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BOUYGUES BATIMENT
INTERNATIONAL
Bouygues experience of Concrete PPVC in Singapore and Dragages' vision for MiC in Hong Kong
April 2021

Contents

1. Experience Sharing of Concrete PPVC in Singapore
2. Experience Sharing of DfMA solution in Hong Kong
3. Challenges facing in Hong Kong and our Vision

MiC

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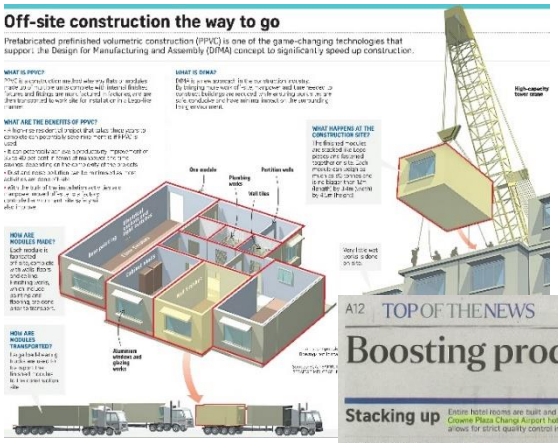
1. Experience Sharing of Concrete PPVC in Singapore

History of PPVC in Singapore

- Singapore Government through Building and Construction Authority (BCA) started PPVC initiative 7 years ago in **2014**
- PPVC development was started as low rise building, such as student hostel, low rise building and 10-storey hotel



Artist's Impression of City Development Limited's (CDL) Executive Condominium at Canberra Drive (Photo credit: CDL)

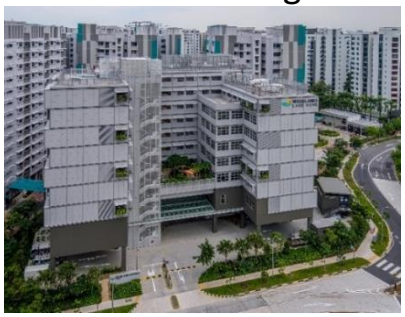
Dragages Singapore PPVC Experience

Crowne Plaza Hotel Extension

Steel PPVC System

10 storey hotel, 252 PPVC modules

Woodlands Nursing Home



Hybrid PPVC System

9 storey nursing home,
343 PPVC modules

Clement Canopy

Concrete PPVC System

40 storey residential (505 units),
1866 PPVC modules

Park Colonial, Woodleigh

Concrete PPVC System

6 blocks, 14-15-16 storey apartments
(837 units),
2514 PPVC modules

Garden Residences, Serangoon

Concrete PPVC System

5 blocks, 15 storey apartments
(613 units),
2012 PPVC modules

Perumal Road

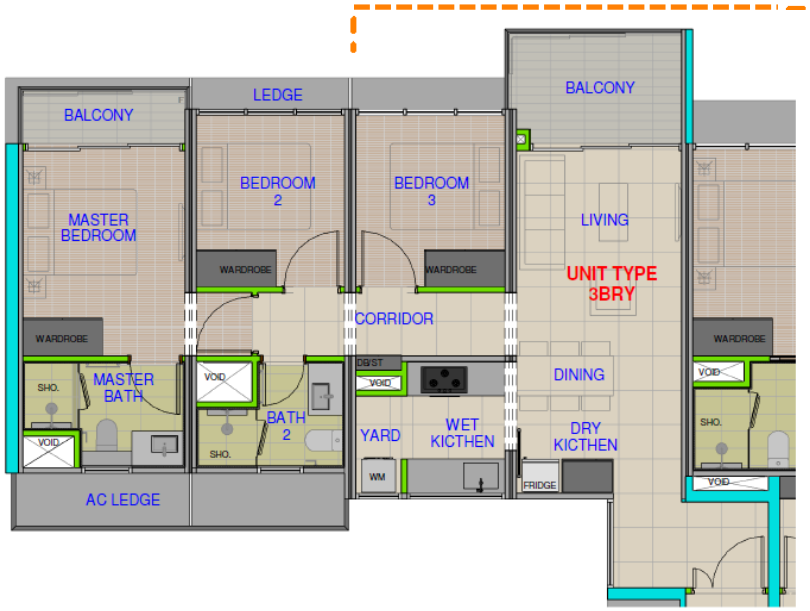
Concrete PPVC System

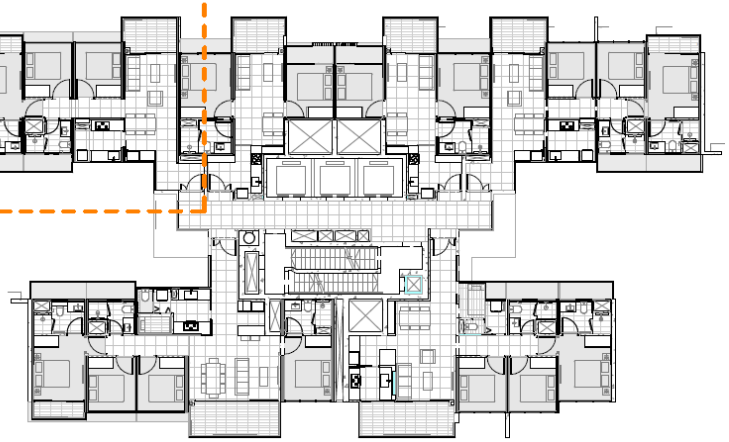
1 tower 23 storey residential (116 units)
1 tower 18 storey service apartment (240 units)
680 PPVC modules

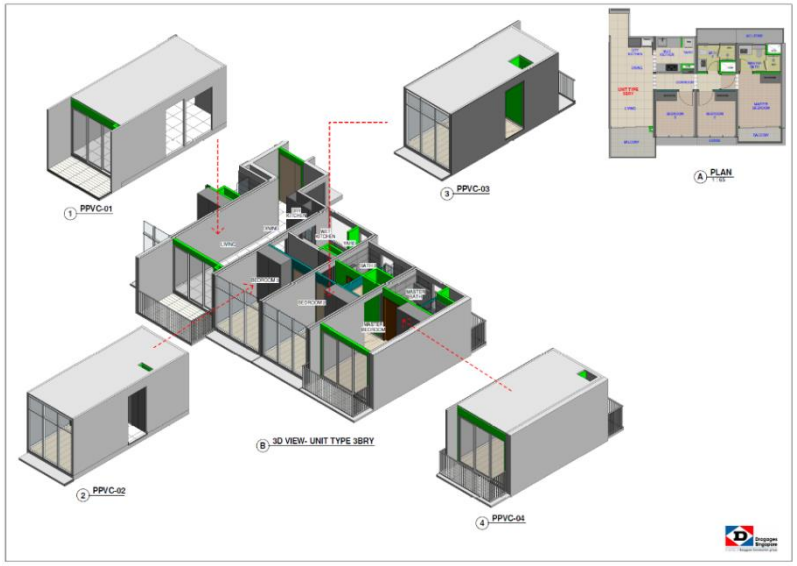
Clement Canopy

- Tallest Concrete MiC in the world
- 46,000m2 GFA in a **40-storey** building
- Client: UOL Venture Development (Clementi) Pte Ltd
- 2 Blocks, 22 modules + 26 modules per floor
- Total **1,866** modules
- Weight of one module: **~18 to 29 tons**
- Module type: **Concrete module**
- Precast yard : Malaysia
- Fitting Out yard: Singapore
- Status: MiC Installation Completed

Modular design for Bedroom Unit







PPVC WALL SYSTEM 200mm THK

EXTERNAL RC WALL – CAST IN SITU

PARTY WALLS: 75-100mm THK drywall/blockwall

- Largest Module size - 8.35m x 3.1m x 3.15mH
- Smallest Module size - 5.75m x 3.0m x 3.15mH
- Module weight between **18 Ton** and **29 Ton**
- Maximum Width of the module - **3.1m**
- Height of the module - **3.15m**

PPVC Construction

Stage 1 – Carcass Fabrication – Malaysia


Panel fabrication / casting


3D Module after casting


Module ready for delivery

Stage 2 – Fit Out Installation – Singapore

Module arrangement


Fit out works


Module ready for delivery

Stage 3 – Site Installation

Preparation for Transfer Slab


Lifting process

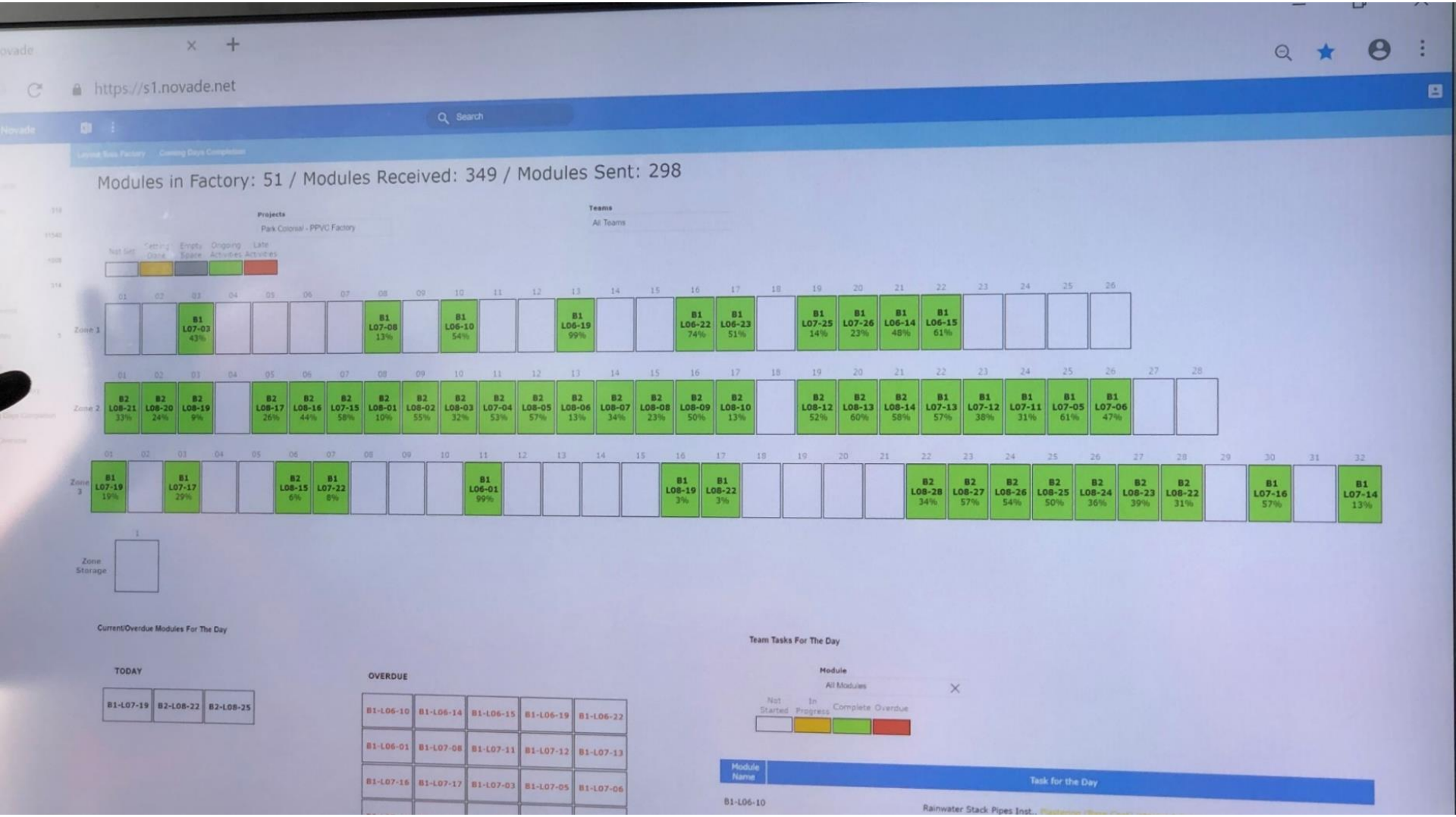
PPVC Module is installed

Precast Yard in Malaysia

Dry Fitting-out Plant in Singapore

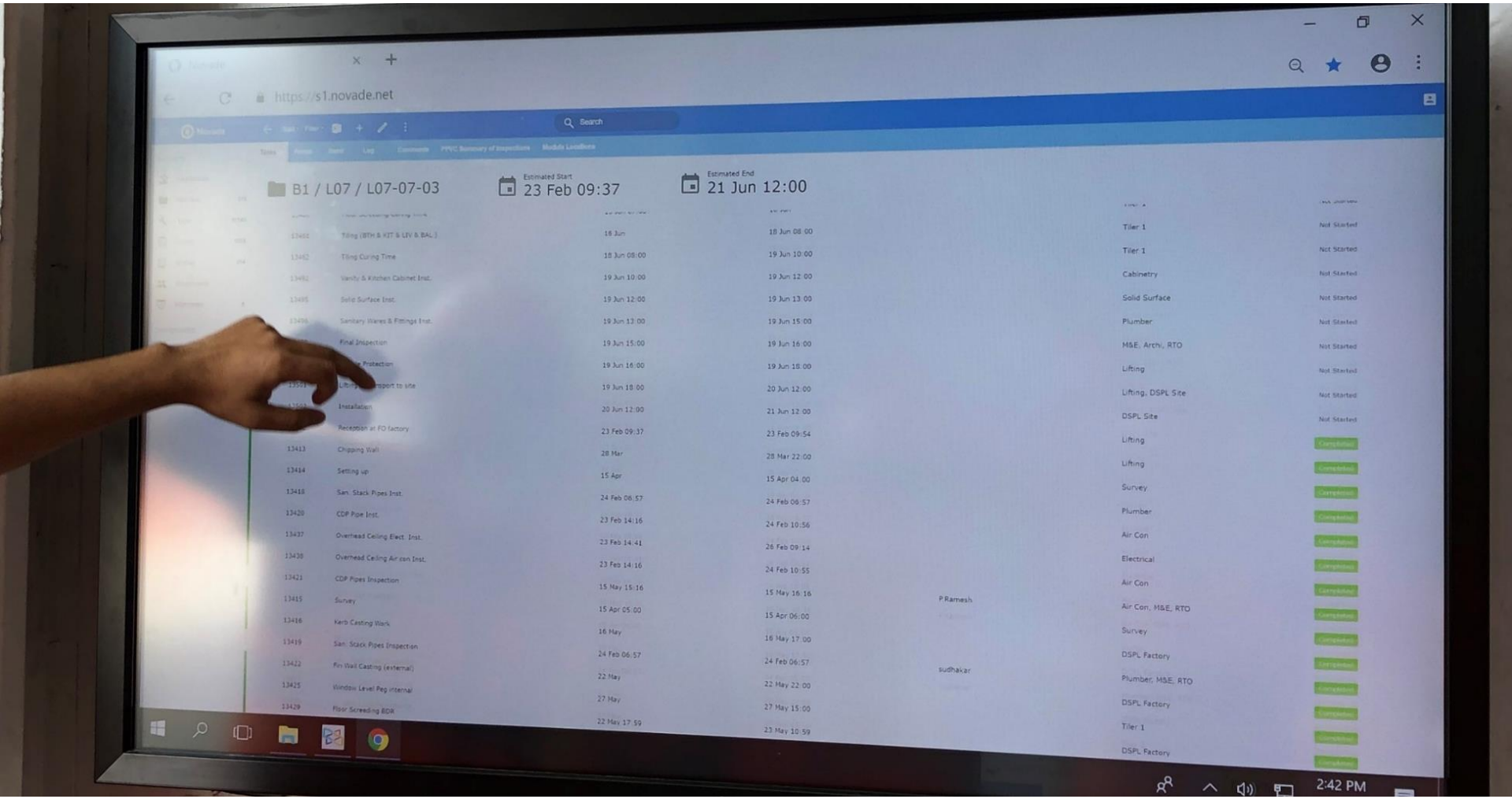
Dry Fitting-out Plant in Singapore

- **Full Digitalization** for work trade management



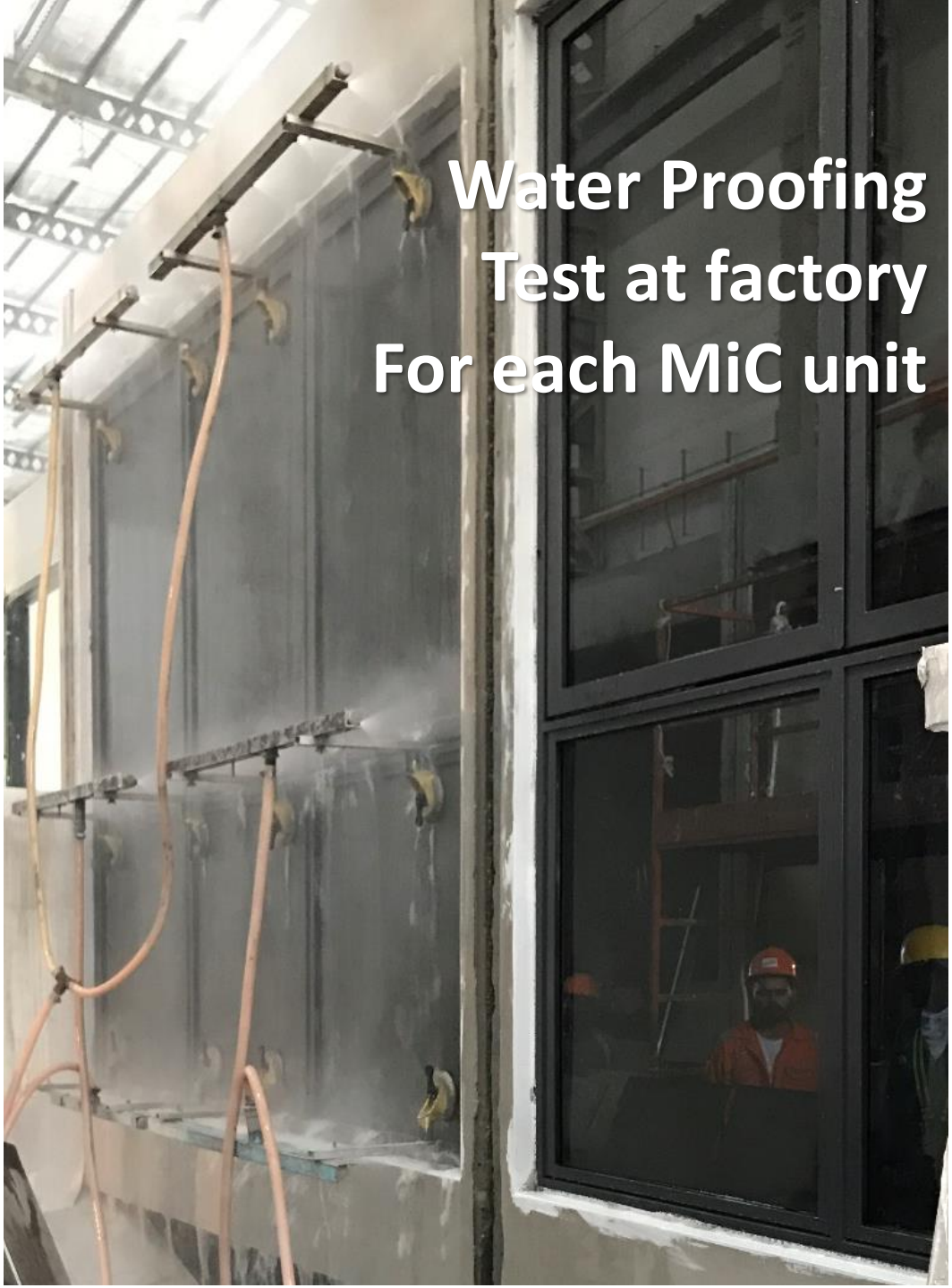
Dry Fitting-out Plant in Singapore

- **Full Digitalization** for work trade management



Block Works

External Façade Installation


Water Proofing
Test at factory
For each MiC unit


Protection works before
delivery to site
DRAGAGES

Concrete MiC Lifting on site

Concrete MiC Lifting on site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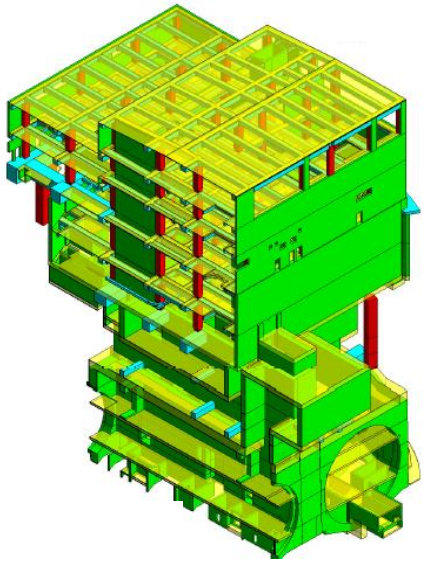
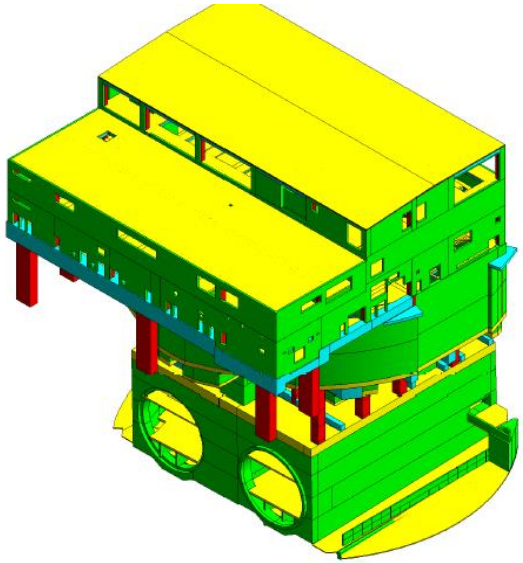
2. Experience Sharing of DfMA solution in Hong Kong

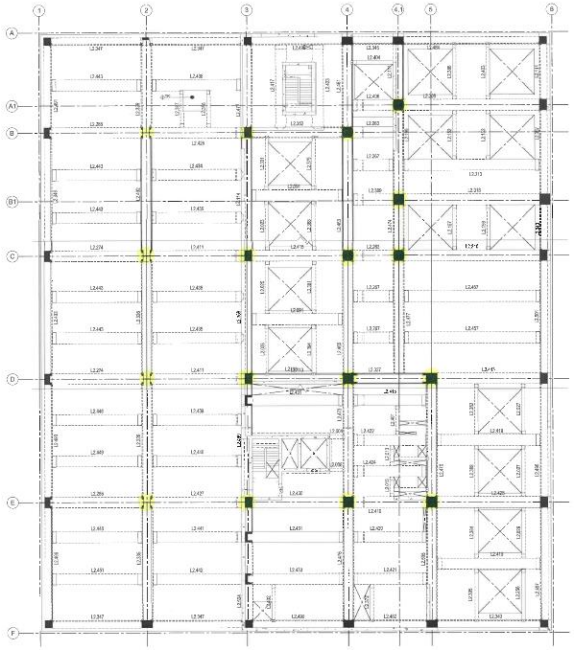
DfMA Solution for Ventilation Building in TMCLK project



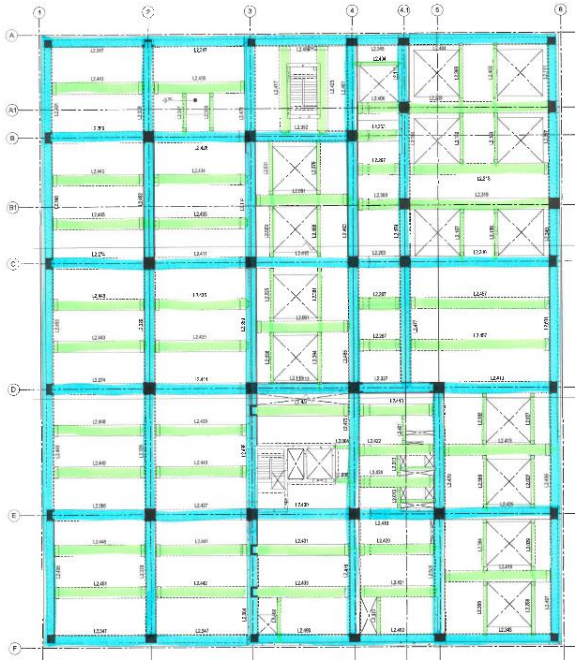


DfMA Structural Component

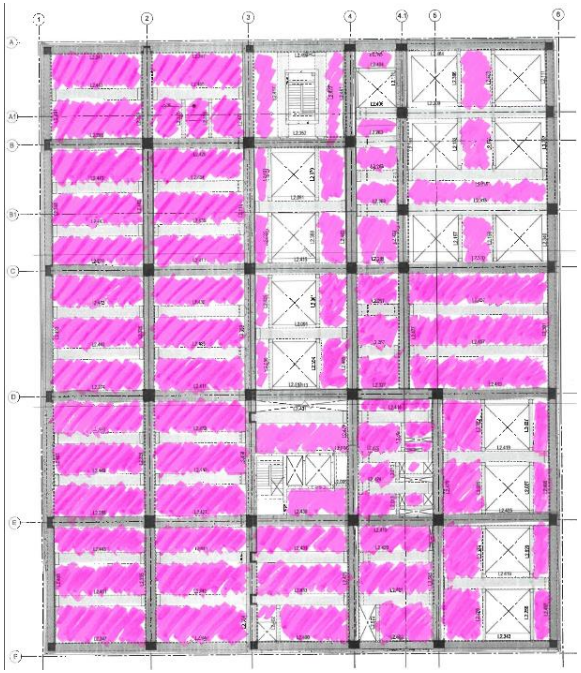
1) Columns



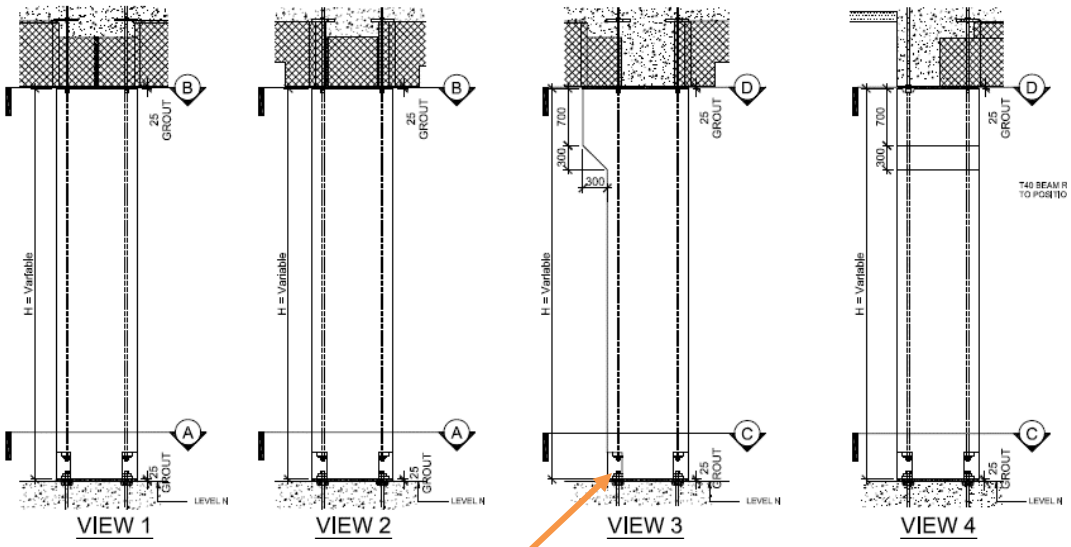
2) Beams



3) Slabs



DfMA Precast Column

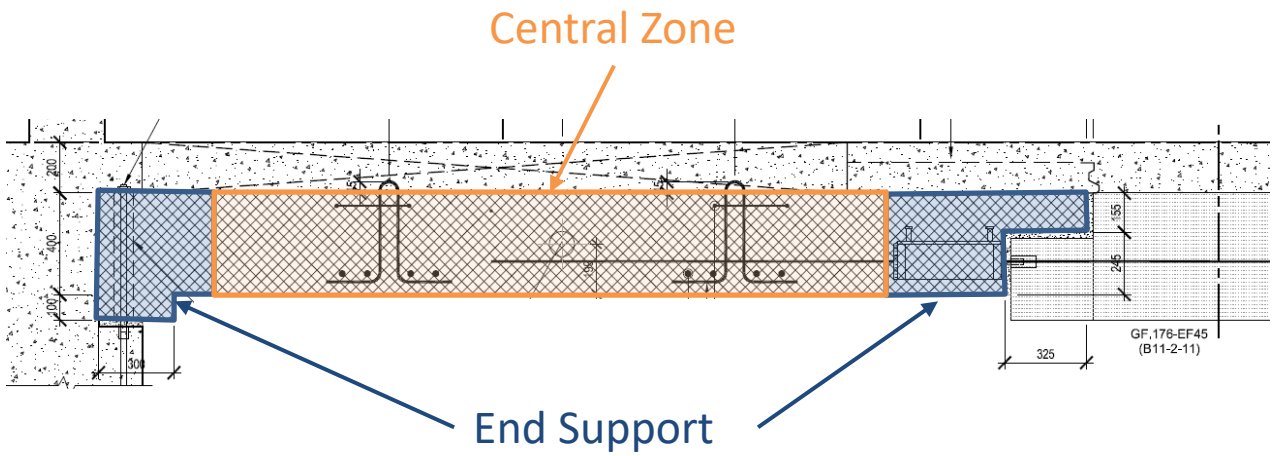


- 2 types of moulds
- 2 columns fabricated per day

Base support

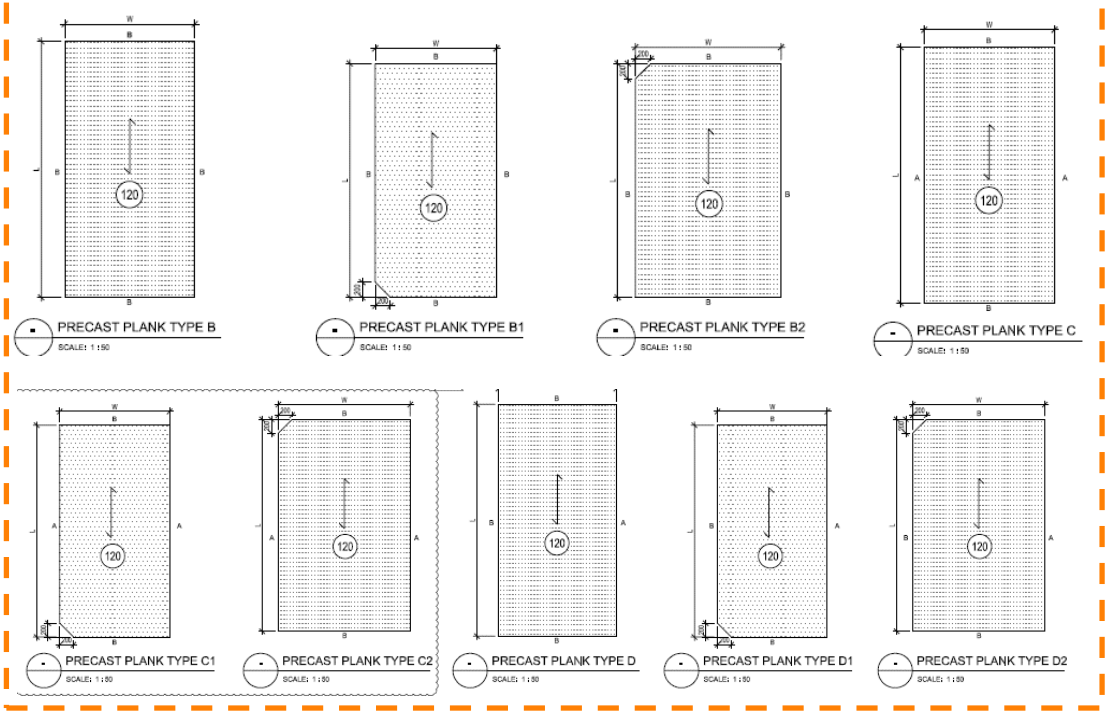
Column with corbel

DfMA Precast Beams

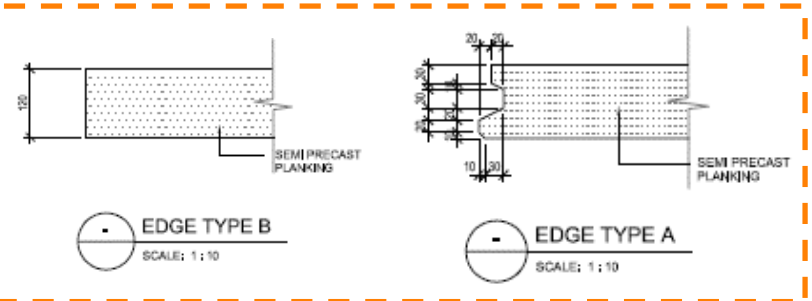


- **11** types of **Central Zone** in term of geometry
- Each types of Central Zone connect wth **2 to 6** possible **End Support** types
- 12 moulds used at the precast factory
- About 3 to 5 pieces fabricated per day

DfMA Precast Slab

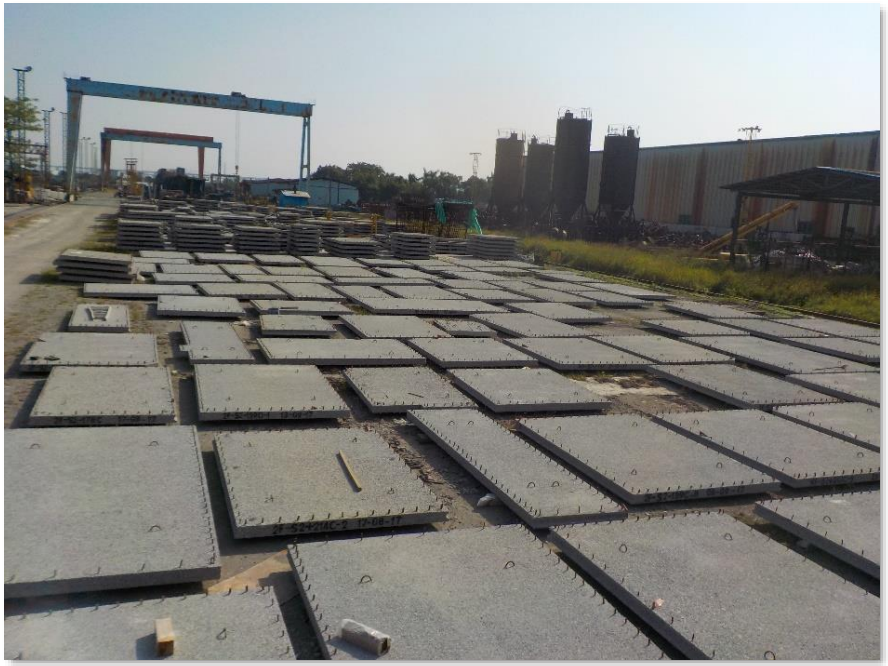


- 9 types of slabs
- 2 types of edge
- 7 moulds
- 7 slabs fabricated per day



Edge details

Fabrication Yard

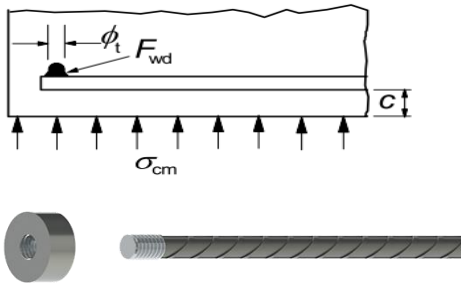


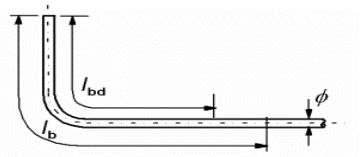
Minimize of Temporary works

- Temporary prop for column not required, ensure column shoe bolt and nut tightened
- Mid prop required for long span beam to support stitching concrete
- End prop for starter bar end details for beam
- Wall corbels for supporting precast slab, no extra prop required in general.

Simple bearing details between elements

- **No ties/fixing** for slab on beam
- Bearing width in consideration of spalling and **construction tolerance**
- Anchorage length of rebar
  - Use of Welded transverse bar
  - Use of mechanical anchorages
  - Reduction of bearing width

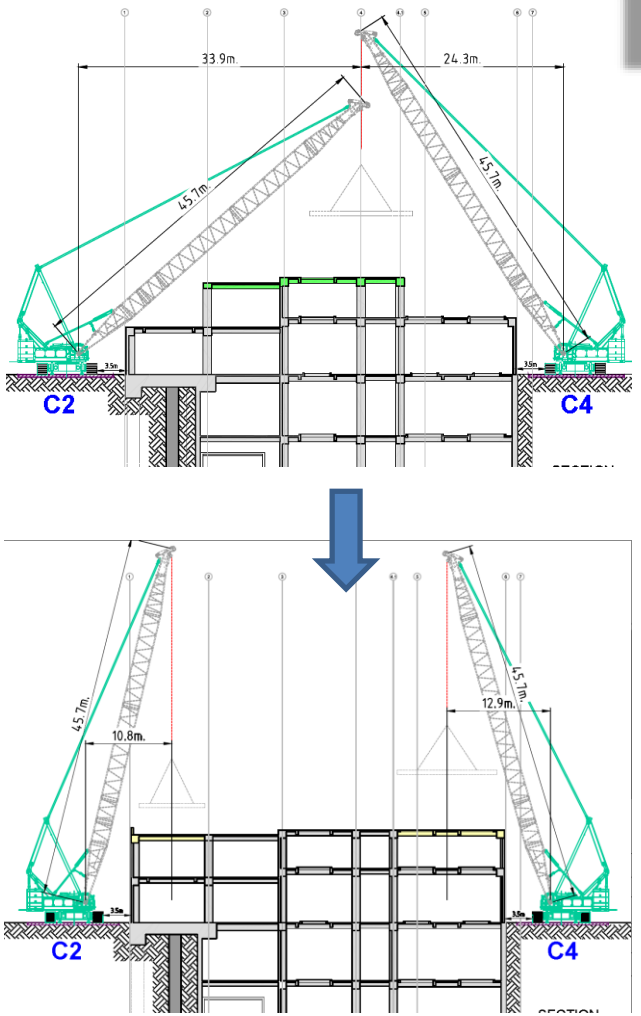




a) Basic tension anchorage length, l_b, for any shape measured along the centreline

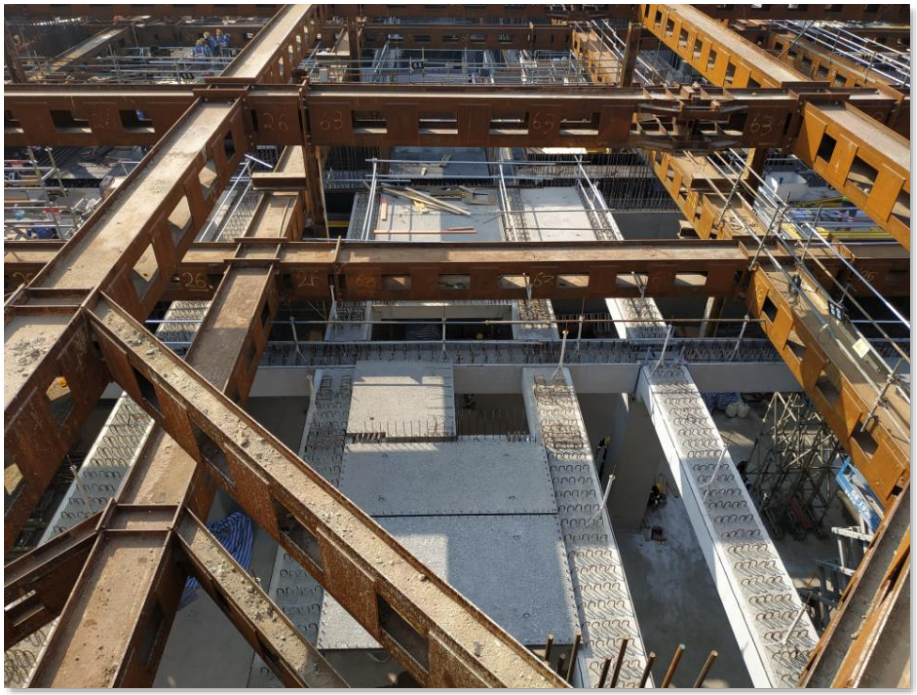
Lifting arrangement

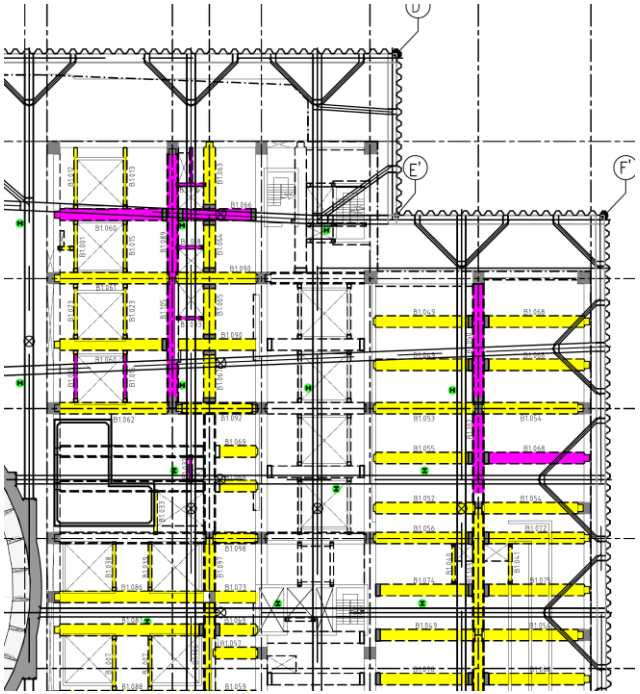
- Install elements **from the centre to the external sides**
- Use the luffing jib to reach the elements in the middle of the building without affecting the external walls



DfMA inside cofferdam

- To do a **mix of precast and in-situ** elements where direct lifting not possible
- Lift on base slab and then move to the correct location on the base slab and lift back up





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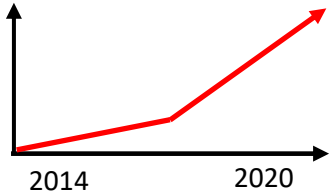
3. Challenges Facing in Hong Kong and Our Vision

MiC Transformation in Singapore

Since it started in 2014….

PPVC system has gone through some transformation

- Quantum of projects increased tremendously



- Method of PPVC has been changed

Steel PPVC System

Hybrid PPVC System

Concrete PPVC System

- Height of PPVC construction has been increased



Low Rise Building


High Rise Building

Similar Transformation in Hong Kong

In line with Government's initiative to push MiC

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The Government of the Hong Kong Special Administrative Region

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Works Branch
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Central Government Offices,
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Ref. : DEVB(PSGO) 38/1
Group : 5

31 March 2020

Development Bureau
Technical Circular (Works) No. 2/2020

Modular Integrated Construction (MiC)

Scope

This Circular sets out the policy on the adoption of Modular Integrated Construction (MiC) for new building works[1] with total construction floor area (CFA) larger than 300m^2 under the Capital Works Programme (CWP) to be tendered on or after 1 April 2020.

Effective Date

2. This Circular shall take immediate effect.

Effect on Existing Circulars and Circular Memoranda

3. This Circular has no effect on existing circulars.

Background

4. MiC is a construction method whereby freestanding volumetric modules with finishes, fixtures, fittings, furniture and building services installation, etc. manufactured off-site and then transported to site for assembly.

[1] Including building works funded under Heads 702 to 707, 709 and 711; and Capital Subvention Projects under Head 708 of the Capital Works Reserve Fund (CWRF).

DEVB TC(W) No. 2 /2020 *Page 1 of 4*

Adoption of MiC in various building types

	Building types	Accommodations	
		List 1*	List 2 **
1.	Staff quarters	• Residential units • Kitchens / pantries • Lavatories	• Corridors / communal areas • Others, e.g. management offices / recreational facilities
2.	Hostels		
3.	Residential and Care Homes		
4.	Schools	• Classrooms • Pantries • Lavatories	• Principal / teachers' rooms, special rooms, laboratories, libraries • Corridors / communal areas • Others, e.g. management offices
5.	Office buildings	• Office areas • Pantries • Lavatories	• Corridors / communal areas • Others, e.g. management offices / receptions / guard rooms / typical E&M rooms
6.	Medical facilities	• General wards • Consultation rooms • Treatment rooms • Accommodation for medical staff, e.g. quarters and offices • Education facilities, e.g. classrooms • Pantries • Lavatories	• Special wards • Operation theatres • Accommodations of special equipment • Corridors / communal areas • Others, e.g. management offices
7.	General		• Staircases and lobbies of above buildings where practicable

* For accommodations under List 1, the use of MiC is mandated. Exemption from SC is required if MiC is not adopted.

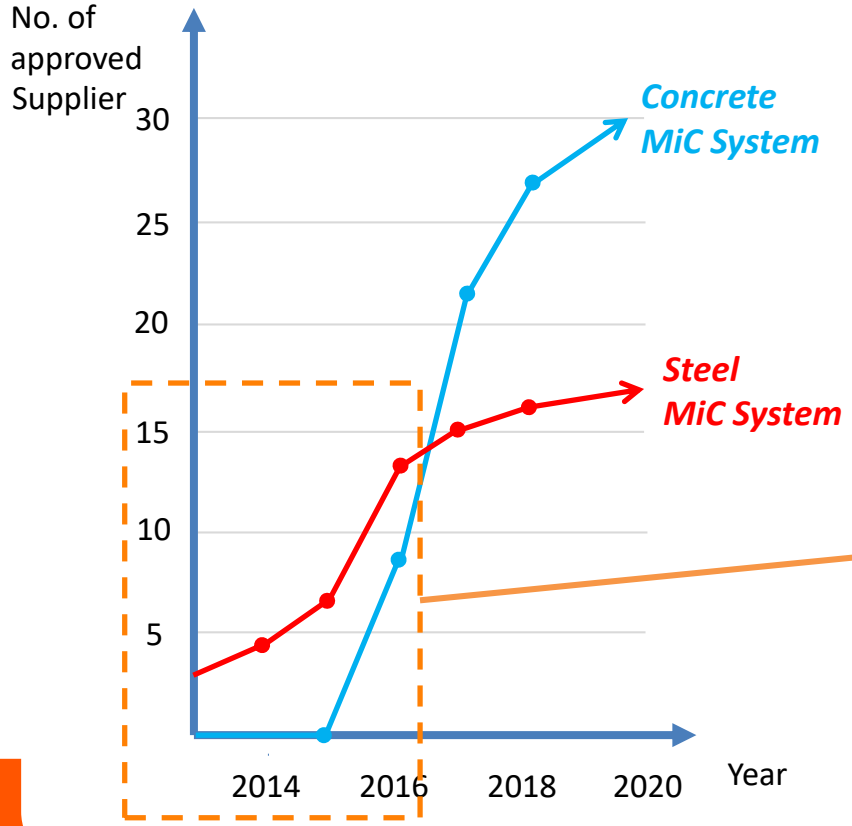
** Accommodations under List 2 are encouraged to adopt MiC whenever practicable. However, flexibility to best suit the functional and technical requirements of individual project is allowed for project office / works agent.

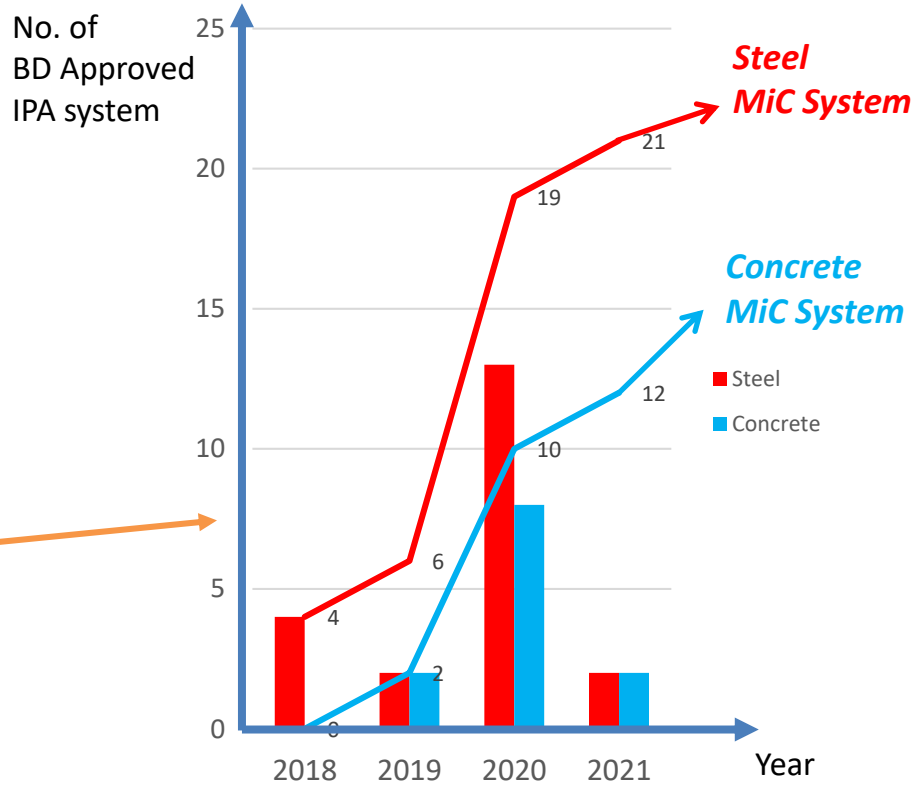
DEVB TC(W) No. 2/2020 Annex II *Page 1 of 1*

- Acoustic
- Vibration
- Fire Protection
- Building Services
- Fitting Out
- .....

New Generation of MiC System

Similar Transformation in Hong Kong





Increasing demand on Concrete MiC

Challenge facing in Hong Kong – Concrete MiC connection

- **Wet-joint connection** is required for providing adequate integrity
- Comprehensive consideration is required for adopting suitable connection method

Singapore
33 m /s
→ 0.65kPa

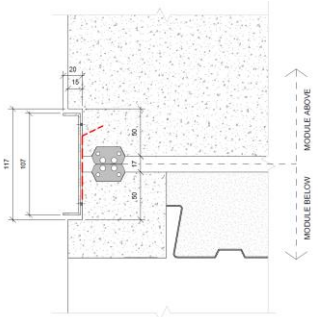
(c) Wind loads	(i) Code of basic data for the design of buildings. Loading. Wind loads – CP 3 Chapter V Part 2, using 33 m/s as the basic wind speed (3 second gust speed); and (ii) Loading for buildings. Code of practice for wind loads – BS 6399: Part 2, using 22 m/s as the basic wind speed (hourly mean speed).

Hong Kong
General
> 2.0 kPa

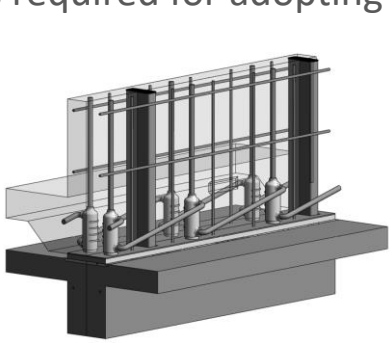
Table 3-1 Wind reference pressure, $Q_{0,z}$

Effective height Z_e (m)	Wind reference pressure $Q_{0,z}$ (kPa)
≤ 2.5	1.59
5	1.77
10	1.98
20	2.21
30	2.36
50	2.56

High Wind Load in Hong Kong

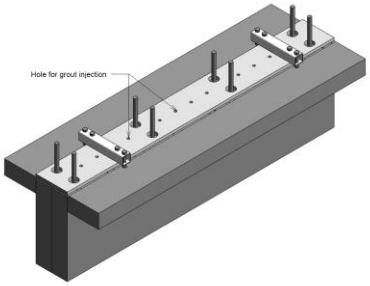


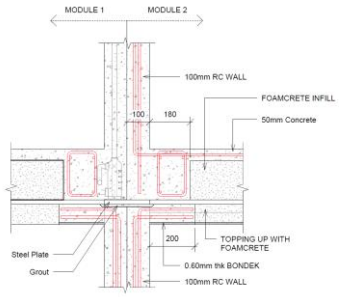
Joint for External Façade

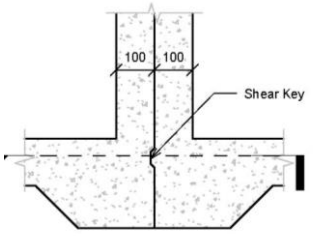


Vertical rebar connection

By grout coupler / grout hole joint / concrete stitch joint







Lateral stability

By in-situ diaphragm slab / rebar lapping in slot / Steel connection plate / composite wall connection

Key to success – Suitable Connection detail

Challenge facing in Hong Kong – MiC vs DfMA?

Myth: Are they separate topics?

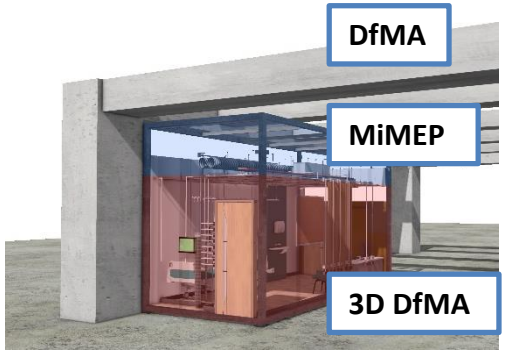
Challenge facing in Hong Kong – MiC vs DfMA?

	Structural system	MEP system	Fitting out
Type 1	MiC method (All in one)		
Type 2	Cast in-situ	3D DfMA method	
Type 3	Cast in-situ	Site-install	3D DfMA
Type 4	DfMA method	MiMEP method	3D DfMA

- **No Single solution** can suit all kinds of project situation
- **Adequate design experience** is required to choose a suitable DfMA/MiMEP/MiC scheme to cater:
  - ✓ Performance requirement
  - ✓ Dimensional constraint
  - ✓ Transportation constraint
  - ✓ Installation constraint

Example of Type 2

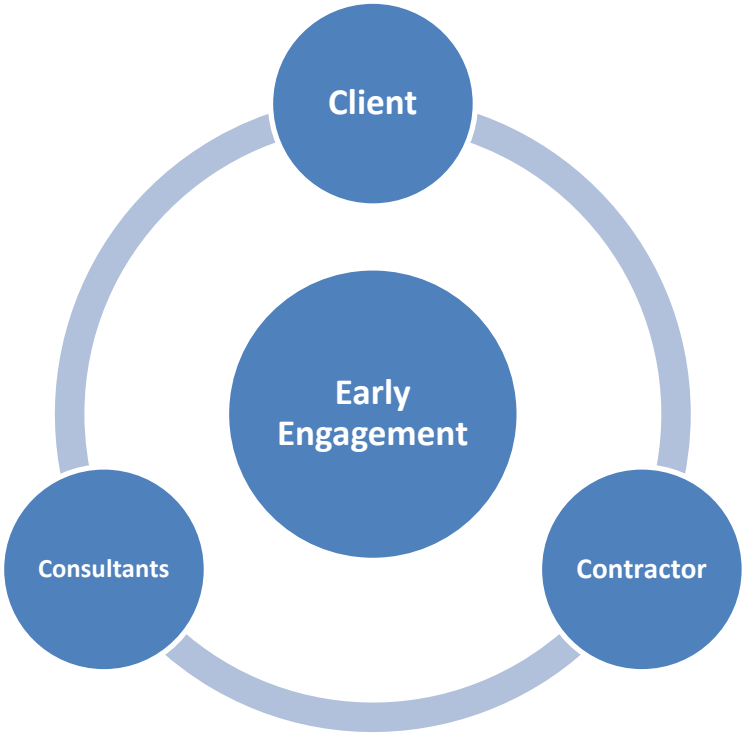
Example of Type 4



Key to success

Strong Design Team to choose suitable MiC/DfMA combination

Challenge facing in Hong Kong – Design Process



Integrated turnkey solution

- An advance MiC module require **high design coordination and integration** between the various trades and expertise

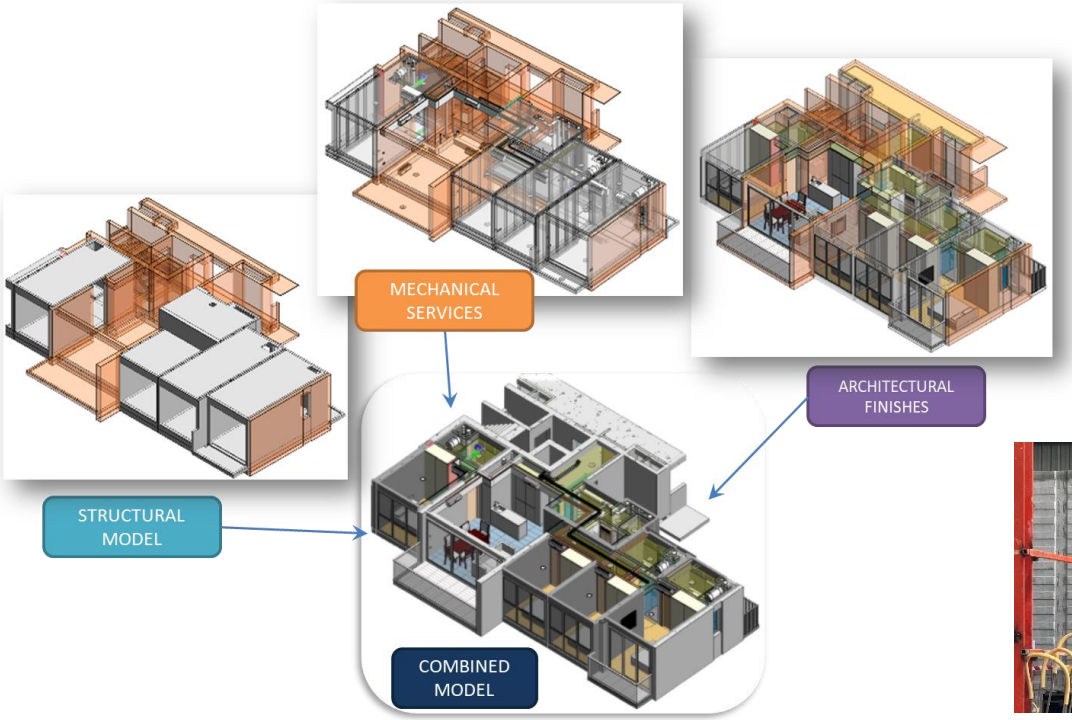
Earlier Approval Process on Design and Material

- MiC design process shall take place **as earliest as possible** to take full advantage in programme
- Design and material approval is in critical path.

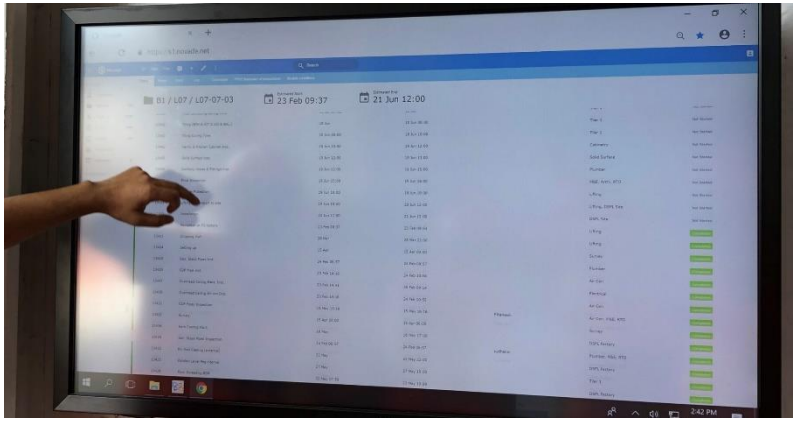
Key to success

Early Engagement between different discipline

Challenge facing in Hong Kong – Digitalization



Digitalized Quality Control System



Full BIM design implementation

Thank You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