7 km long and will be almost completely underground. At the north end of the line, the Admiralty station is undergoing upgrade work to build two new underground platforms for convenient passenger interchange with other lines. This is where the Brokk 800 demolition robot comes in handy; the machine is being used by Modern Concrete Drill Cut Company Ltd to create a 30 m long shaft. The method chosen is a jumbo drill technique, which drills holes into the bedrock. Then handheld splitters are used to break the material. Afterwards the Brokk 800 fitted with a breaker carries out excavation.

The Brokk 800, launched in 2011, is ideal for use in tunnelling work. The machine features a weight of 11,050 kg, width of 2,200 mm and minimum height of 2,647 mm. It has a vertical reach of 10,700 mm and horizontal reach of 9,400 mm.

“Our intention was to clear out around 1.5 m daily but we soon realised that this fantastic machine has even better capacity,” said OK Wong, president of Modern Concrete Drill Cut Company Ltd. “I couldn’t think of a better method for this task, combining the enormous capacity with all the normal Brokk advantages, such as electrically driven and remote control.”

“During this project the Brokk 800 is really put to the test and we are so pleased to receive this testimony from an esteemed and experienced customer,” said Martin Krupicka, MD of Brokk AB. “I am convinced that this machine will continue to triumph within the tunnelling industry all over the world.”

Modern Concrete Drill Cut Company Ltd offers demolition services including blade saw cutting, wire saw cutting, bursting, splitting, crushing etc. With a fleet of 19 Brokk machines, ranging from the smallest Brokk 40 to the largest Brokk 800, the company puts a strong emphasis on the environment-friendly demolition concept such as low noise level and vibration-free method. The company operates offices in Shanghai, China; Hong Kong; Macau and Singapore.
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Advocates

Developer Category  Platinum

CITY DEVELOPMENTS LIMITED

- The adoption of the prefabricated bathroom units (PBU) in CDL’s residential developments is one of the company’s key productivity initiatives. The use of PBU improved construction productivity by about 77 percent. It also reduced construction waste while improving water tightness of the bathrooms. To date, CDL has installed close to 8,000 PBUs in its residential developments.

- CDL has pioneered the adoption of drywalls since 2000. Drywalls are easier to install, less labour intensive and provide a better quality finish compared to the traditional brick wall. To date, CDL has constructed and handed over more than 7,000 residential units with drywalls.

- Since 2011, CDL has kickstarted the adoption of Building Information Modelling (BIM) during the planning and construction phase of its projects. The use of BIM helped facilitate better teamwork among the consultants and builders to improve the overall productivity, safety and quality of the projects. The Quayside Isle was the first project by CDL that was designed using BIM. Since then, all new projects by CDL have adopted BIM in their design and construction phase.

- CDL has also inculcated productive construction methods in its builders. These include the ‘no external scaffold’ and ‘no struts to basement’ methods, which are more labour efficient, easier to construct and provide a better quality finish.

HOUSING & DEVELOPMENT BOARD

- The HDB Construction Productivity Framework is a three-stage approach to drive productivity at pre-construction, construction and post-construction stages.
  - One initiative during the pre-construction stage is the use of Building Information Modelling (BIM). It allows all parties of a project to communicate via a common platform, thus reducing construction conflicts upfront during the design stage.
  - At the construction stage, HDB requires its builders to make use of more productive equipment.
  - During the post-construction stage, HDB reviews design guidelines, materials, construction details and methods based on the feedback from residents. Lessons learnt will be used to improve the design and construction of future projects.

- HDB has advocated the use of precast technology since the 1980s. Examples of precast building components include precast facade with cast-in windows, columns, floor slabs, staircases and refuse chutes. In recent years, HDB further optimised the use of precast components coupled with large panel system formwork. The optimisation enabled HDB to achieve higher productivity gains.

- Under the lift upgrading programme (LUP), the use of steel structure with aluminium cladding for the lift shafts was introduced in 2007. As the steel lift shafts weighed only a fraction of the conventional RC shafts, a longer section of the shaft could be hoisted each time, thus improving the efficiency of the hoisting operation. In addition, the use of steel shafts eliminated the need to grout different sections of the lift shafts thereby saving time and manpower. Machine roomless lifts were also designed such that most of the components could be placed within the shaft containing the lift car. As no machine room was required, there was a reduction in construction time and cost.
Chip Eng Seng Contractors advocates the use of precast concrete components extensively in its projects. This would minimise the in-situ structural works on site and reduce the reliance on foreign workers. The firm has even set up its own precast yard to produce a wide range of precast components. The first precast yard was set up in Tampines in 2003 while a second yard was set up in Senai, Malaysia in 2010.

Since 2007, the firm has adopted the use of system formwork including table form, jump form and aluminium form in its projects to improve productivity.
Advocates

Consultant Category

ADDP ARCHITECTS LLP

- ADDP Architects is equipped with the experience and knowledge in designing buildable systems such as the prefabricated bathroom units (PBU) and drywalls in its residential projects. The buildable design score for projects like Parc Emily, Wilkie Studio and Cliveden @ Grange were 88, 84 and 86 respectively.

- The on-site precast yard was strategically set up in the Sengkang N4 C16 project to eliminate the transportation of precast components from the factory to the site. Approximately 30 percent of the precast elements were cast in the on-site precast yard. The just-in-time approach was used during the installation process to minimise the storage space of the precast components.

Builder (Open) Category

KIMLY CONSTRUCTION PTE LTD

- The firm also actively shares knowledge with the industry through seminars and contributes articles to different publications.

- The firm also adopted BIM in the Tresalveo project to simulate the construction schedules and detect clashes between mechanical and electrical (M&E) services. This reduced the number of reworks and improved the productivity on site.
DLE M&E PTE LTD

• With co-funding from the Mechanisation Credit (MechC) Scheme, DLE purchased scissor lifts to improve the efficiency of electrical conduit installation. This method has since replaced the traditional method of erecting scaffolds, which is highly labour intensive.

• DLE also placed great emphasis on training and upgrading the skills of its workers. The firm has successfully utilised the Construction Productivity & Capability Fund (CPCF) to help subsidise the training cost.

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Institutional Buildings Category

ITE HEADQUARTERS AND ITE COLLEGE CENTRAL @ ANG MO KIO

The eighth-storey ITE College Central and Headquarters comprise an administration block, four school blocks, three workshop blocks, an aerospace block and a sports block.

- Extensive use of precast and prefabricated elements helped the project achieve high construction productivity. There was minimal use of labour, which resulted in reduction of labour cost. Elimination of formwork and staging also produced a clean and safe working environment.

- Drywall construction was adopted to achieve faster construction timeline and superior quality control. The minimal wet trades on site resulted in on-site energy conservation and less wastage.

- The use of system formwork greatly reduced the time and manual labour involved in setting and striking the formwork. Large areas of slab were simpler, faster and safer to form.

- Modular system comprising steel lintels and stiffeners replaced the traditional use of reinforced concrete stiffeners, which resulted in the easier installation. This saved time and manpower.

Project Team

Architectural Consultant:
RSP Architects Planners & Engineers (Pte) Ltd

Structural Consultant:
RSP Architects Planners & Engineers (Pte) Ltd

M&E Consultant:
Squire Mech Pte Ltd

Builder:
Kajima Overseas Asia Pte Ltd

Client:
Institute of Technical Education

Construction Cost:
S$394,050,000

Gross Floor Area:
192,820 sq m
Tiong Seng Prefab Hub is a five-storey single-user general industrial building (precast factory) with ancillary concrete batching plant and temporary workers’ dormitory at 63 Tuas South Avenue 1 (Tuas Planning Area).

- High volume of precast was incorporated in the construction, thus reducing in-situ casting and increasing productivity. Double tee slab was used at every level instead of in-situ slab, which helped in reducing manpower, time, cost and risk of working at height.

- ST100 shoring system was used to support main beams weighing 32 t. This eliminates the need to dismantle and re-erect traditional scaffolding if there is a change in location, which in turn reduces manpower and improves productivity.

- Peri’s RCS climbing system was used for all staircases and lift shafts. This sped up processes and helped to achieve better quality off-form finishes.

- Steel fibre reinforcement slab was used instead of welded mesh in the construction of the external driveway. This helped to reduce manpower, time and cost.

- Precast elements and advanced formwork system were used to achieve off-form finishes. The project also used dust free grinder, which is handy and easy to use, to achieve better productivity and quality.

**Project Team**

Architectural Consultant:
Look Architects Pte Ltd

Structural Consultant:
LSW Consulting Engineers Pte Ltd

Builder:
Tiong Seng Contractors (Pte) Ltd

Client:
Robin Village Development Pte Ltd

Construction Cost:
S$12,000,000

Gross Floor Area:
19,813.11 sq m
VoLaRi is a condominium housing development comprising one block of 12-storey residential units with a basement carpark, swimming pool and communal facilities.

- Improved productivity was achieved by using a full precast envelop system. The external walls with full precast components eliminated the need for scaffolding, which was time consuming and laborious.
- The project was able to achieve a seven-day per floor cycle consistently, thus easing space constraint on site in having to stock up materials required for conventional wet work. This also helped keep the site tidy and clean.
- Peri’s Skydeck system was used for slab construction and Peri’s SRS steel formwork system was used for the vertical components. This cut down on construction time and reduced manpower.
- Dry wall partition was used for most internal walls. They can be installed easily, requiring less labour.
- Prefabricated bathroom units (PBU) were installed in this development, resulting in reduced construction time.
- Conversion of common reinforced concrete staircase to steel staircase allowed the staircase to start its modular production prior to the construction of RC structural wall. This helped to shorten the time needed to construct the structure and eased the carpentry manpower for precast yard.
- The ‘one push-press fitting technology’ was adopted in this project. This system does not require any tools during installation. It only requires a press-to-fit action to secure the water pipes, thus reducing manpower. Lesser space was also needed for storage.
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Fixed gangways are bridge buildings that connect the terminal building and docking aircrafts at second storey. This project involves the replacement of 14 fixed gangways with dimensions of approximately 32 m (L) x 3.15 m (W) x 2.8 m (H).

- Repetition of design module and modularisation of steel truss enabled standardisation of member size, length and connection details. Standardisation streamlined coordination, fabrication and reduced wastage. It also improved speed of construction.
- Extensive pre-fabrication was adopted in this project. Pre-fabrication at the off-site yard helped to achieve better coordination control to meet tight construction schedule.
- Steel members were assembled at an off-site yard and this allowed only simplified construction on-site that substantially reduced the use of material, temporary works and manpower needed. Minimised on-site installation and temporary works also reduced the disruption of airport operation.

**Project Team**

Architectural Consultant:
RSP Architects Planners & Engineers (Pte) Ltd

Structural Consultant:
RSP Architects Planners & Engineers (Pte) Ltd

M&E Consultant:
Squire Mech Pte Ltd

Builder:
Takenaka Corporation

Client:
Changi Airport Group (Singapore) Pte Ltd

Construction Cost:
S$23,925,716

Gross Floor Area:
1,700 sq m
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Punggol Green Primary School is a new primary school commissioned by the Ministry of Education, comprising two blocks of five-storey teaching facilities, one block of multi-purpose hall and one block of indoor sports hall with canteen at Punggol Field/ Punggol Walk.

- The project adopted the modular concept, repeats in its structural grids, opening and services core. This concept allowed systematic repetition of a typical layout from floor to floor. Modular size was adopted for ease of construction, thus saving time and manpower.
- Extensive use of precast concrete was adopted to hasten the construction speed and enhance its buildability. The classroom blocks were fully precast including the first storey and roof. The extensive use of precast elements such as precast columns, beams, hollow core slab, planks and staircases resulted in less labour requirement, improved safety, quality and higher productivity.
- The use of precast external facade walls instead of brick wall system helped to reduce the construction cycle and improve the water tightness of the building envelope.
- Internal drywall system in lieu of conventional brick wall helped to ease construction and reduce wet trades on site, thereby increasing the efficiency and speed of construction. This also resulted in higher quality finish, faster installation and better housekeeping.
- Building Information Modelling (BIM) was adopted in this project to better visualise building details and detect clashes to avoid abortive work. The team had a clearer overall vision of the project and was able to firm up decisions quickly.

Project Team
Architectural Consultant:
ID Architects Pte Ltd
Structural Consultant:
DE Consultants (S) Pte Ltd
M&E Consultant:
AECOM Singapore Pte Ltd
Builder:
Lian Soon Construction Pte Ltd
Client:
Ministry of Education, Singapore
Construction Cost:
S$24,966,500
Gross Floor Area:
19,984.36 sq m
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Punggol East Contract 21 (PEC21), also known as Punggol Spring, is located at the junction of Punggol Drive and Edgefield Plains. It comprises five blocks of 17-storey residential blocks, one multi-storey carpark with electrical sub-station, and one precinct pavilion.

- The full precast system simplified the construction as it provided standardisation and repetition of precast components for every storey. Thus lesser manpower was needed, resulting in an increase in productivity. The off-site production of precast components also resulted in better quality finishes.

- Steel lift frames and aluminium cladding system were used for the construction of lift shafts. The steel frames were fabricated off-site and pre-assembled to two-cores steel frames before being delivered to the site. The installation of steel lift frames in two-storey duplex modular section by means of bolts, nuts and welding reduced the construction time on site. It also contributed to the ease of construction and improved productivity.

- The Bioswales system, an environment-friendly system, was adopted in the project. It takes on the cleansing function by treating storm water through fine filtration and improves water quality. It is a self-sustaining system that requires minimal maintenance.

**Project Team**

- Architectural Consultant: Surbana International Consultants Pte Ltd
- Structural Consultant: Surbana International Consultants Pte Ltd
- M&E Consultant: Surbana International Consultants Pte Ltd
- Builder: Qingjian International (South Pacific) Group Development Co Pte Ltd
- Client: Housing & Development Board

**Construction Cost:**

- S$99,960,000

**Gross Floor Area:**

- 61,964.50 sq m
**Projects**

Residential Non-Landed Buildings Category $\geq$ 25,000 sq m  
**Gold**

**THE PEAK @ TOA PAYOH**

The Peak @ Toa Payoh is a public housing development comprising two blocks of 42-storey residential flats with sky terrace at the 22nd storey and three blocks of 40-storey residential flats. It is located at Lorong 1A Toa Payoh.

- Extensive use of precast components, which were cast off-site and delivered to the worksite prior to installation. The extensive use of precast planks had enabled the slabs to be cast with minimal formwork, saving considerable time in the construction of the superstructure.
- An identical and mirror image unit layout was adopted for the entire elevation of each building block. Due to the simplified design, the types of precast moulds and material required for the fabrication of mould were also reduced. Moreover, manpower and potential errors during construction were also minimised.
- Precast internal partition walls were used in this project instead of the conventional brick walls. The method of installation of the precast partition walls is a cleaner and faster alternative that requires only bedding material and welding works for the connection joints. Manual transportation of bricks to the units was thus eliminated, resulting in reduced labour cost and time.

**Project Team**

Architectural Consultant:  
JGP Architecture (S) Pte Ltd  
Structural Consultant:  
BC Koh & Partners LLP  
M&E Consultant:  
J Roger Preston (S) Pte Ltd  
Builder:  
Straits Construction Singapore Pte Ltd  
Client:  
Hoi Hup Sunway JV Pte Ltd  
Construction Cost:  
S$293,587,318  
Gross Floor Area:  
126,931.12 sq m
Woodlands N2C12 (Straits Vista) is located in Woodlands, fronting Marsiling Lane. The development comprises two 30-storeys and one 26-storey residential blocks with 382 units of three- and four-room flats, complemented by a generous central green space filled with varied amenities and a four-storey multi-storey carpark.

- Most of the structural vertical columns and walls for the project were designed as precast solid components, which eliminated the reliance on labour intensive and time consuming erection of external scaffold, external formwork and platform system.
- Part of the main water pipe was fitted with stainless steel press-fit fittings to prevent leakage at the joints. Press-fit fittings use clamping technology, thus are easier to install.
- Ferrolite lightweight partition panels were used in most areas, except wet areas, to increase productivity due to its fast, easy and economical installation without compromising integrity and insulation performance.

**Project Team**

Architectural Consultant: Surbana International Consultants Pte Ltd
Structural Consultant: Surbana International Consultants Pte Ltd
M&E Consultant: Surbana International Consultants Pte Ltd
Builder: Ho Lee Construction Pte Ltd
Client: Housing & Development Board
Construction Cost: S$63,970,000
Gross Floor Area: 53,437.36 sq m
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