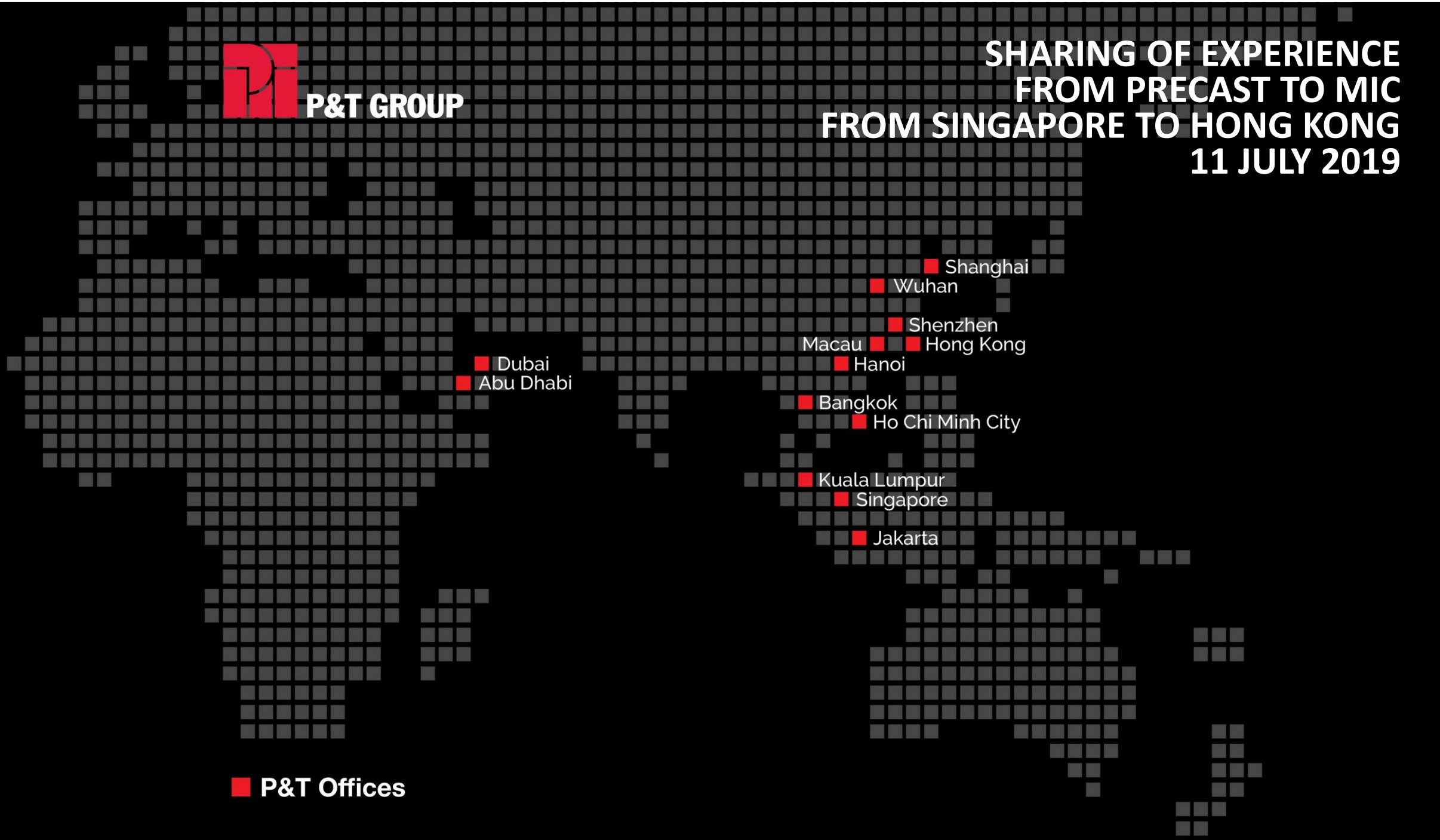
P&T GROUP

SHARING OF EXPERIENCE FROM PRECAST TO MIC FROM SINGAPORE TO HONG KONG 11 JULY 2019



Outline of Today's Presentation

- Precast to PPVC – P&T's Singapore experience
- Key milestones
- Current PPVC design in Singapore
- Applying experience to Hong Kong MiC design

Terminology

HK

MiC

- Modular
- Integrated
- Construction

SG

PVC

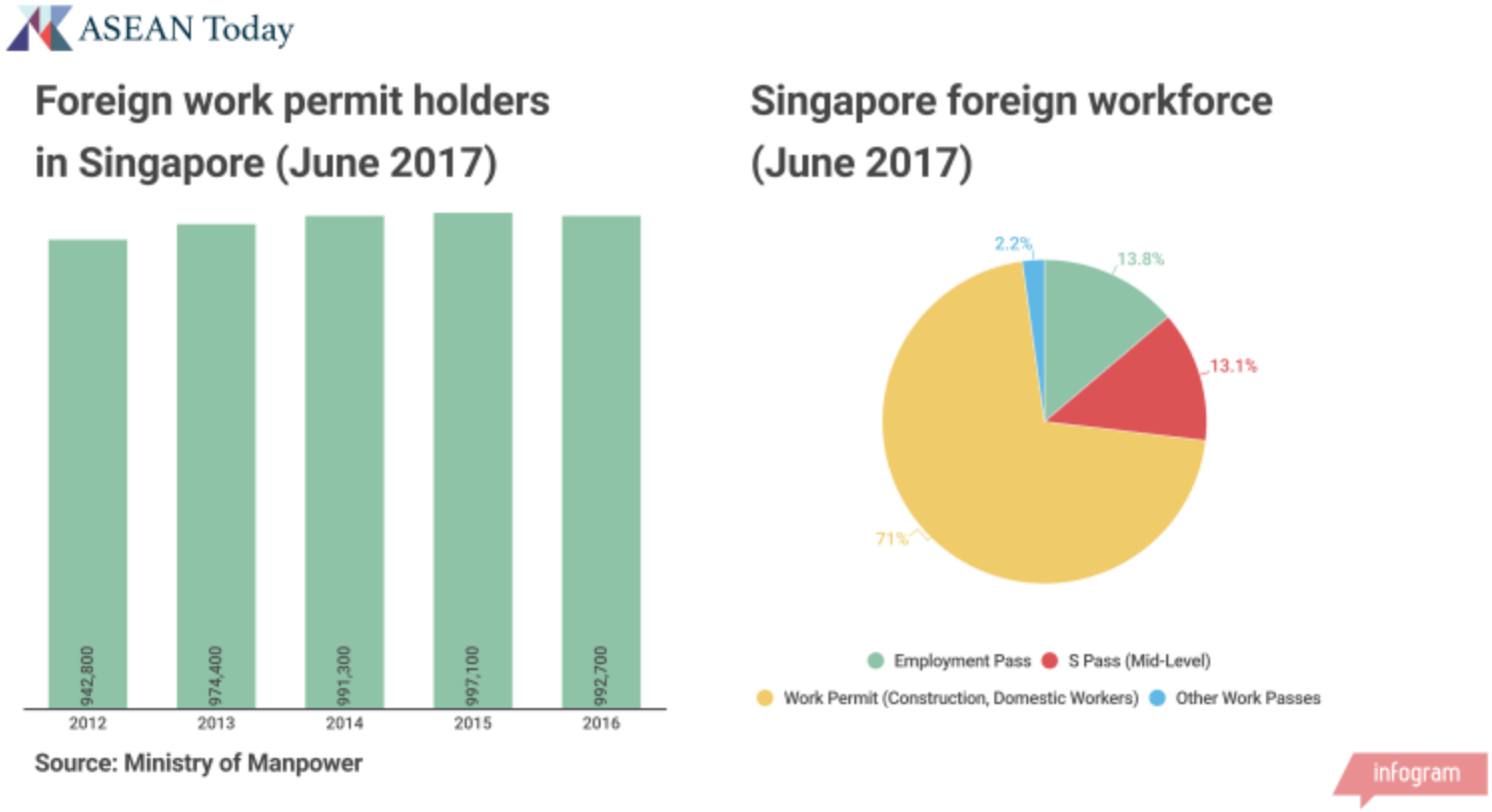
- Precast
- Volumetric
- Construction

SG

PPVC

- Precast
- Pre-finished
- Volumetric
- Construction

Singapore

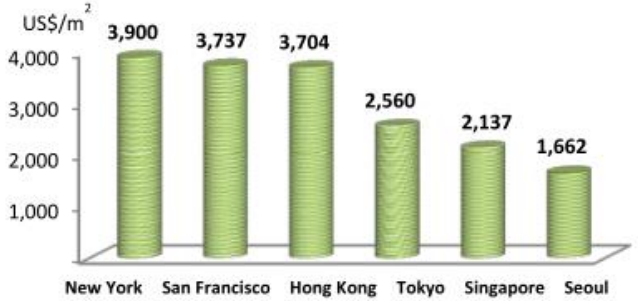


Dec 2013 Riot at Little India, Singapore

To improve productivity and reduce dependency on foreign workers

Hong Kong

Figure 4 – Average construction costs comparison in selected cities*

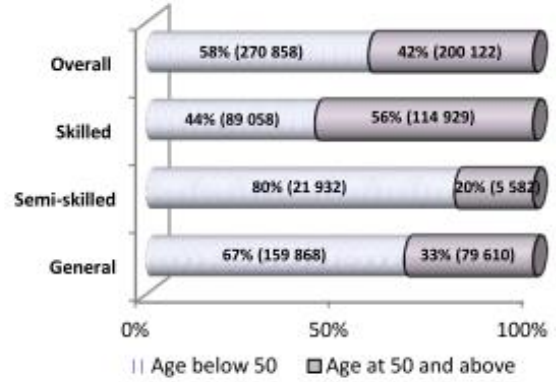


Note: (*) The costs are based on the costs of six building types including high rise apartment, office block, warehouse, hospital, school and shopping mall.

Figure 5 – Skilled workers shortage forecast in selected trades

	2018	2019	2020	2021	2022
Concretor					
Plumber					
Carpenter					
General welder					
Metal worker					
Plasterer & related workers					
Electric fitter					
Ventilation mechanic					
Lift and escalator mechanic					
Number of workers in shortage:					
501-1 000	1 001-1 500	1 501-2 000	≥2 000		

Figure 6 – Percentage of registered construction workers by age



Precast to MiC – some milestones

1992

Singapore HDB Tampines N4C24 – precast beam, slab and wall

2001

Singapore Woodsvale Exec Condominium – **precast column**, beams and slab

2003

Hong Kong Grandeur Terrace Precast slab

2005

Singapore Park Green Exec Condominium – **precast shear wall**, columns and fascade

2010

Mapletree Business City – precast hollow core slab

2011

2011 to present Singapore **35 Public Housing Projects** comprsing >13,000 homes – precast beam, slab, column and wall

2013

Singapore The Crest Condominium Project – **precast biaxial voided deck**, shear wall, balcony, fascade

2014

Honkg Kong Shatin 36C Subsidised Housing Project – precast structural wall

2015

Singapore HDB Bukit Batok N4C11 **PPVC construction**

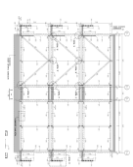
2015

Singapore Canberra Drive Condominium PPVC construction

2017

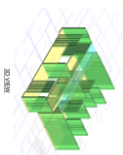
Hong Kong Matrix Deck - Breast Cancer Foundation

2018



Hong Kong, Pre-acceptance submission for steel MiC system

2018



Hong Kong, Pre-acceptance submission for **40 Sty Concrete Mic Building**, HK patent appln no. 18114717.3

2019

Hong Kong, Pre-acceptance submission for **20S Steel / Aluminium MiC** system, HK patent temp appln no. P6001

PRECAST STRUCTURE (1990 – 2000)

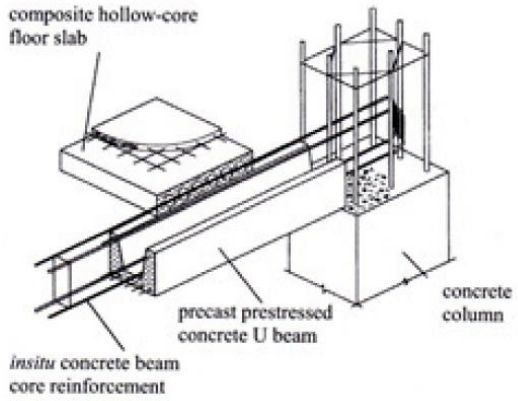
HDB Tampines Public Housing (1992)

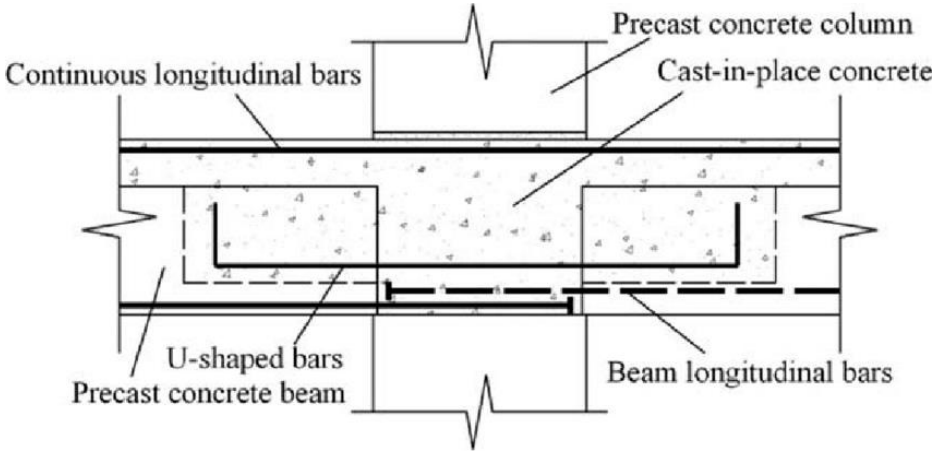
- Precast non-structural fascade
- Precast half slab
- Precast staircase
- Precast beams
- Cast in situ columns and shear walls

Casa Cairnhill (1990)

- Precast non-structural fascade
- Precast staircase

PRECAST STRUCTURE (1990 – 2000)





- Similar detailing as cast in situ concrete
- Void out some parts to be cast at the site to effect structural connection
- Reinforcement protrudes out from structure, obstructing placing of members

- Difficulty in installation
- Site fix reinforcement formwork still here and there

WE NEED TO SIMPLIFY

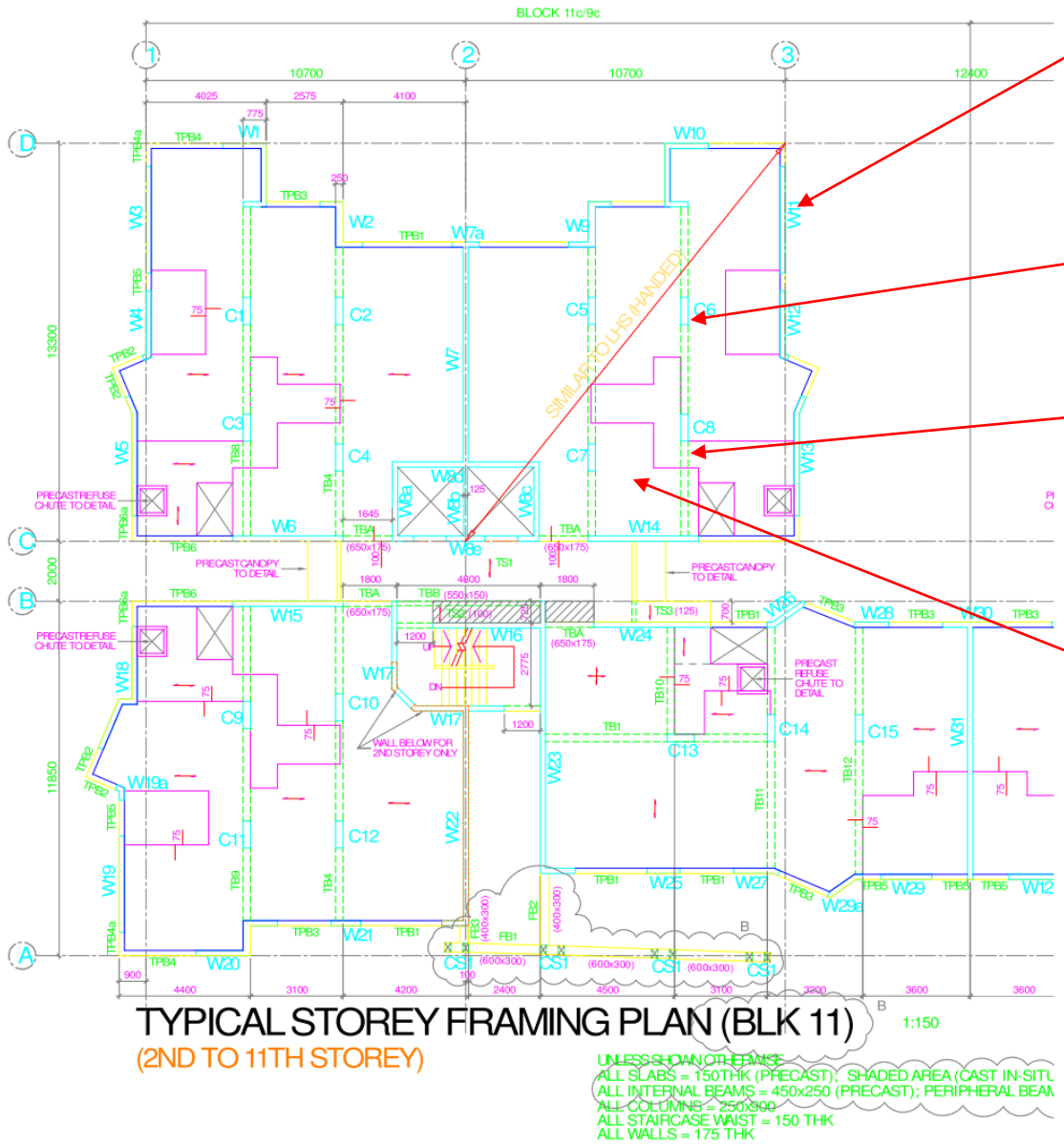
WOODSVALE EXECUTIVE CONDOMINIUM (2001)

- Design and Build procurement method
- Design for precast from beginning stage

9 blocks of apartments, 969 units, GFA 95,184m2

BCA Best Buildable Design Award 2001

WOODSVALE EXECUTIVE CONDOMINIUM (2001)

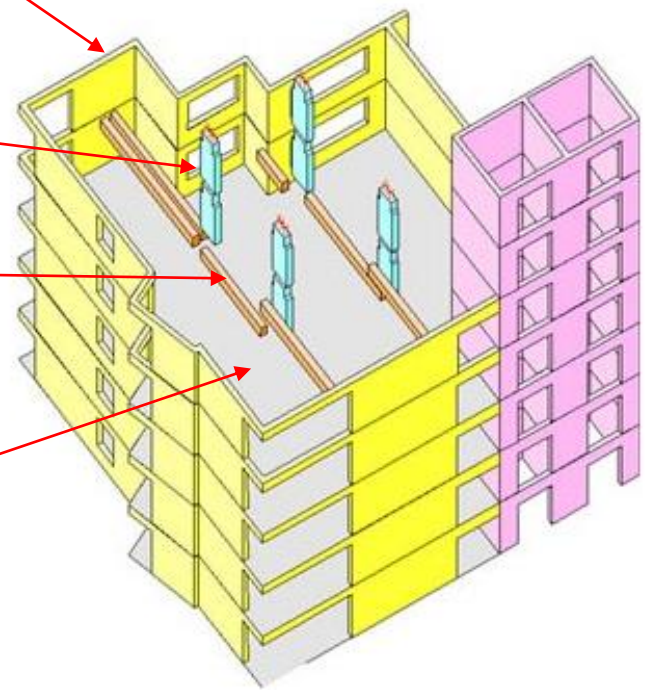


System form cast in situ perimeter shear wall

Precast columns

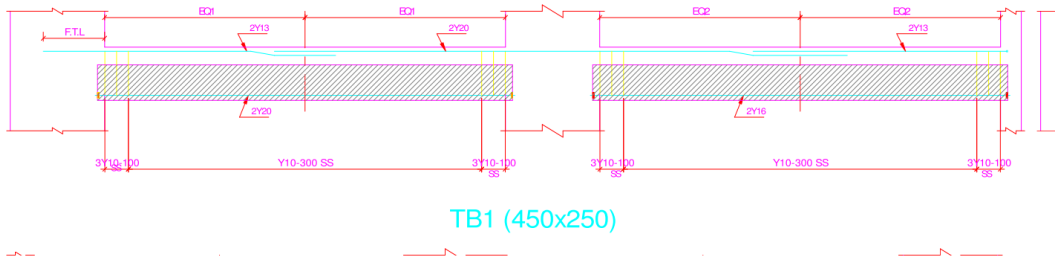
Precast beams

Precast prestressed half slab

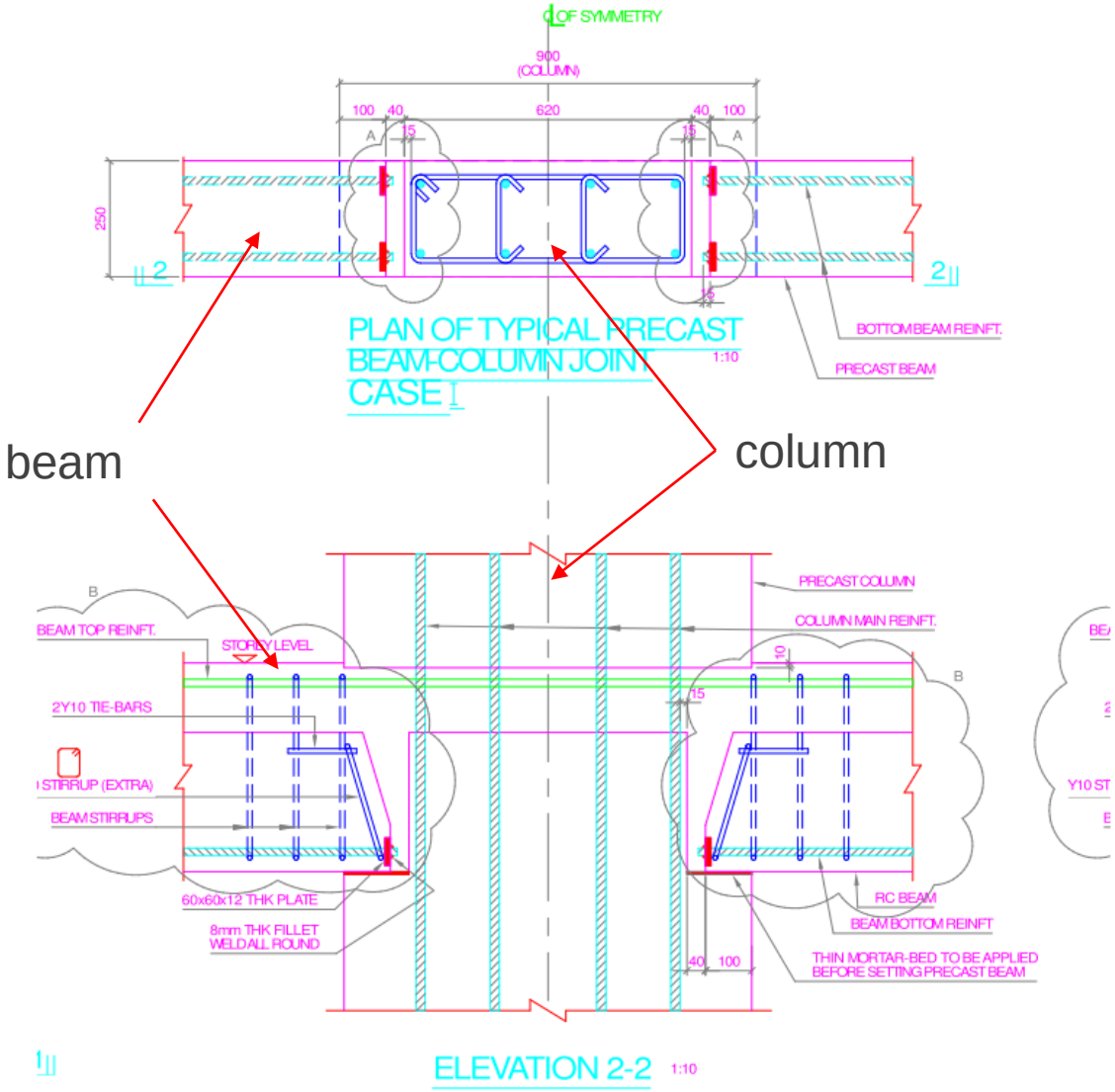


- Simple framing – shortest load path
- Work with Architect from beginning to design for precast
- Good teamwork with Client, Architect and Contractor

WOODSVALE EXECUTIVE CONDOMINIUM (2001)

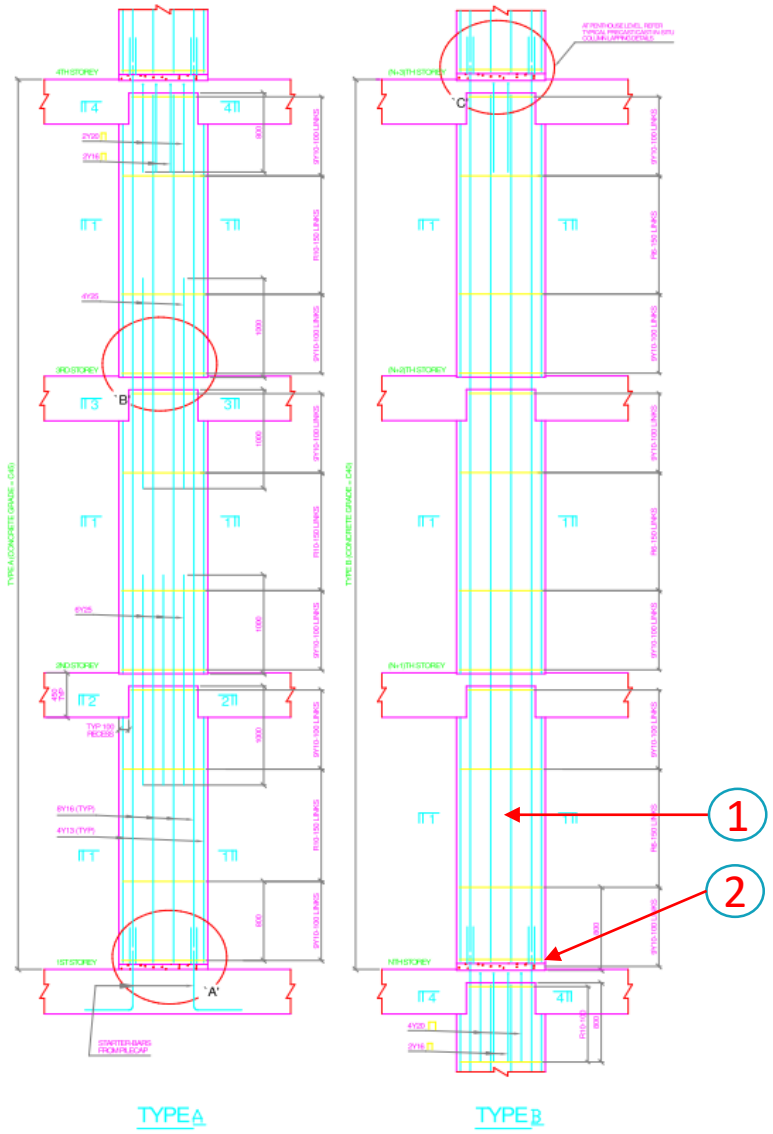


- System formwork cast in situ perimeter shear wall (175mm)
- Precast prestressed half slab
- Precast beams
- Precast columns, up to 3 storeys high
- Precast staircase

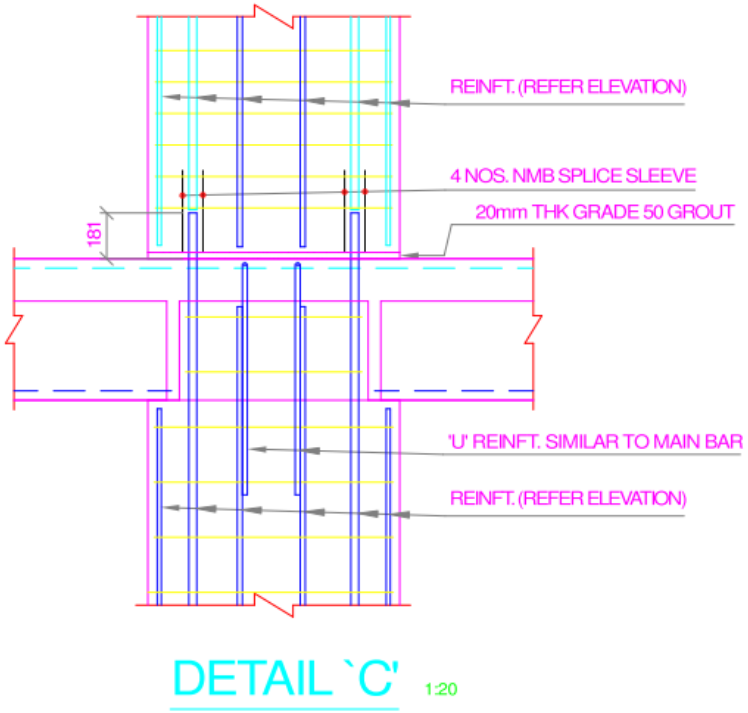


- Simplify column beam joint

WOODSVALE EXECUTIVE CONDOMINIUM (2001)



- 250x900 precast columns
- Early adoption of grout filled pipe sleeve splicing system



PARK GREEN EXECUTIVE CONDOMINIUM (2005)

- Design and build procurement method
- Early involvement to design for precast

BCA Best Buildable Design Award 2005

PARK GREEN EXECUTIVE CONDOMINIUM (2005)

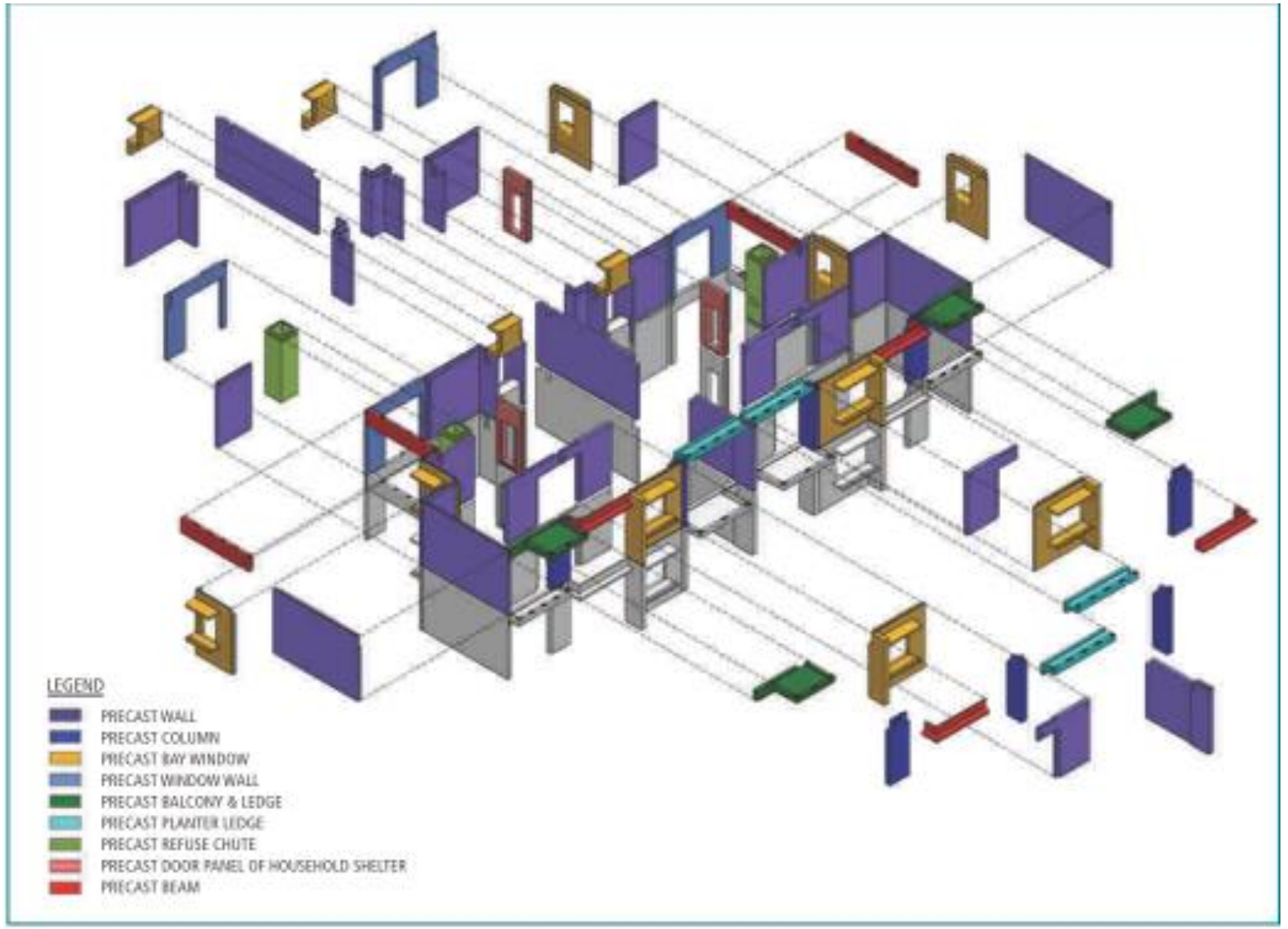
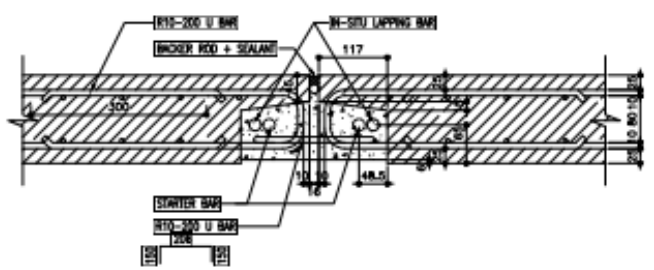
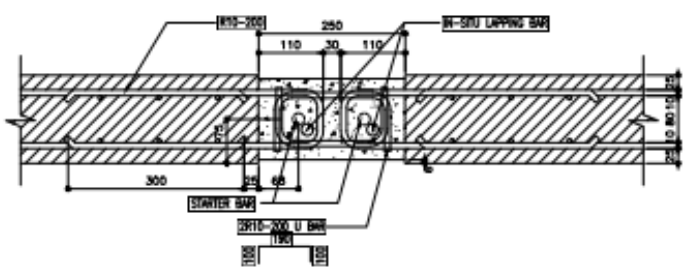


Fig. 6.5 – Isometric view of precast components used

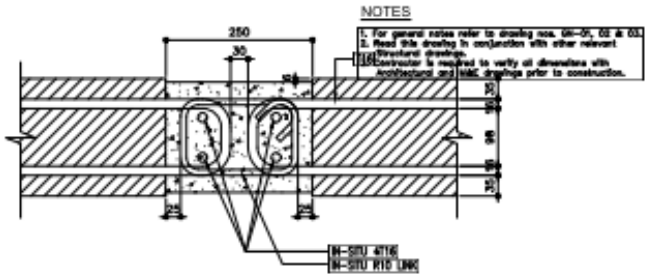
- All vertical elements are precast – shear wall, fascade, balcony …etc
- All horizontal elements are 175mm cast in flat plate with table form
- Early application of precast shear wall



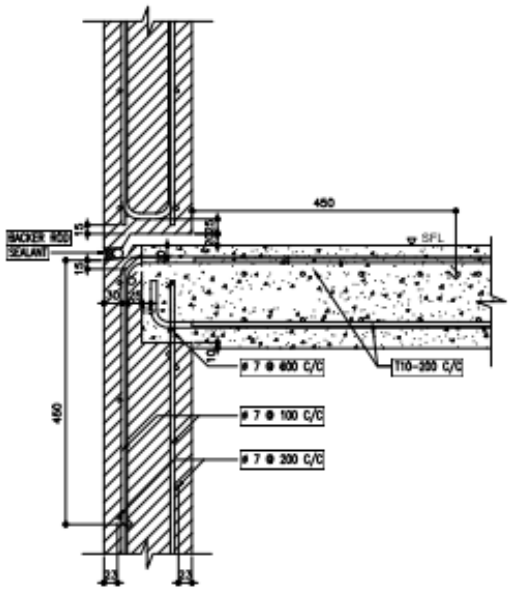
VERTICAL JOIN



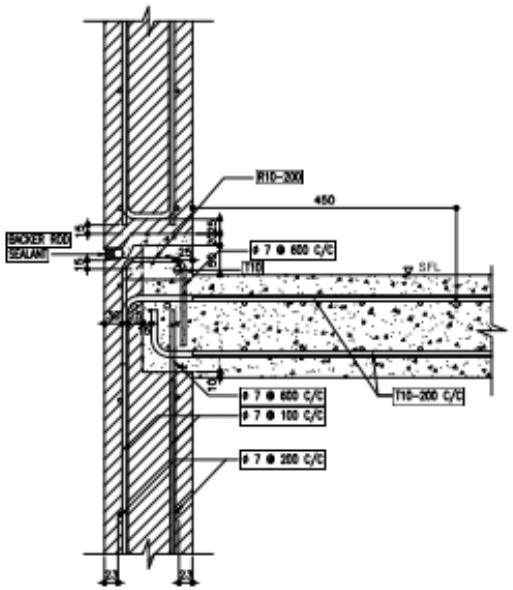
TYPICAL INTERNAL VERTICAL JOINT



DETAIL OF DOOR WALL BEAM



TYPICAL LOAD BEARING WALL HORIZONTAL JOINT



TYPICAL HORIZONTAL JOINT AT BATHROOM AREA

Fig. 6.9 – Lowering of precast wall panel during installation

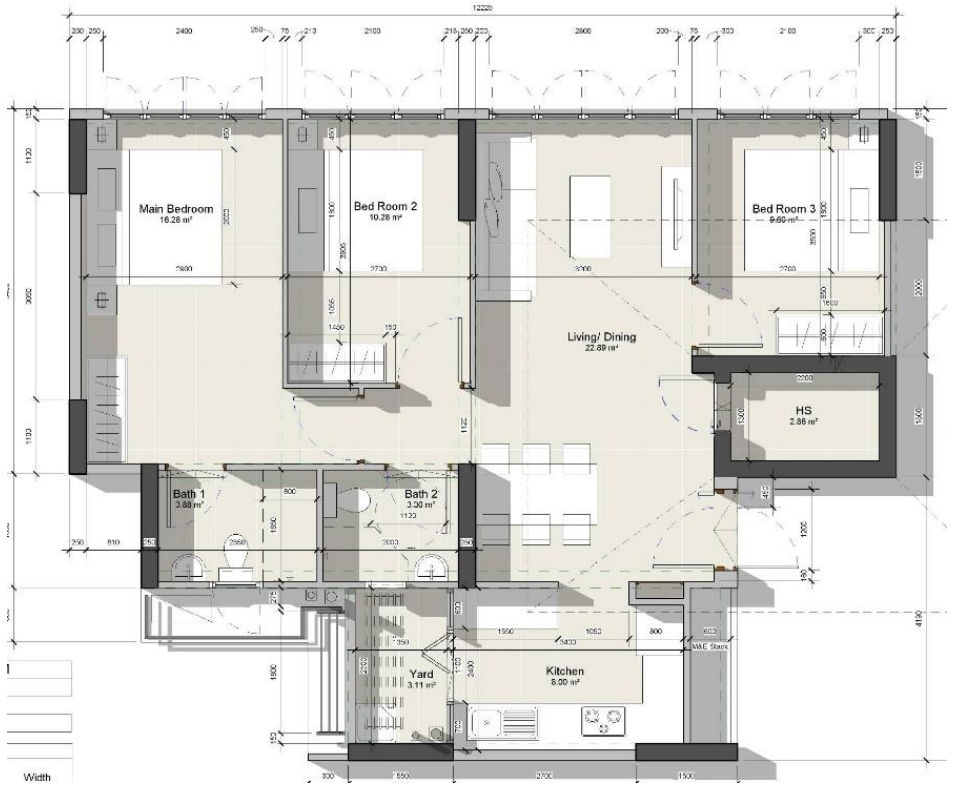
- **Simple connection details**
- **Less protruding bars**
- **Reduced site formwork**

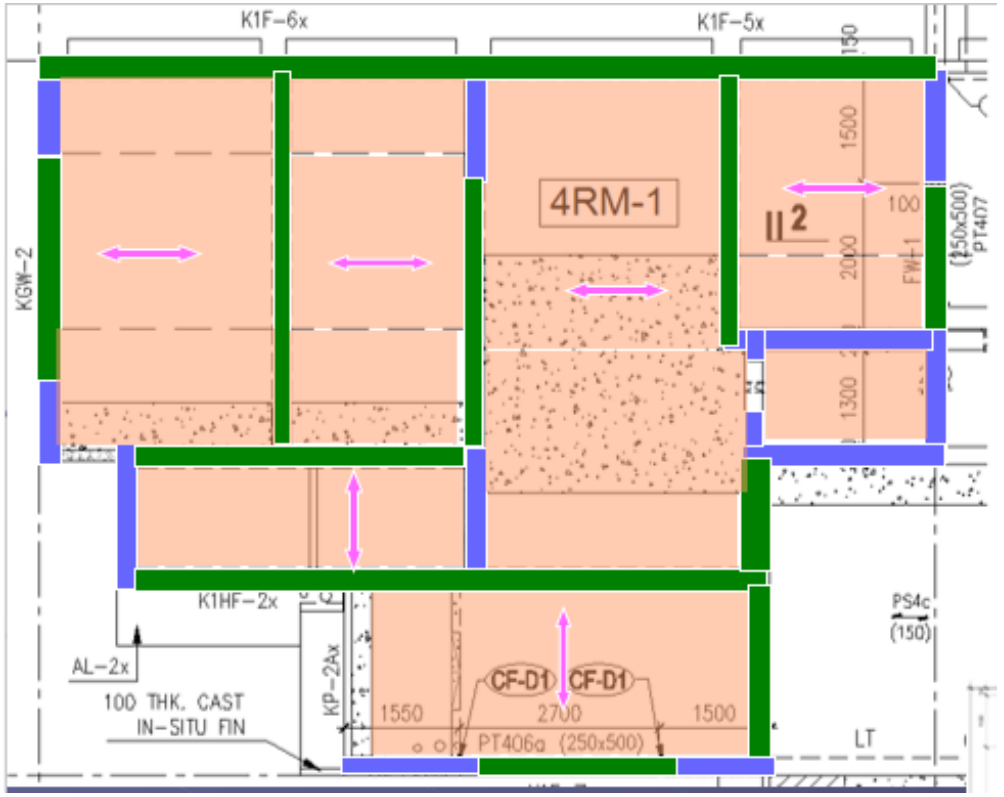
PARK GREEN EXECUTIVE CONDOMINIUM (2005)

Fig. 6.11 – On-site precasting for simpler components

- **Precast 2D elements on site, saving in transportation**
- **Omit external scaffolding**

SINGAPORE HDB PUBLIC HOUSING， >13,000 UNITS（2012 TO PRESENT）





- **Precast fascade including windows**
- **Precast beams**
- **Precast prestressed half slab**
- **Precast or cast in situ columns and walls**

- **Precast volume approximately 40% to 70%**

SINGAPORE HDB PUBLIC HOUSING >13,000 UNITS (2012 TO PRESENT)

SINGAPORE HDB PUBLIC HOUSING >13,000 UNITS （2012 TO PRESENT）

Precast House Hold Shelter

Precast service duct

Precast Refuse Chute

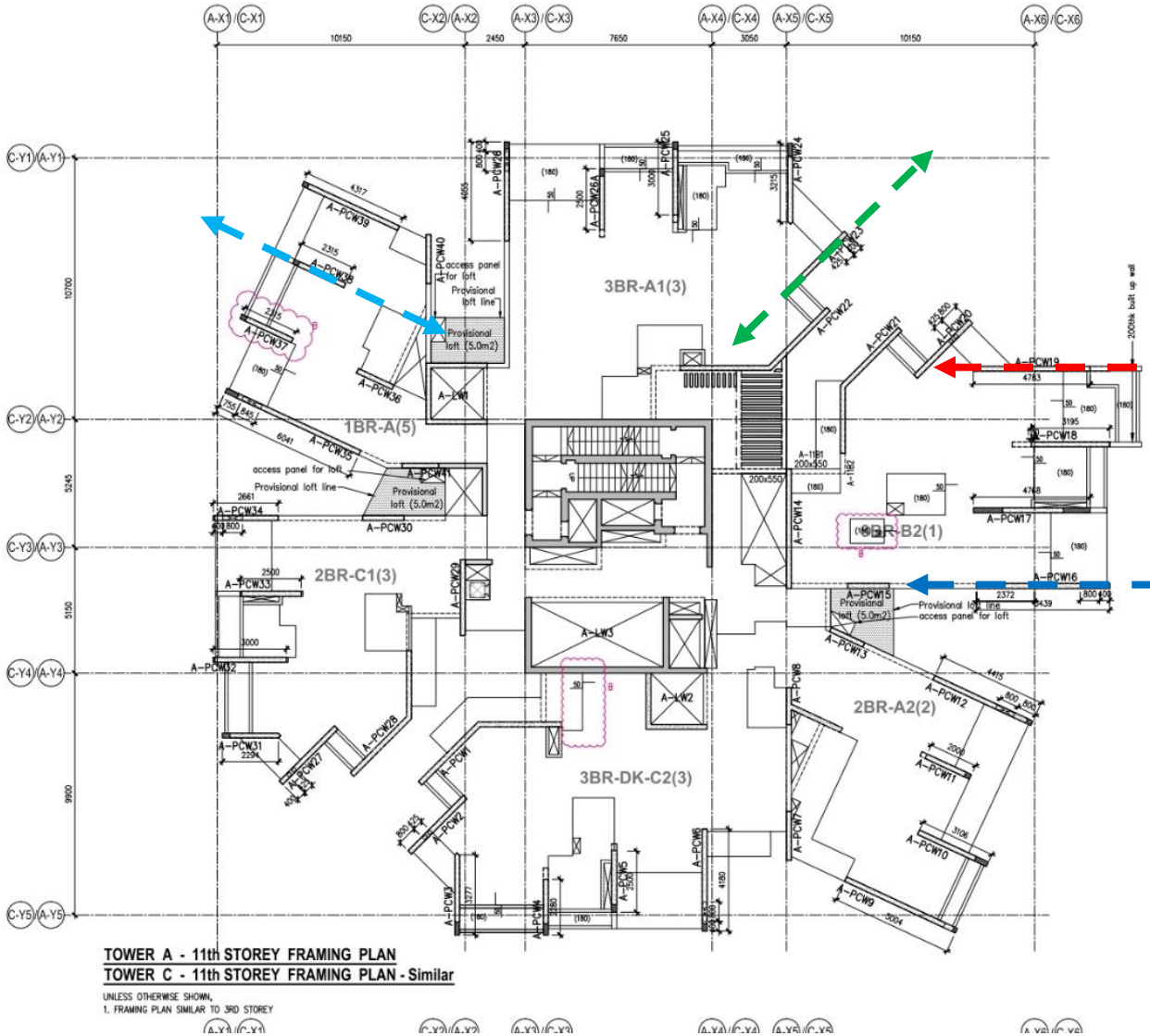
SINGAPORE HDB PUBLIC HOUSING >13,000 UNITS （2012 TO PRESENT）

- Standardised precast design and specifications
- Systematic approach to control quality and cost
- Standard floor height, standard precast staircase and other components
- HDB projects built up a strong supply chain of precast products and skills
- Validation of various types of precast design methods and precast joint details
- Good library of proven precast components and details

THE CREST CONDOMINIUM (2015)

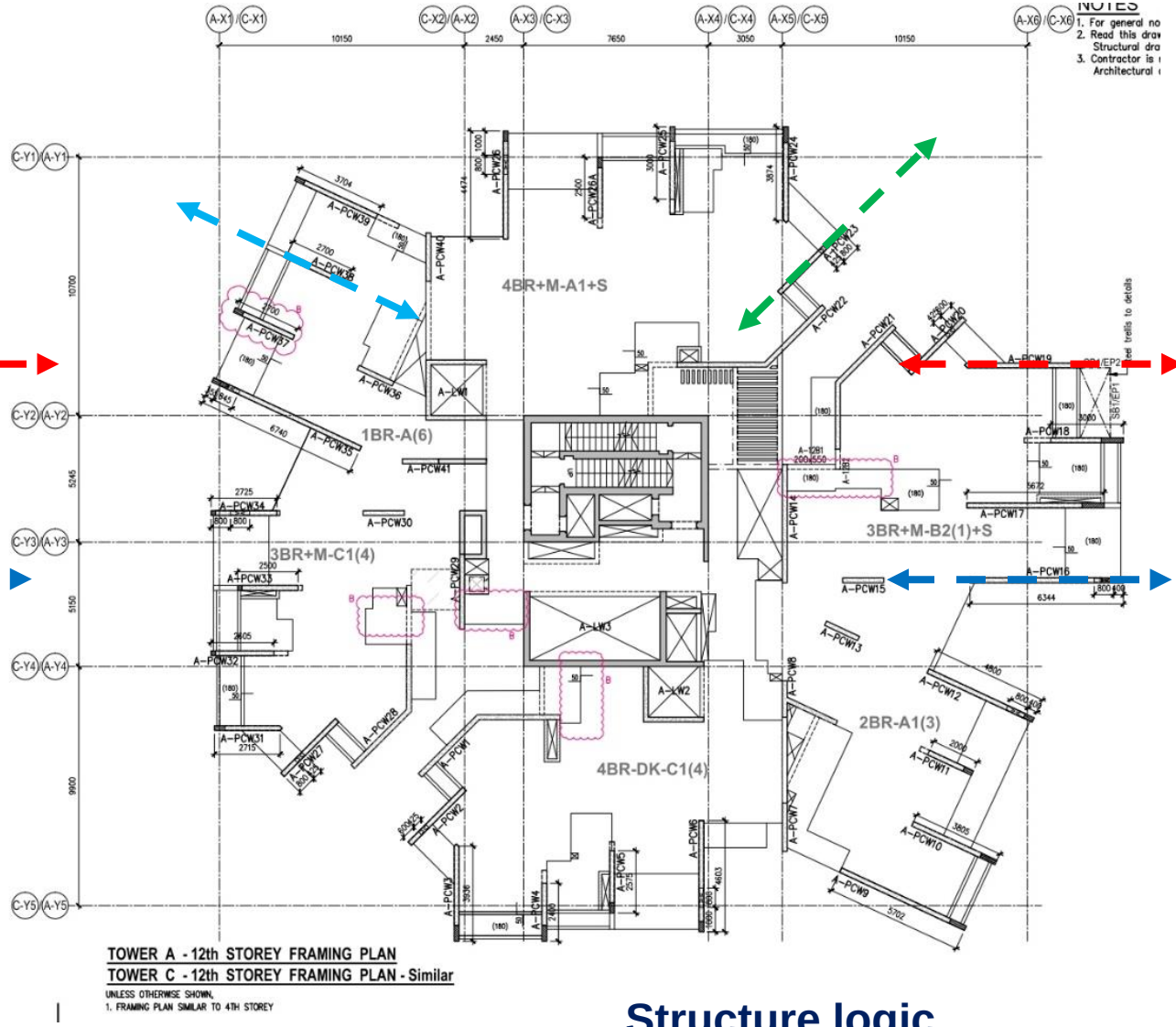
- **Private high end development**
- **Complex massing, floor plans changes every floor**
- **Difficult for both cast in situ and precast structure**

THE CREST CONDOMINIUM (2015)



TOWER A - 11th STOREY FRAMING PLAN
TOWER C - 11th STOREY FRAMING PLAN - Similar

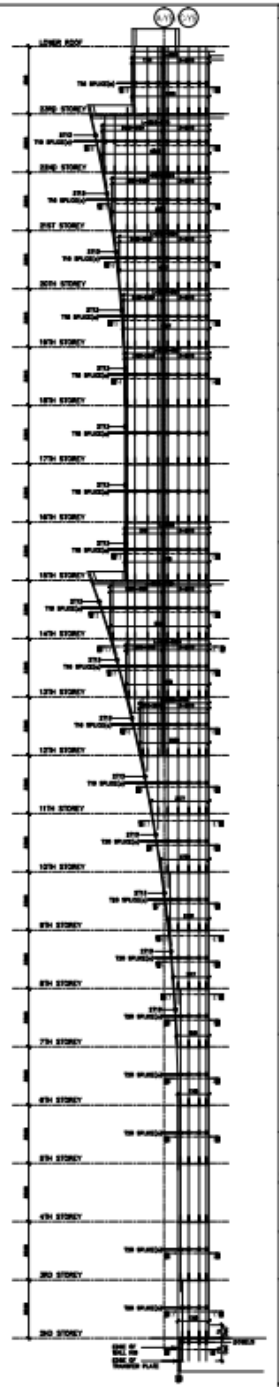
UNLESS OTHERWISE SHOWN,
1. FRAMING PLAN SIMILAR TO 3RD STOREY



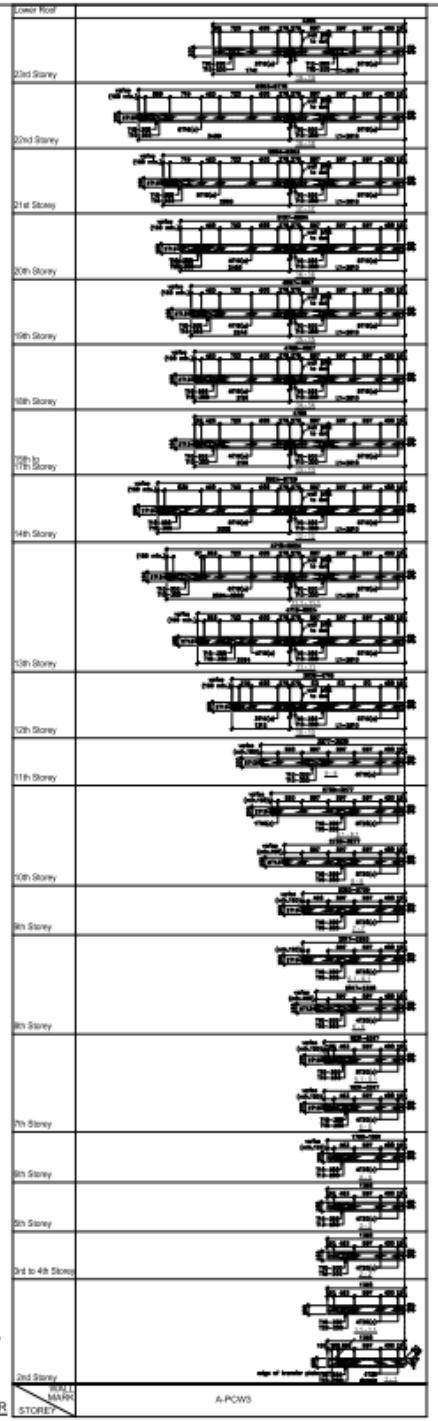
TOWER A - 12th STOREY FRAMING PLAN
TOWER C - 12th STOREY FRAMING PLAN - Similar

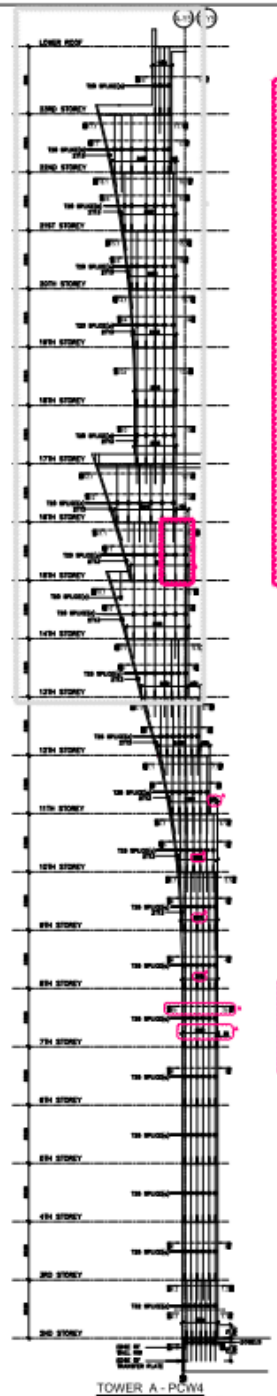
UNLESS OTHERWISE SHOWN,
1. FRAMING PLAN SIMILAR TO 4TH STOREY

Structure logic

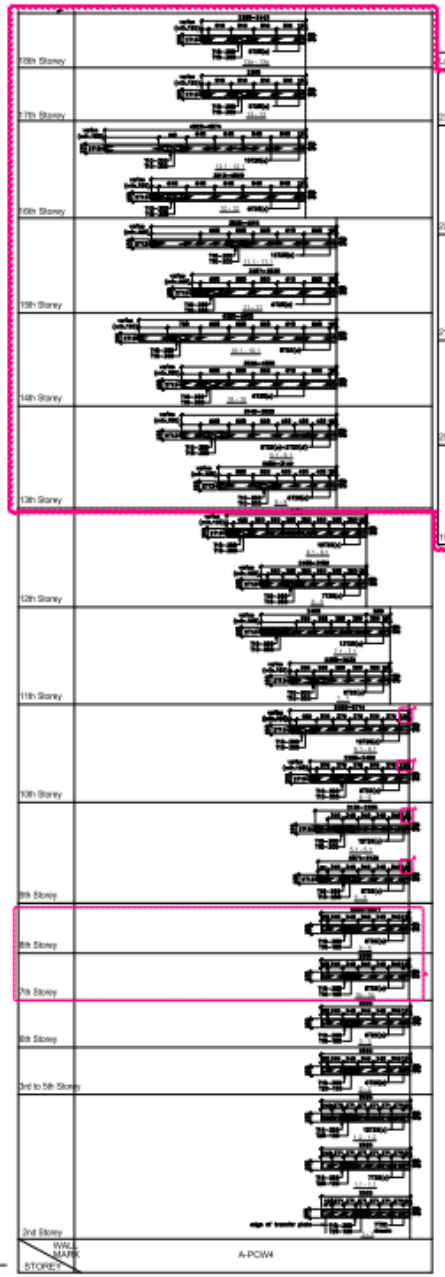


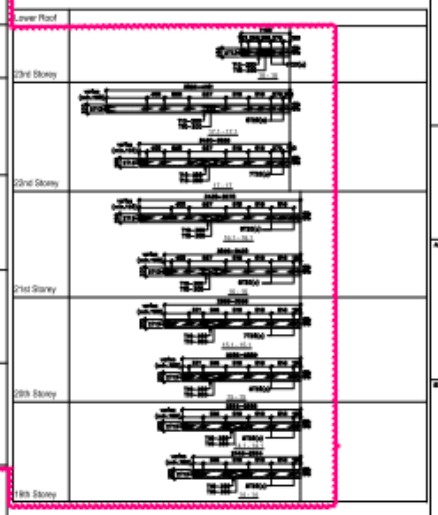
TOWER A - PCW3
TOWER C - PCW3 - SIMILAR



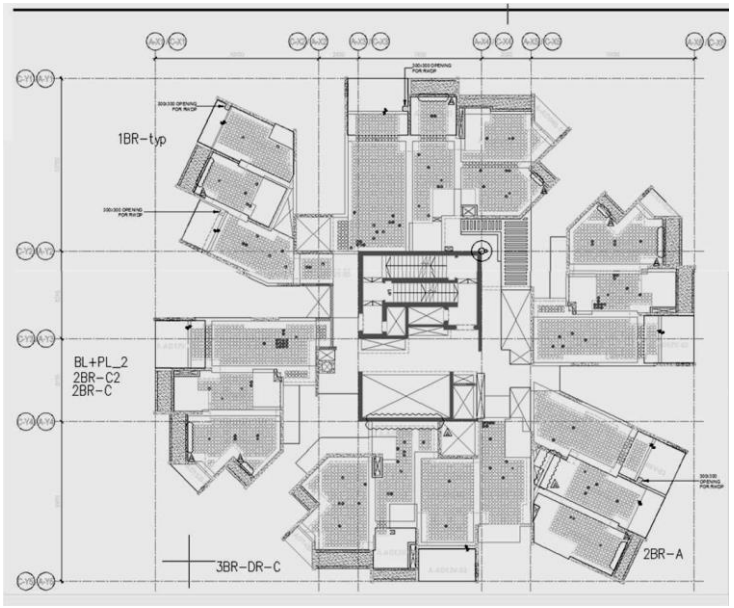


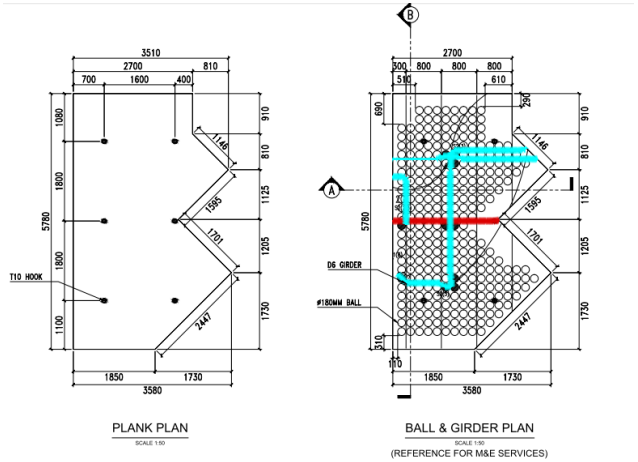
TOWER A - PCW4
TOWER C - PCW4 - SIMILAR



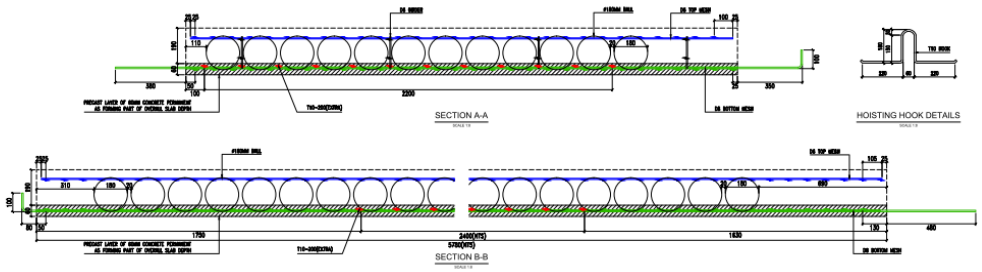


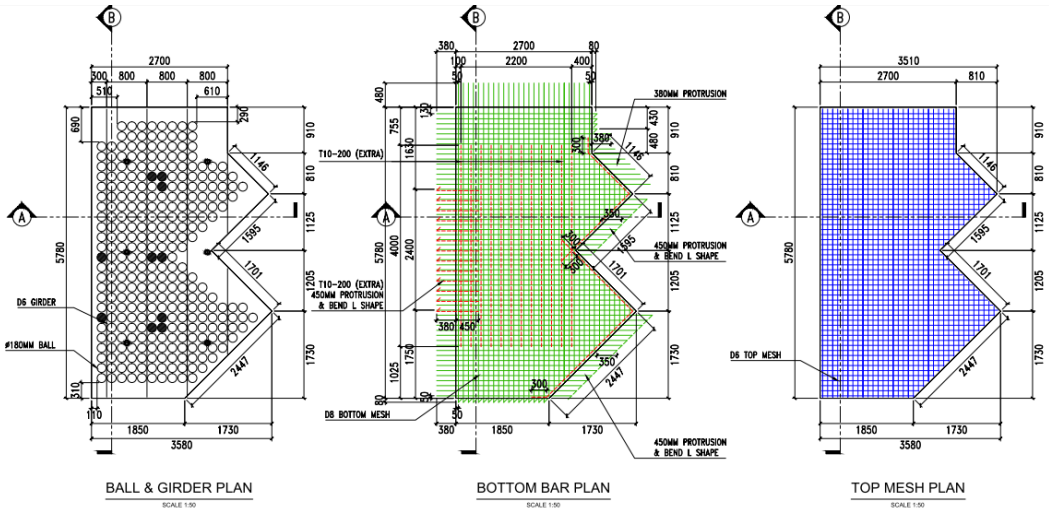
THE CREST CONDOMINIUM (2015)





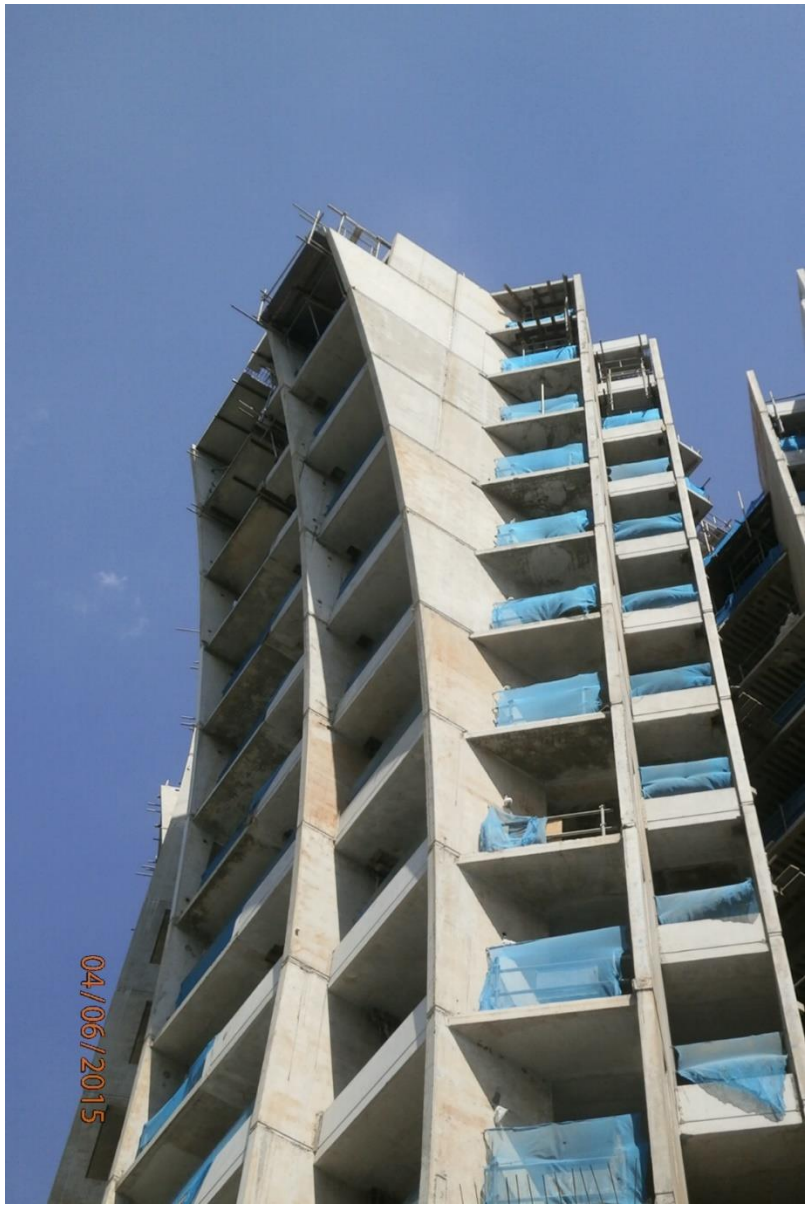
- Precast biaxial voided slab
- Spans up to 7.5m from core to perimeter
- 2D slab precast on site





THE CREST CONDOMINIUM (2015)

THE CREST CONDOMINIUM (2015)



- Completed 2018
- Complex geometry
- Large scale 2D precast on site
- Precast shear wall connected by NMB splice sleeve
- Precast slab without beam

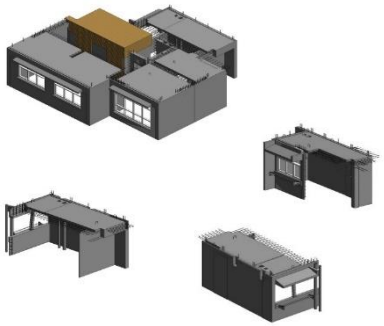
PROGRESSION TO MODULAR CONSTRUCTION

Cast in situ

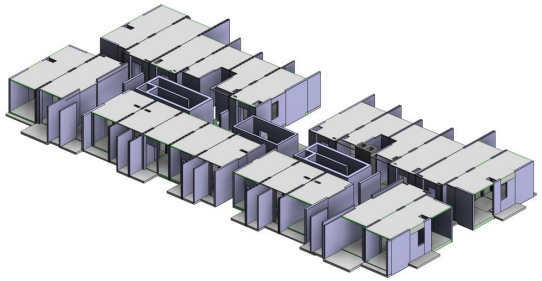
Semi-precast

Load bearing precast wall and column, precast slab

An evolution - key design ingredients such as connections, joints …etc, were achieved progressively over time and finally integrated in modular construction design



PVC



PPVC

PROGRESSION TO MODULAR CONSTRUCTION - PVC

wall joint

wall joint

slab joint

PROGRESSION TO MODULAR CONSTRUCTION

HDB WEST TERRA (2014 - 2018)

Commenced design in 2014
First Precast Volumetric Construction project in Singapore

- ✓**PVC modules**
- ✓**Precast bathroom units (PBU)**
- ✓**Volumetric household shelters**

Other precast elements

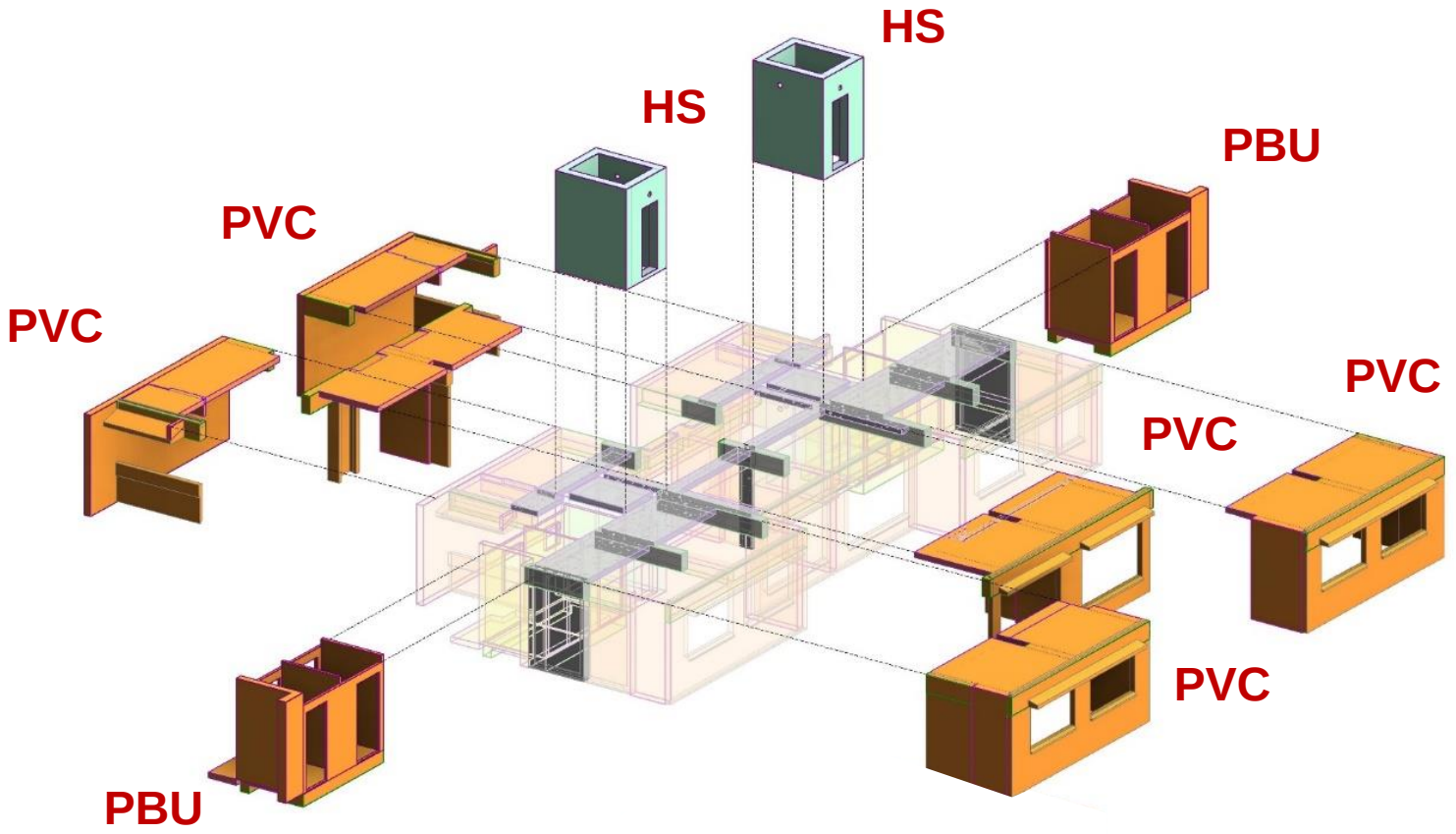
Design and Build contractor – Teambuild Construction Pte Ltd

PROJECT TITLE	**HDB West Terra at Bukit Batok N4 C16 and 17**
LOCATION	**Bukit Batok West Avenue 6**
DESCRIPTION	**9 Blocks of 22-storey residential building (Total 1793 units) with 2 blocks multi-storey carpark, ESS, precinct pavilions and commercial block**
GFA	**196,180.23 sq.m**
SITE AREA	**53,280 sq.m**
CONSTRUCTION	**27 months (Project completed in 4th Quarter 2017)**

HDB WEST TERRA (2014 - 2018)

Typical 2RM 45m² Unit Type

HDB WEST TERRA (2014 - 2018)



HS, PBU & PVC Components managed by Assemblies

HDB West Terra at Bukit Batok (2031 PVC Modules)

PPVC (FROM 2014)

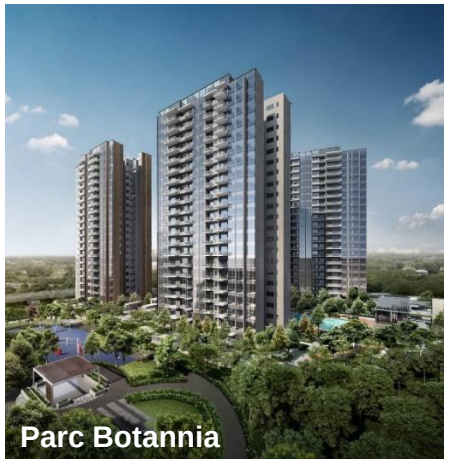
2012	2014	2015	2016	2017
				
Residential Halls at North Hill NTU (Architect consultant)	**HDB Bukit Batok West Terra at N4 C16/17**	**The Brownstone Exec Condo at Canberra Drive**	**HDB Valley Spring at Yishun N4 C22**	**HDB Fernvale Glades at Sengkang N4 C31**
First PPVC design and adoption in Singapore for Institutional and Student Hostel highrise project Steel PPVC technology is piloted with the support of NTU	First PVC for Public housing high rise residential project Coupled with 100% PBU and Mass Engineered Timber (MET)	First PPVC for Private housing high rise residential project Project adopted DfMA technology for the Balconies erection	First PPVC for Public housing high rise residential project All Units adopted PPVC method. 1st project with HHS integrated with PBU	PPVC for Public housing high rise residential project All Units adopted PPVC method. HHS being integrated with the Bedroom

PVC
- **Precast**
- **Volumetric**
- **Construction**

PPVC
- **Precast**
- **Prefinished**
- **Volumetric**
- **Construction**

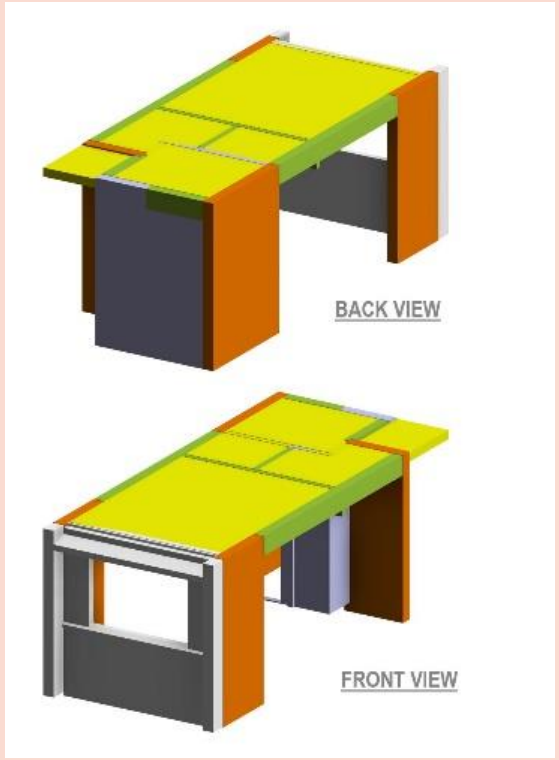
PPVC (FROM 2014)

PROJECT	PPVC TYPE	NO. OF STOREY	NO. OF UNITS	
The Brownstone EC	Concrete	10-12	638	completed
Parc Riviera	Concrete	36	752	Under construction
Valley Spring @ Yishun	Concrete	14	824	Under construction
Parc Botannia	Concrete	22	735	Under construction
Fernvale Glades	Concrete	14	1911	Under construction
Stirling Residences	Concrete	40	1259	Under construction

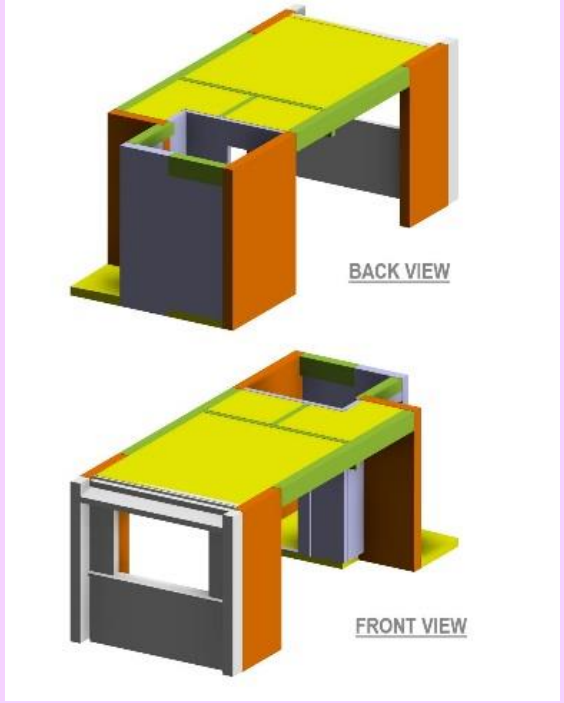


PPVC (FROM 2014)

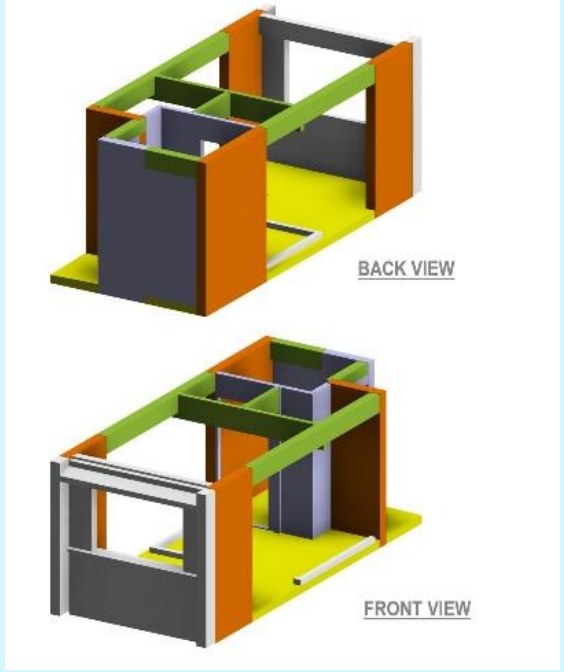
N Shape



N+U Shape

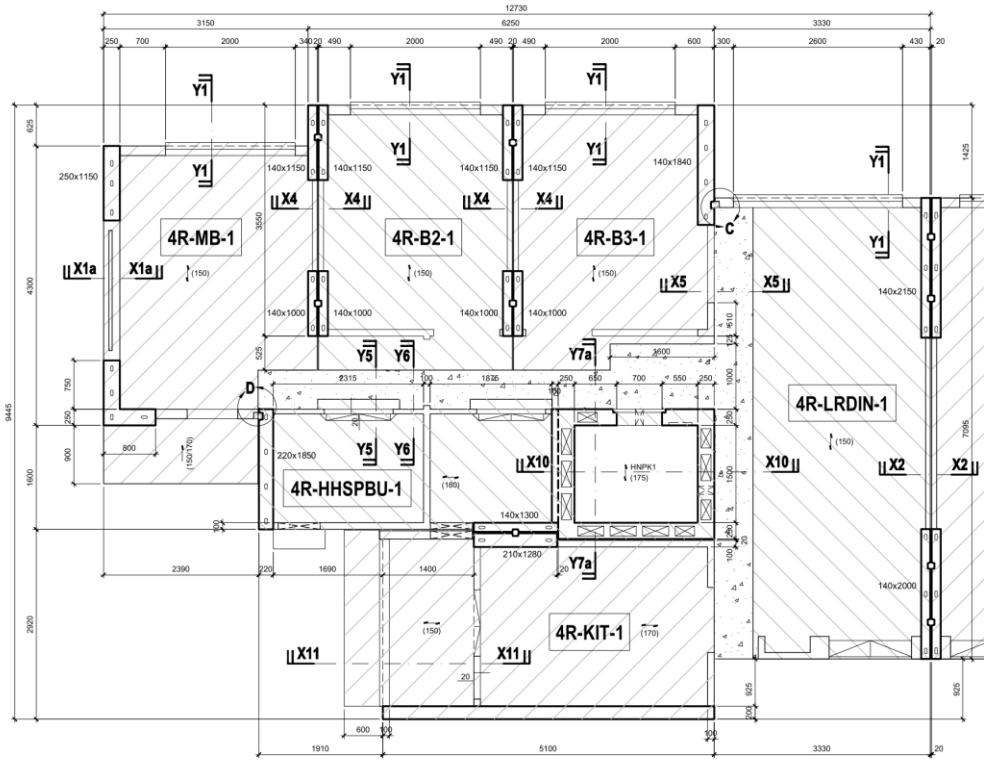


U Shape

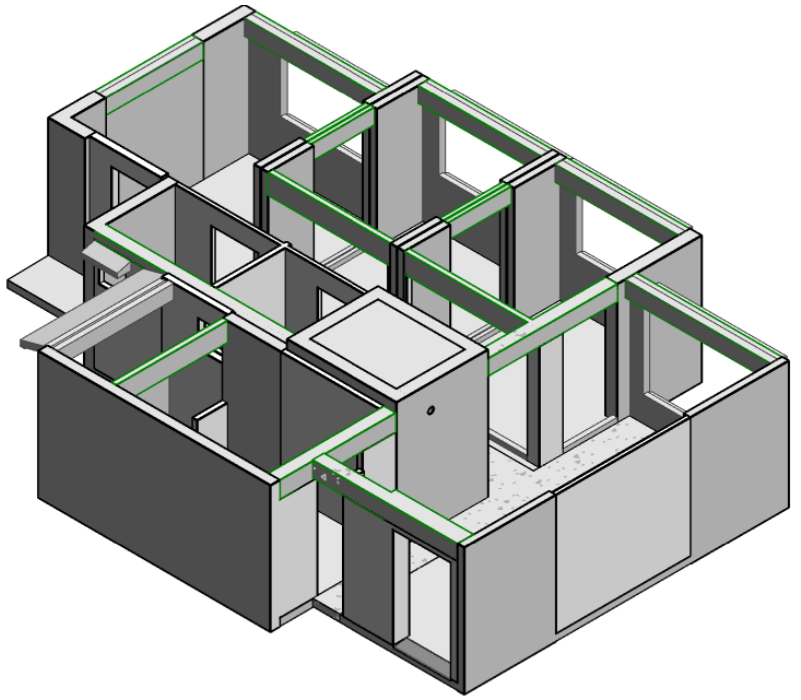


HDB YISHUN VALLEY SPRING (2016 - 2018)

HDB YISHUN VALLEY SPRING (2016 - 2018)



4R UNIT - BASE PLAN

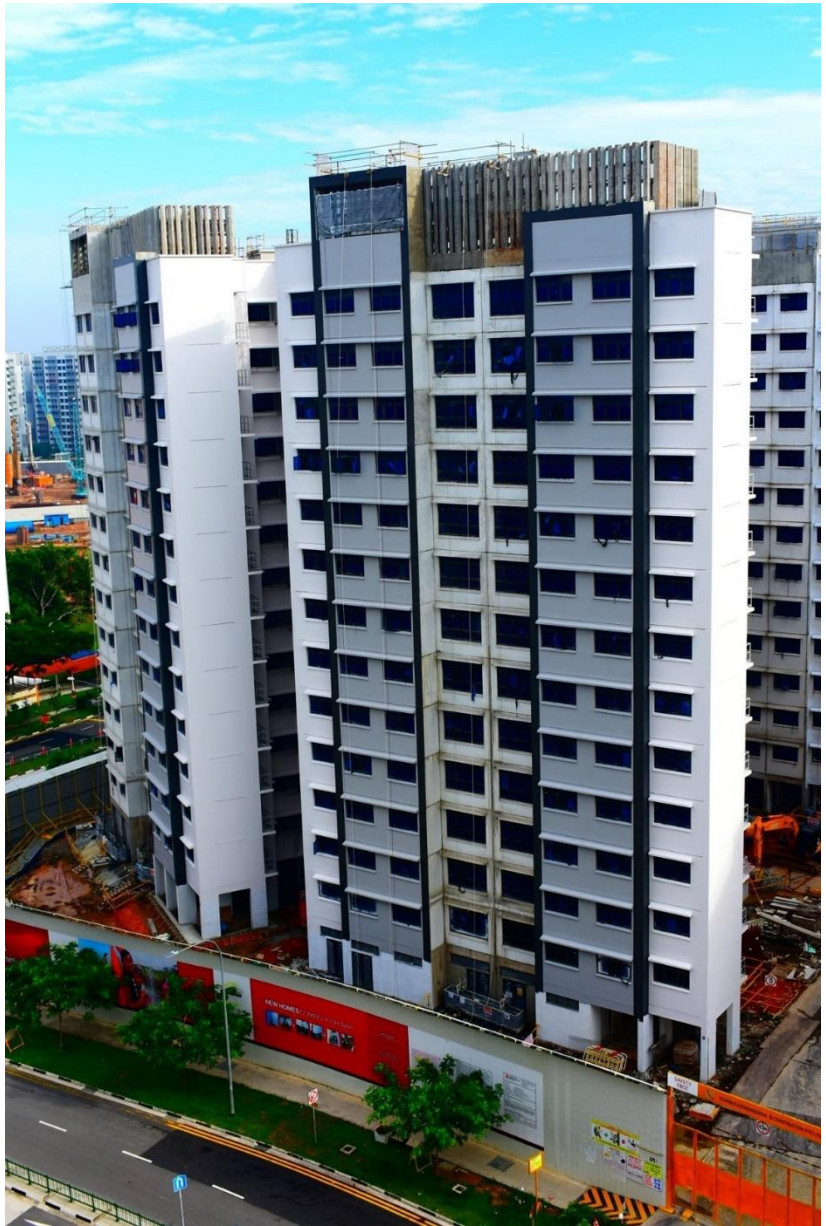


STRUCTURAL FRAMING PLAN

4 Room Units

HDB YISHUN VALLEY SPRING (2016 - 2018)

HDB YISHUN VALLEY SPRING (2016 - 2018)

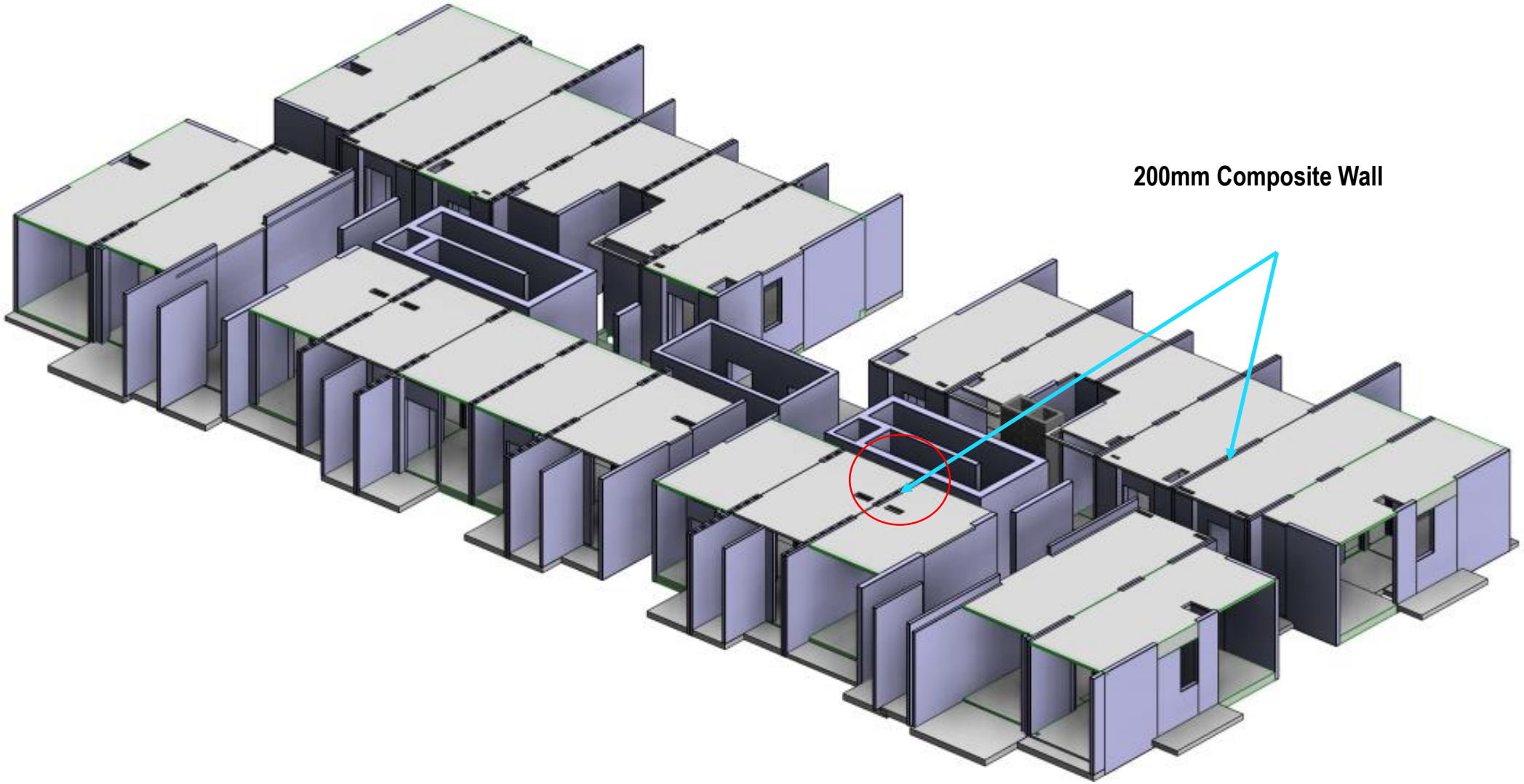


- U shaped PPVC modules
- Non-composite double wall
- Less cast in situ strip compared with West Terra
- Hoisting by heavy duty tower crane

TAMPINES TAPESTRY (2016 - 2018)

S/N	Description	Remarks
1	Project Name	The Tapestry
2	Project Address	Tampines Ave 10 (Parcel C)
3	Contract Sum	$180,400,000
4	Commencement Date	1 November 2017
5	Contract Completion Date	31 October 2020
6	Contract Duration	36 months
7	Client	Bellevue Properties Pte Ltd (CDL)
8	Main Contractor	Woh Hup Private Limited
9	Type of PPVC	Reinforced Concrete (RC) PPVC – 6-sided

TAMPINES TAPESTRY (2016 - 2018)



TAMPINES TAPESTRY (2016 - 2018)

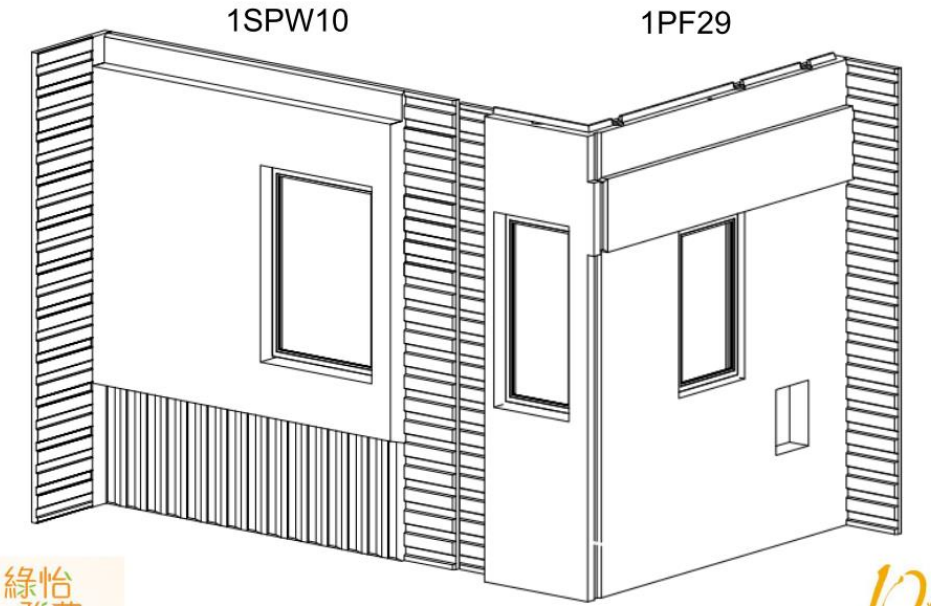
TAMPINES TAPESTRY (2016 - 2018)

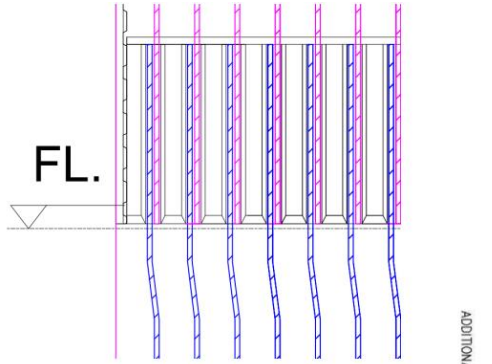
HONG KONG HOUSING SOCIETY SHATIN 36C （2016 - 2018）

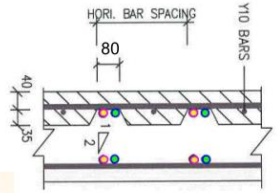
HONG KONG HOUSING SOCIETY SHATIN 36C （2016 - 2018）

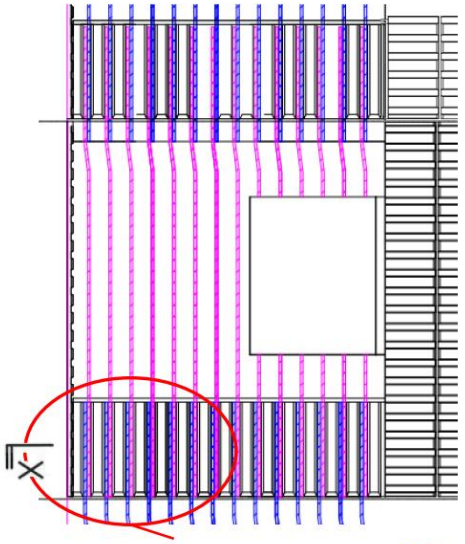
- Precast structural wall for perimeter
- Omitted external scaffolding
- Details mainly following guidance of HK COP for Precast Structure 2016

HONG KONG HOUSING SOCIETY SHATIN 36C （2016 - 2018）

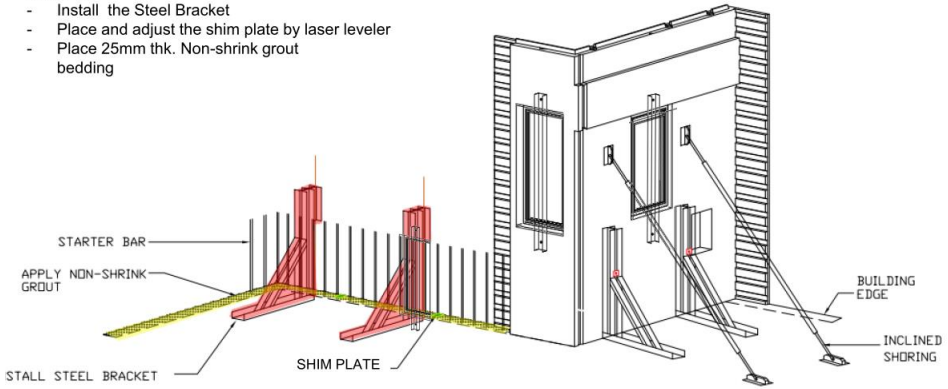




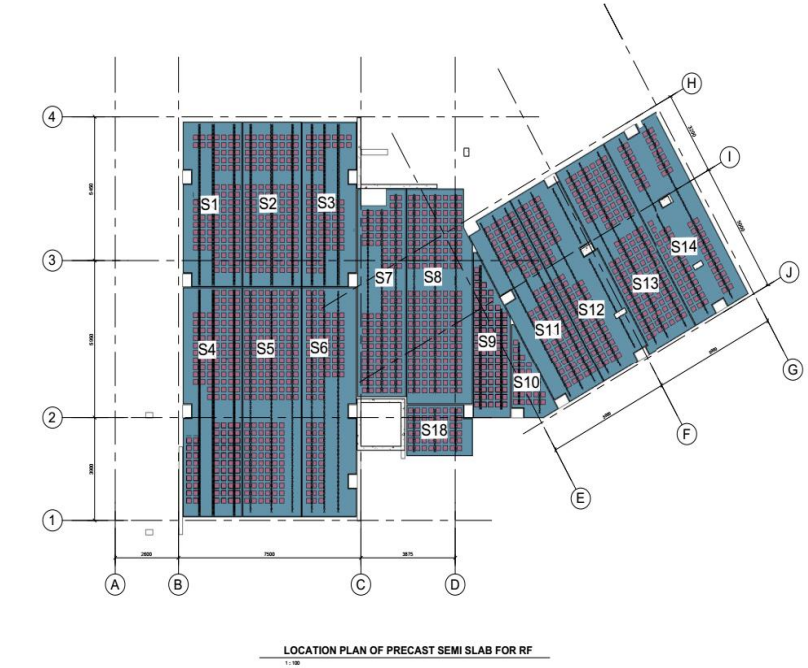




Stage 1 :
- Install the Steel Bracket
- Place and adjust the shim plate by laser leveler
- Place 25mm thk. Non-shrink grout bedding



BREAST CANCER FOUNDATION (2016 - 2017)



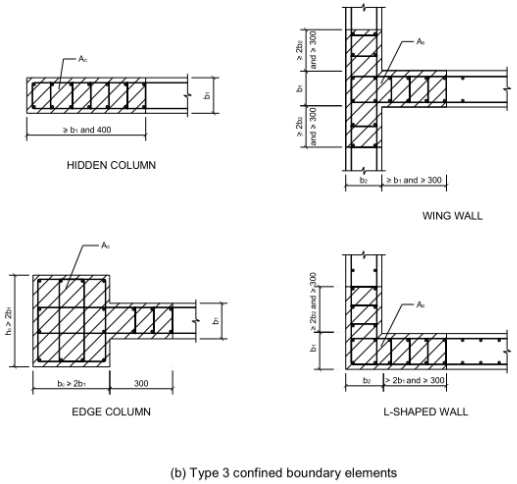
LOCATION PLAN OF PRECAST SEMI SLAB FOR RF

BREAST CANCER FOUNDATION （2016 - 2017）

First biaxial voided slab project in Hong Kong

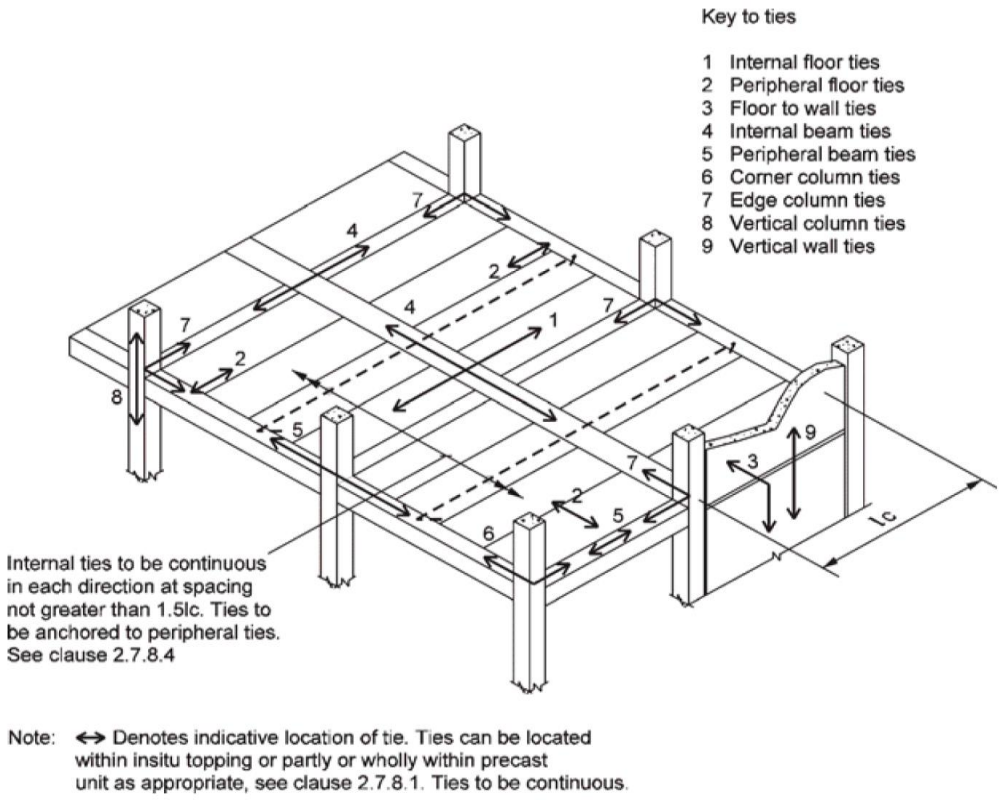
HK 40 STOREY CONCRETE MiC SYSTEM (2018 - 2019)

Comparison	Singapore	Hong Kong
规范	EC1 EC2	COP for Structural Use of concrete 2013 COP for Precast Concrete Construction 2016 COP on Wind Effects in HK
Design Hourly mean wind speed at 10m	18.4 m/s	38.7m/s
Limits to compression ratio	NA	SUC cl. 9.9.3.3
Confined boundary zone	NA	SUC 9.9.3.4 to 9.9.3.6 Up to Y12 – 150 links

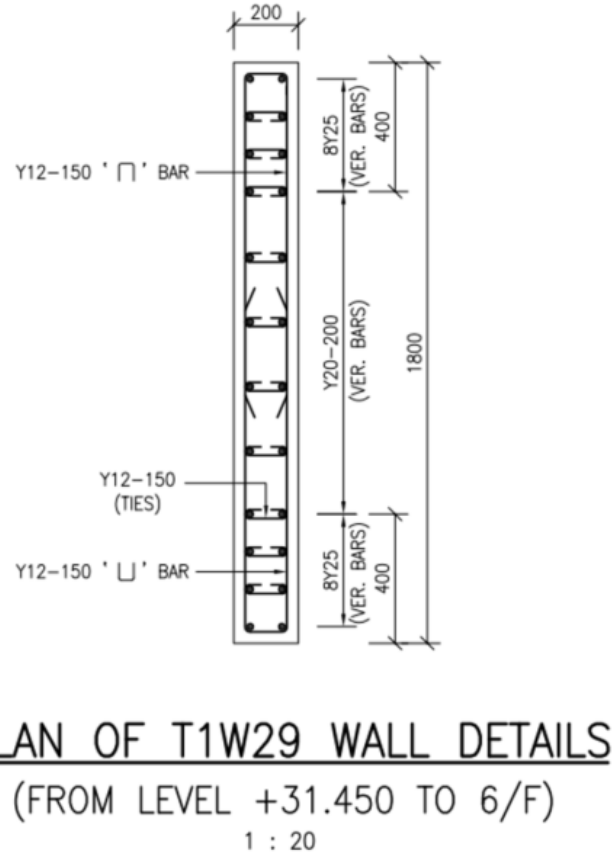


(b) Type 3 confined boundary elements

HK 40 STOREY CONCRETE MiC SYSTEM (2018 - 2019)



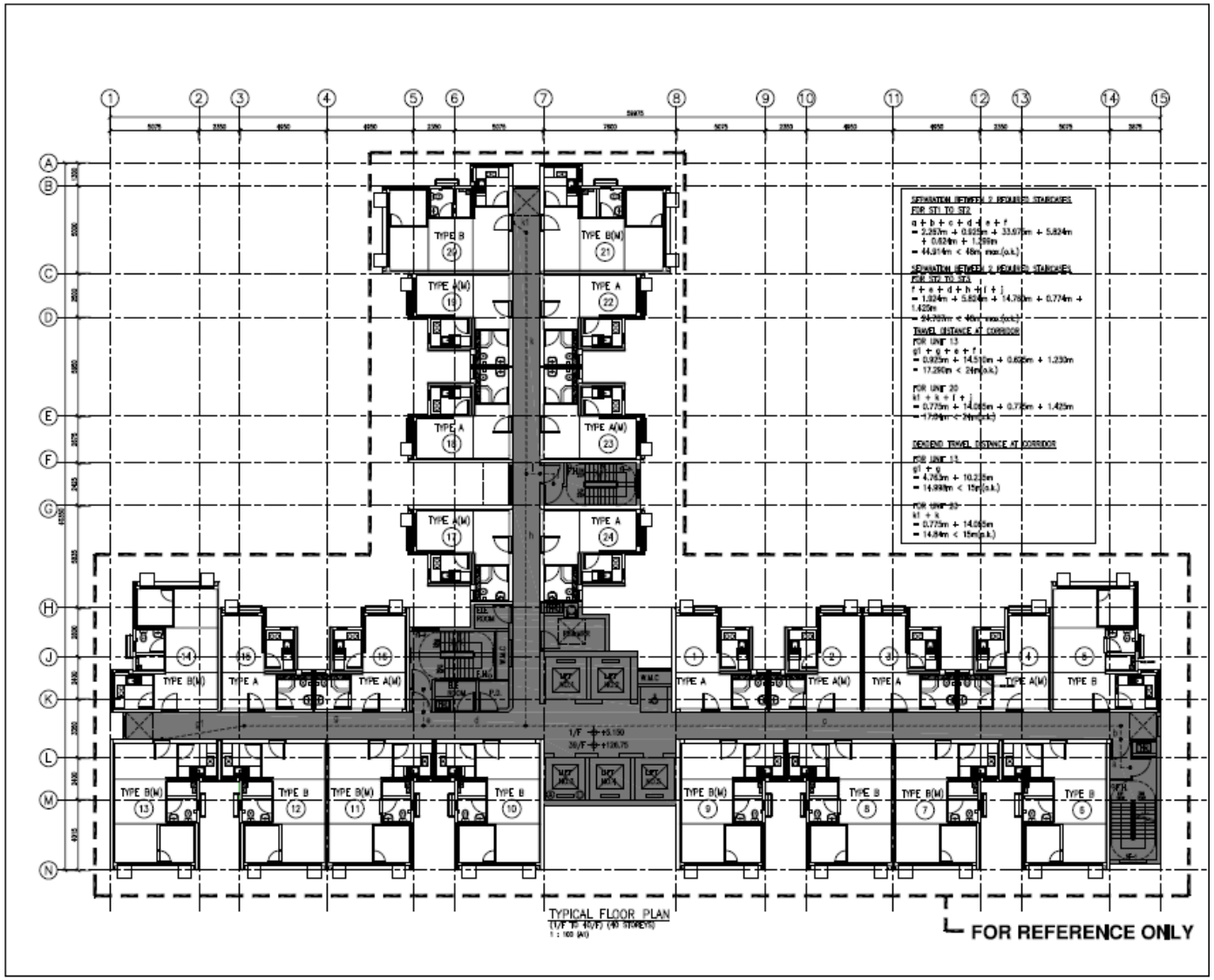
Note: ↔ Denotes indicative location of tie. Ties can be located within insitu topping or partly or wholly within precast unit as appropriate, see clause 2.7.8.1. Ties to be continuous.



PLAN OF T1W29 WALL DETAILS
(FROM LEVEL +31.450 TO 6/F)
1 : 20

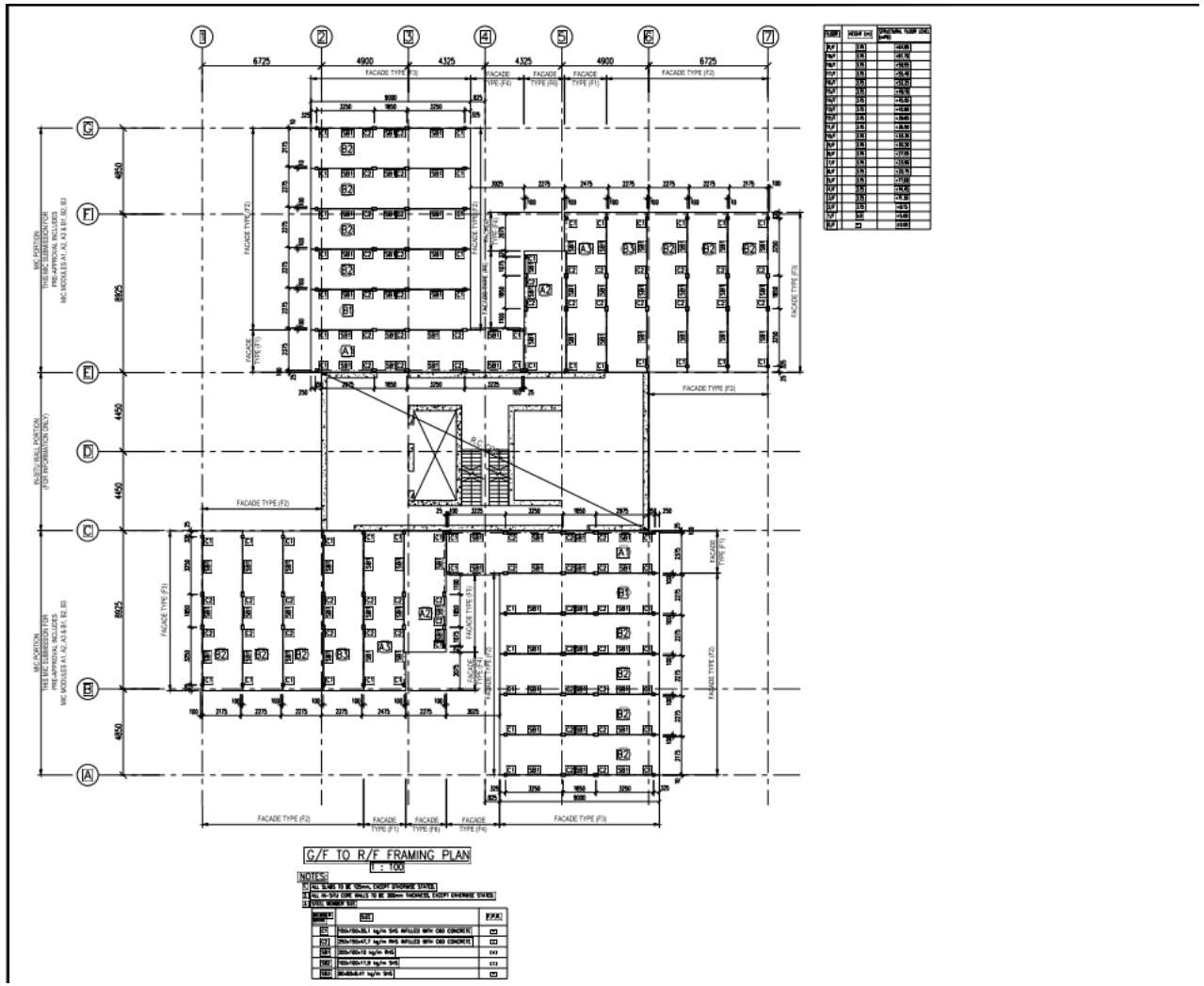
- Robustness - Provide effective periphery and internal ties to Cl.6.4.1

HK 40 STOREY CONCRETE MiC SYSTEM (2018 - 2019)



- 40 storey MiC design
- Based on Singapore system with some modification

OTHER MiC SYSTEMS (2018 - 2019)



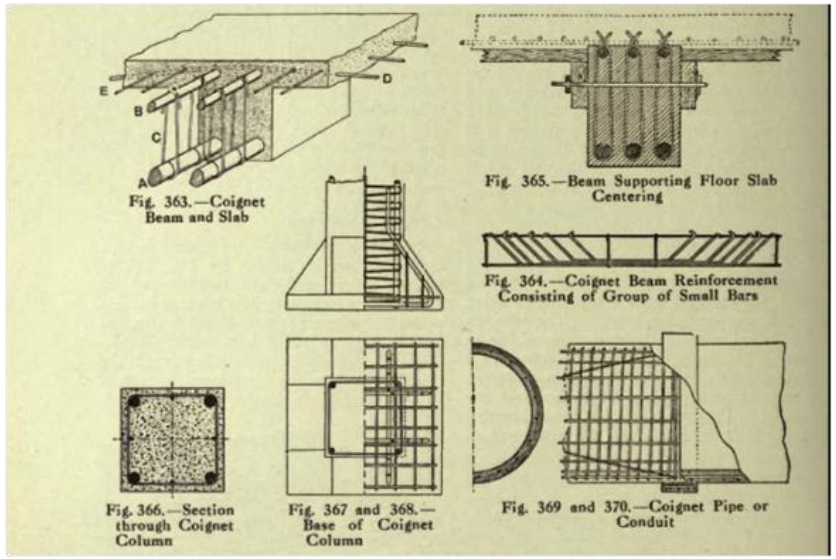
- 20 story steel MiC system
- Aluhouse
- Submitted for pre-acceptance in Mar 2019

OBSERVATIONS

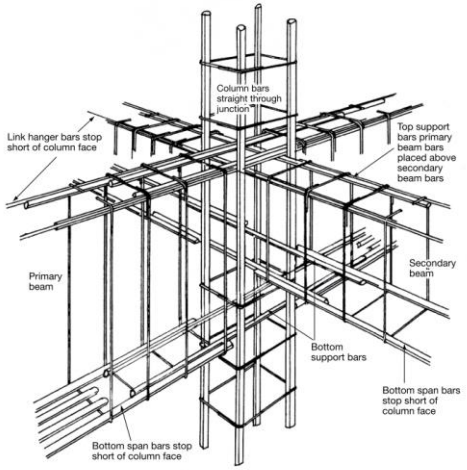
- Singapore has a long process of development from precast to PPVC
- Learning by developers, consultants, contractors, sub-contractors and suppliers
- Teamwork between all parties required to implement new technologies / continual R&D
- Progressively gained confidence in design methods, joint details, construction processes and performance of precast structure
- While MiC is being promoted in Hong Kong, continual development and practice of precast structure should not be neglected

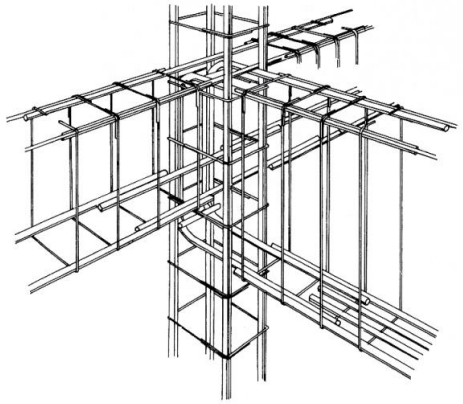
Francois Coignet House, 1853

Cast in situ detailing does not work well for precast
Need paradigm shift from cast in situ detailing
A lot of room for improvement



Coignet Reinforced Concrete System





IstructE Standard Method of Detailing Structural Concrete, 2006

THANK YOU