

Annex – BCA Design and Engineering Safety Award winners

DESIGN AND ENGINEERING SAFETY AWARDS 2024

Rivière

 <i>Photo Credit: SCDA Architects & Finbarr Fallon</i>	Qualified Person	Er. Aaron Foong Kit Kuen
	C&S Consultant	KTP Consultants Pte Ltd
	Builder	Woh Hup (Pte) Ltd
	Developer	Frasers Property Singapore
	Architectural Consultant	P&T Consultants Pte Ltd

Key Challenges

- Challenging geology consisting thick layers of soft Marine Clay with unbalanced lateral earth pressure swaying towards Singapore River housing three levels of deep basements.
- Tight site with one single access point surrounded by existing buildings and the Singapore River requiring optimization of the construction productivity both on-site and off-site.
- Meticulous restoration of three units of a century old Godown heritage buildings with stringent conservation requirements to create new connectivity, improve sheltered accessibility and spatial specifications for modern commercial use.

Solutions and Features

- Engineering-led innovation and collaborative team approach realizing the strut-free circular earth retaining structures made up of diaphragm wall panels for the basement construction enabling high productivity, robust and an overall buildable solution.
- Dual-pronged approach in combining numerical engineering modelling methods and experimental testing of the PPVC wall structures to ensure safe and optimized DfMA installation for the high-rise construction.
- Restoration transformation delivered via rigorous engineering analysis with carefully considered loading scenarios and in-depth investigative testing to ensure structural integrity of the newly integrated structures while maintaining the charm of the key historical features.

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CapitaSky

 Photo credit to CapitaLand	Qualified Person	Engineer Yiong Hoi Liong
	C&S Consultant	P&T Consultants Pte Ltd
	Owner	79RR LLP (CapitaLand)
	Builder	Shimizu Corporation
	Architectural Consultant	DCA Architects Pte Ltd
	Geotechnical Specialist	Professor Harry Tan Siew Ann
	Specialist Consultant	Meinhardt (Singapore) Pte Ltd
	Specialist Consultant	KK Lim & Associates Pte Ltd
	Concept Architect	Gensler Singapore Pte Ltd

Key Challenges

- Located at former Central Provident Fund (CPF) building, CapitaSky 185m tall, 29-storey Grade A Office Building is the **1st Commercial Redevelopment Building** in Central Business District (CBD) to **REUSE 100% of Existing Bored Piles**.
- Former CPF building was supported on 186 bored piles and a 10m thick cellular raft with two basements of 10m deep basement walls that were built along the boundary line site basement plan of 100m length by 33m width within close proximity of other adjacent high-rise buildings.
- The site is in close proximity to the existing underground railway tunnels (East-West Line) along Robinson Road and within LTA Railway protection zone (1st Reserve line).

Solutions & Features

- Adoption of Design for Manufacturing and Assembly (DfMA) with implementation of Integrated Digital Delivery (IDD) to integrate the work processes from design, fabrication and assembly on-site, as well as the operations and maintenance of the building, Productivity improved by 45%.

DfMA

- Hybrid Structural System - Precast Perimeter Columns/ Precast Central Corewalls & Precast Perimeter Beams with Steel Structural Beams / Steel Structural Deckings.
 - 17m Long Cantilever Steel Truss System for 9m high clear ceiling at Level 2 Main Lobby.
 - Building self-weight is significantly reduced with steel structural elements which attributes lighter foundation. This is an Important Contribution factor for the REUSE of existing bored piles
- Sustainable Design – Reduce, Reuse & Recycle – REDUCTION OF EMBODIED CARDON EMISSION – 37% Reduction in Carbon Emission for 100% Reuse of Existing Piles with saving of 8400tons of Concrete for new piles.
 - REUSE of all Existing 186 Bored Piles and 42 New Bored Piles for the foundation works
 - RETAIN Existing substructures and cast a new 3m thick pile raft within existing basements which successfully minimized environmental impact and avoided excessive ground movement to safe guard surrounding buildings and the railway tunnels.

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Surbana Jurong Campus

 <i>Photo credit to Surbana Jurong & Darren Soh</i>	Qualified Person	Er. Aaron Foong Kit Kuen
	C&S Consultant	KTP Consultants Pte Ltd
	Builder	Boustead Projects E&C Pte Ltd
	Developer	Surbana Jurong
	Architectural Consultant	Surbana Jurong Consultants Pte Ltd
	Concept Architect	Safdie Architects

Key Challenges

- Inverted pyramid self-shading structures of the blocks with over one-third of the narrowest Eastern Block's building footprint cantilevered over the base of the building.
- Intricate engineering design solution using sophisticated linkage structures was required to enable seamless connectivity across the ten blocks and translucent spatial quality of the atrium space for the biophilic development.

Solutions and Features

- Innovative Design for Manufacture and Assembly (DfMA) design strategies using Precast Post-tensioned Concrete Vierendeel frames in the Eastern Blocks is underpinned by rigorous engineering research via high granular modelling and scenario-based nonlinear analysis, ensuring the cantilevered building structures remain durable under the effect of concrete creep and shrinkage in long run.
- 8-storey high steel "A" frame structures feature slender vertical columns coupled with slanted columns supported by long-span compression arch that connect all ten blocks with aerial walkways and support full-height glass facade. Meticulous buckling analysis was conducted to reconcile complex load paths and ascertain effective length of structural elements, considering the complex geometrical conditions.
- The fully cantilevered entrance canopy, up to 16 metres in length with a remarkable span-depth ratio of 40, carries the glass canopy without any support of conventional tiebacks, requiring sophisticated parametric analysis and robust structural design. This innovative engineering design of translating the vertical lever arm to a horizontal plane was inspired by the Artist's Conk fungus.

- Complex engineering integration of bridging elements, via the multi-storey hanging bridging buildings spanning 31m interwoven with the elegant demountable tensile lightweight cable structures in the atrium roof spanning 40m, enables seamless connectivity across all the blocks, contributing to a sustainable, resilient, and immersive biophilic environment.

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BCA Braddell Campus Phase 2 Intensification Project

 <i>Photo credit to Xylia Chen</i>	Qualified Person	Er. Chan Ewe Jin Er. Sharron Ng
	C&S Consultant	ECAS Consultants Pte Ltd
	Builder	Dragages Singapore Pte Ltd
	Developer	Building and Construction Authority
	Architectural Consultant	ADDP Architects LLP

Key Challenges

- Implementation of 3 different types of Design for Manufacturing and Assembly technologies (DfMA) in one project within a fixed timeline.
- The adoption of Mass Engineered Timber (MET) as construction material in Singapore's wet-and-hot cyclical weather condition.
- Prop free construction installation method to be adopted. Erection and construction without the use of temporary propping and support
- The adoption of 6-sided PPVC poses constraints to the space utilization requirement in the design e.g. office space etc.

Solutions and Features

- Integrated Project Delivery (IPD) and Virtual Design and Construction (VDC) were adopted and supported by the "Big Room" and Integrated Concurrent Engineering (ICE) concept work to achieve close collaboration and ensure the success of the project in a timely manner.
- Meticulous moisture management for the MET structure with a systematic moisture monitoring plan during construction stage to ensure moisture can be wicked off and prevention of the water standing after each rain event. Good practices were also put in place to ensure no standing water collected on the Cross Laminated Timber (CLT) or being trapped in the MET connections.

- For Prop free erection, the structural steel cores at the 7-storey block (MET) were first erected for structural stability and acted as a safe working access. This was followed by zone-by-zone installation with the sequence of column-beam-CLT in each zone. For the 16-storey tower block with the adoption of Advance Precast Concrete System (APCS) and open module, the team devised a 3-dimensional APCS wall i.e. precast L-shape wall.
- Open module i.e. an inverted “U” system which omitted the bottom slab provides more flexibility in spatial configurations for open office space in design leading to less boxy building envelope.

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JTC Logistics Hub @ Gul

 <i>Photos credit to Kimly Construction Pte Ltd</i>	Qualified Person	Er. Kam Mun Wai
	C&S Consultant	Meinhardt (Singapore) Pte Ltd
	Builder	Kimly Construction Pte Ltd
	Developer	JTC Corporation
	Architectural Consultant	AWP Pte Ltd
	Structural Steel Specialist	SEN SG Pte Ltd

Key Challenges

- JTC Logistics Hub @ Gul is an integrated facility comprising a 9-storey multiple-user ramp up warehouse, an Inland Container Depot (ICD) and a heavy vehicle park, all under one roof.
- The design of both the warehouse and ICD involves long span structures ranging from 12m to 22.65m and high imposed loadings.
- The ICD is high-volume, with stringent inter-storey drift control and slender columns of up to 45m.

Solutions and Features

- Advanced DfMA technologies with prop-free construction was adopted. Hybrid structural systems that are highly buildable, are engineered to overcome the unique challenges and requirements of the warehouse and ICD.
- The warehouse adopts full precast concrete construction for the beams, ribbed slabs, columns and walls, stitched with in-situ concrete topping to achieve monolithic framed structure. The precast ribbed slabs and beams are acting as permanent formworks which avoid the need of temporary falsework during erection.

- Innovative steel is implemented for the ICD, pioneering the first application of the SEN System in Singapore. The system consists of two traits - Thin Steel-plate Composite (TSC) Beams and Form Prefabricated Steel Reinforced Concrete (FPSRC) Columns.
- The 45m high FPSRC columns are cast-in-situ concrete columns which are reinforced with steel lattices, prefabricated using battened structural angles. The system is ideal for productive erection and casting of the tall concrete columns in the ICD.
- The project is executed with Integrated Digital Delivery (IDD), embracing virtual design, automation and smart construction technologies. Deployment of super high performance cranes (up to 64 ton capacity), is implemented to improve site safety, buildability and precast supply resilience.

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Contract T219 – Construction of TEL Orchard Station and A&A to NSL Orchard Station

 <i>Photos credit to Finbarr Fallon</i>	Qualified Person	Er. Lim Soon Hui
	C&S Consultant	AECOM Singapore Pte Ltd
	Builder	Penta-Ocean / Bachy Soletanche Joint Venture
	Developer	Land Transport Authority
	Architectural Consultant	SAA Architect Pte Ltd

Key Challenges

- To convert existing Orchard MRT station into a major interchange station with minimal disruptions to train operations and inconvenience to patrons of ION Orchard shopping mall and residents staying at 56 storey high end ION Orchard Condominium.
- To design and construct a shortest and direct platform link between TEL and NSL below the existing Orchard station without compromising operational requirements.
- To engineer a workable and safe solution in mining sequence, underpinning at the existing Orchard Station without compromising the structural integrity.
- To construct platform link below Orchard Boulevard without temporary traffic diversion and open cut top-down or bottom-up construction.

Solutions and Features

- Designed mining and underpinning scheme without compromising pile load transfer, existing NSL base slab deflection and track movement. Strategic placement of instruments ensured the monitored data in par with step-by-step modelling on mining, underpinning and pile cutting operations without disrupting train operation.
- Designed innovative mini steel pipe pile with double flat jack installed, to ensure existing NSL base slab is supported during the mining and underpinning operation. Deployed a special tailored-made low headroom multi-task piling machine for boring into hard strata, following the lowering of rebar cage and threaded steel piles prior to casting and grouting operation.
- Adopted 1200mm diameter pipes together with retractable micro-tunnel boring machine (M-TBM) and steel frames formed an interlocked water-tight canopy roof for the mining underneath the existing Orchard Boulevard without temporary traffic diversion for the deep platform link construction.