NANYANG TECHNOLOGICAL UNIVERSITY
SINGAPORE

presented by

Paul Chain
Chief Executive Officer
NTU Development &
Facilities Management

24 April 2018

In 2010, the Building and Construction Authority (BCA) of Singapore first promoted the use of Pre-fabricated, Pre-finished Volumetric Construction (PPVC) in Singapore.

Nanyang Technological University answered the call and took the challenge to be the first institution to use PPVC in 2013 in a relatively large scale project.

Residential Halls at Nanyang Avenue (PPVC) - Completed

Residential Halls at Nanyang Crescent (PPVC) - Completed

Gross Floor Area - 48,550 m2

Construction Cost - $123.706 mil
($151.622 - $27.916)
Construction Cost per m2 - $2,548/m2

Project Cost - $132.003 mil
Project Cost per m2 - $2,719/m2

Construction Period - 31 months

- Why PPVC for Singapore?

- Too much unskilled foreign labour

- Why NTU?

- If not NTU, who?

- Why the hesitation and resistance to use PPVC?

- Objection No. 1 : Never do before

- Objection No. 2 : No experience to rely on

- Objection No. 3 : Risky to be the first to try

- Objection No. 1 : Never do before.

  There are many things in life we never do before but we still do it – do not want to try because no direct benefits to one self.

- Objection No. 2 : No experience to rely on.

Building Codes are still applicable to the completed structure. More tedious and complicated in the design process.

No rocket science.

Immanuel Kant says " Enlightenment refers to man's departure from his self-imposed tutelage …. Have courage to use your own reasons."

Translate that to what we are doing – "Enlightenment refers to engineers' departure from the normal design process and design handbooks …. Have courage to go back to basic engineering principles."

- Objection No. 3 : Risky to be the first to try.

Risky is because one thinks that it is difficult. It may be something new to you but certainly not that difficult. And that is because:

“Ignorance is the cause of fear”

“Difficulty comes from our lack of confidence”

Seneca The Younger

- More importantly is what do we want to achieve?

- How do we want our industry to be structured?

- Why other industries are better off?
  - do not have to rely so much on unskilled labour
  - off-season farm worker

- Why can't we build a building like say, a car, with a lot of engineering and without unskilled labour?

- The answer is:

  (1) To industrialize the construction process

  (2) To have less but more skilled, highly motivated and better rewarded workers

- NTU would like to participate, if not taking the lead, in restructuring the construction industry in Singapore.

NTU Sports Hall – The Wave

Gross Floor Area - 9,772 m2

Construction Cost - $28.370 mil
($34.990 -$6.620)
Construction Cost per m2 - $2,903/m2

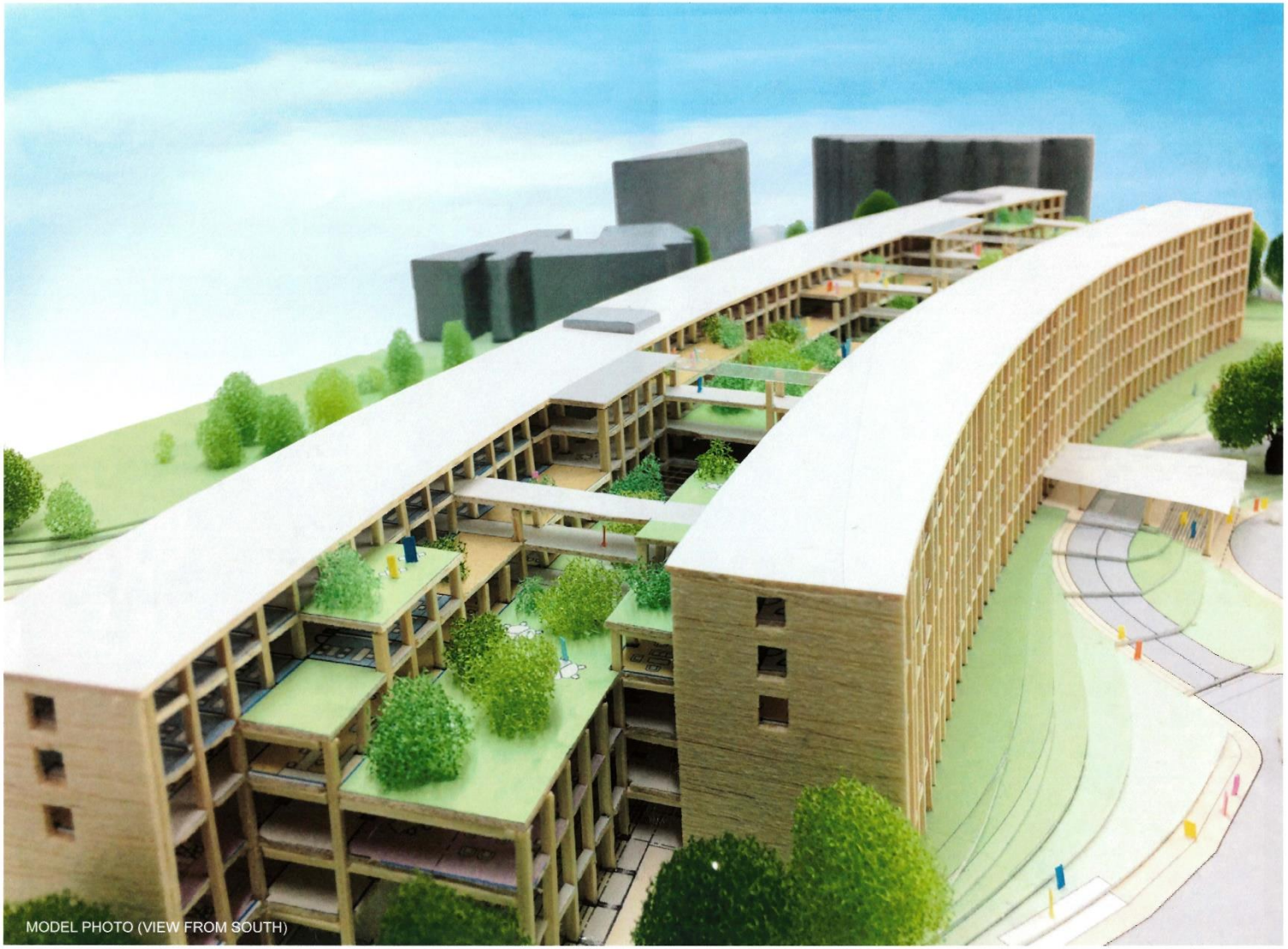
Project Cost - $34.380 mil
Project Cost per m2 - $3,518/m2

Construction Period - 19 months

Academic Block South

INTERIOR IMAGE
(CONTINUOUS ASSEMBLY FROM LIBRARY TO AUDITORIUM)

Academic Block South



ACADEMIC BUILDING SOUTH "LEARNING AMIDST THE SCENT OF WOOD"
TOYO ITO & ASSOCIATES, ARCHITECTS + RSP ARCHITECTS PLANNERS & ENGINEERS LTD

6

In conclusion -

“It is not because things are difficult that we do not dare, it is because we do not dare that they are difficult.”

Seneca The Younger

NANYANG TECHNOLOGICAL UNIVERSITY
SINGAPORE

presented by

Siew Hoong Kit
Director (Projects)
Office of Development &
Facilities Management

24 April 2018

NTU's Journey on Game-Changing Technologies Adoption

Pre-fabricated Pre-finished Volumetric Construction (PPVC) in Singapore: NTU Case Studies (Residential Halls)

International Conference on Modular Integrated Construction
Kowloon Shangri-La Hotel, Hong Kong
by Development Bureau (Hong Kong SAR) and
The University of Hong Kong

24 April 2017
Office of Development & Facilities Management

Forward

- NTU adopted PPVC for 2 hostel developments from 2014 to 2017
- PPVC construction method has been implemented successfully
- Productivity gains are encouraging and achievable
- Changes to the consultancy and construction industry are required
- Acceptance of the product by the public is required
- This short presentation will provide an overall insight on PPVC from the owner's perspective
- The pointers provided could be the catalyst for further thought processes in productivity planning

Outline

- PPVC – what is?, objectives, schematics
- Project Brief
  - Development Projects in NTU
  - NTU1 – Resi Halls at North Hill
  - NTU2 – Resi Halls at Nanyang Crescent
- Production Processes to Installation
  - PPVC method means…..
  - PPVC method – off-site location….
  - PPVC method comprises of…..
- NTU's Experience
- Further Developments and Improvements
- Concluding Remarks

WHAT IS PPVC?

"Prefabricated Prefinished Volumetric Construction"
>> a construction method whereby
>>> free-standing volumetric modules
(complete with finishes for walls, floors and ceilings) are -
a. constructed and assembled; or
b. manufactured and assembled,

in an accredited fabrication facility, in accordance with any accredited fabrication method, and then installed in a building under building works."

-Building and Construction Authority

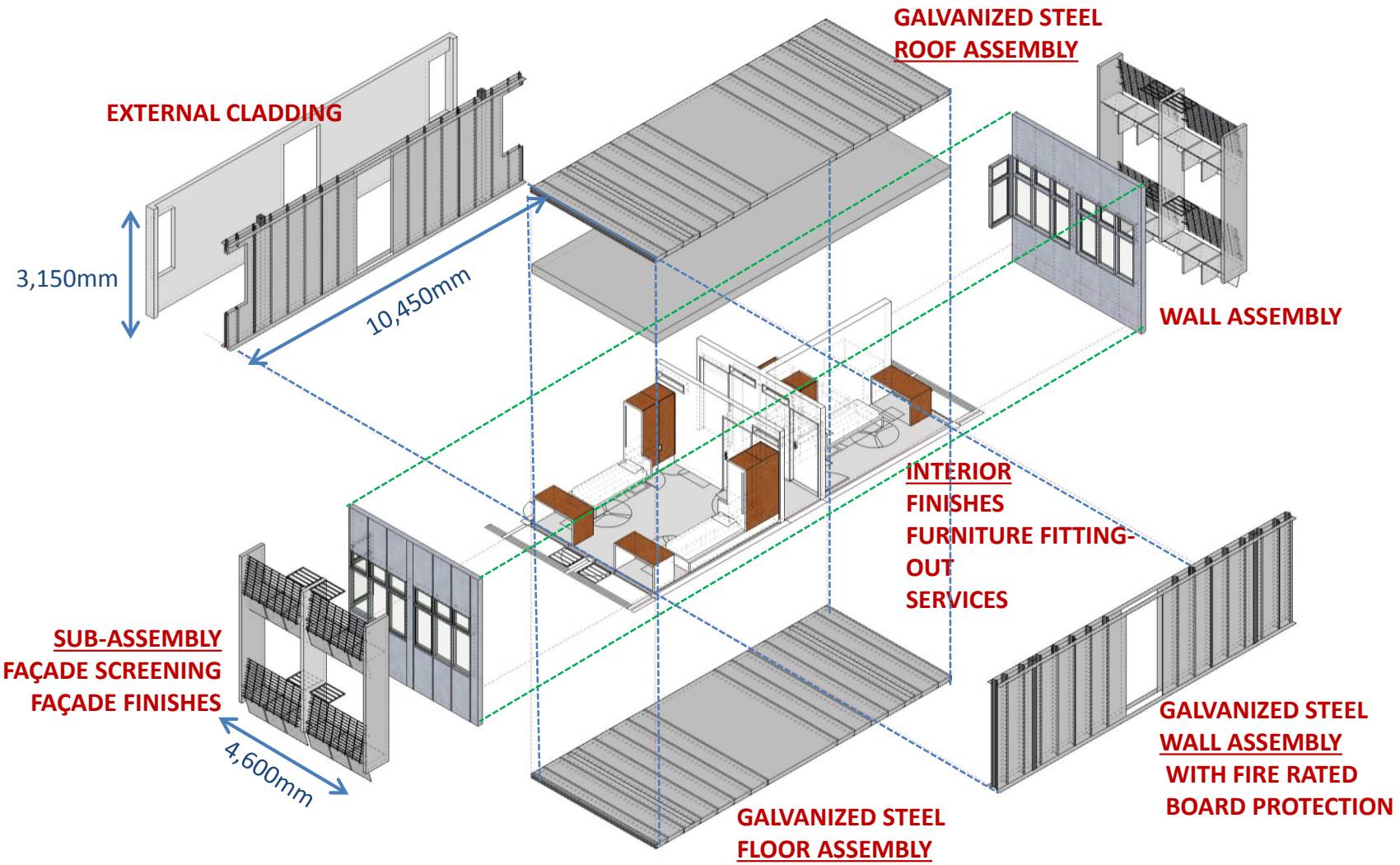
PPVC – the objectives

INCREASE IN PRODUCTIVITY

- **Savings in construction time** up to about 15% - 20% from conventional construction.
- **Savings in manpower** up to about 25% - 40% from conventional construction. All the fabrication and assembly process are completed at off-site factory, thus reduces labour intensive construction activities.
- **Parallel on-site and off-site** construction concurrently.
- **Shorter floor cycle construction** from 14-21 days of conventional construction to approx. 4 days only for PPVC on site installation. **However longer preparation before construction.**
- **Higher consistency in quality and quality assurance** of building works in controlled factory fabrication and assembly environment
- **Construction safety –** Minimize labour intensive works at height at construction site
- **Environment** – Reduce noise and dust pollution on-site
- **Sustainability** – Reusable steel material
- ***Cost premium*** *- for a start*

PPVC – schematic form

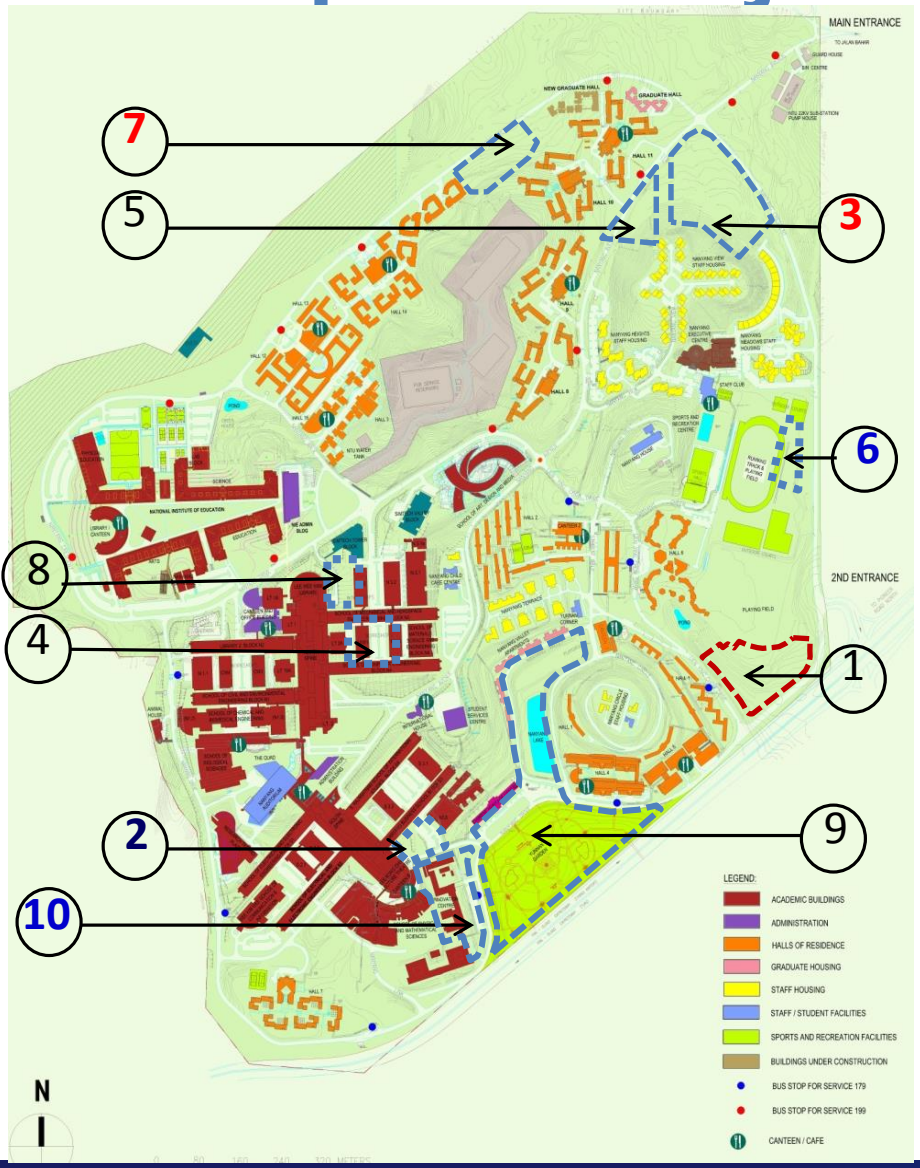
Major Components of a typical module



Outline

- PPVC – what is?, objectives, schematics
- **Project Brief**
  - **Development Projects in NTU**
  - **NTU1 – Resi Halls at North Hill**
  - **NTU2 – Resi Halls at Nanyang Crescent**
- Production Processes to Installation
  - PPVC method means…..
  - PPVC method – off-site location….
  - PPVC method comprises of…..
- NTU's Experience
- Further Developments and Improvements
- Concluding Remarks

Project Brief
Development Projects in NTU (as of 24 April 2018)



Completed

1) Residential Halls at Nanyang Drive
2) Learning Hub South (The Hive)
3) **Residential Halls at Nanyang Avenue**
4) Academic Block North (NSAB)
5) Faculty Housing at Nanyang Avenue
6) New Sports Hall (EWS)
7) **Residential Halls at Nanyang Crescent**
8) Learning Hub North

Construction Stage

9) Yunnan Garden Re-Development

Design Development Stage

10) Academic Building South (EWS)

Project Brief – PPVC Adoption Timeline

2011 (since) Promotion by BCA on adoption of game-changing technologies in the construction sector for productivity gains

2013 1 Aug > NTU's media announcement of NTU's adoption of PPVC in its residential halls


F THE NEWS THURSDAY, AUGUST 1, 2013 THE STRAITS TIMES

hostel to be Lego-style

g's rooms will be built ut together on site

2014 23 Jun >> NTU1 main contract award
15 Aug Media announcement of similar adoption for Crowne Plaza
8 Sep BCA briefing to government agencies on PPVC
Sep/Oct NTU1 Project detail consultation with authorities

2015 15 May >> NTU1 start production of 1st steel chassis
2 Jun >>> NTU2 main contract award
2 July BCA's 2nd Exec WS on Game Changing Technologies
17 Aug > NTU1 lifting and installation of 1st complete module
13 Oct BCA's Build Smart Conference – PPVC key note paper

2016 6 Jan *** DPM Tharman and National Productivity Council site visit
23 Mar >>> NTU2 lifting and installation of 1st complete module
7 Aug NTU1 – Substantial completion
1 Sep NTU1 – TOP (occupation)
31 Dec NTU2 – completed all modules installation

2017 22 Jun NTU2 – TOP (occupation)

Project Brief – NTU1

Project Information

Gross Floor Area - 54 000 m2
No. of single occupancy rooms - 1288 (1288 students)
No. of double occupancy rooms - 294 (588 students)
No. of apartment-type units - 66 (220 students)
12 apartments for Faculty-in-Residence
Construction – Conventional integrated with PPVC

GREEN MARK PLATINUM - Awarded by BCA (2014)

Project Brief – NTU1

PPVC DESIGN INTEGRATION WITH CONVENTIONAL CONSTRUCTION

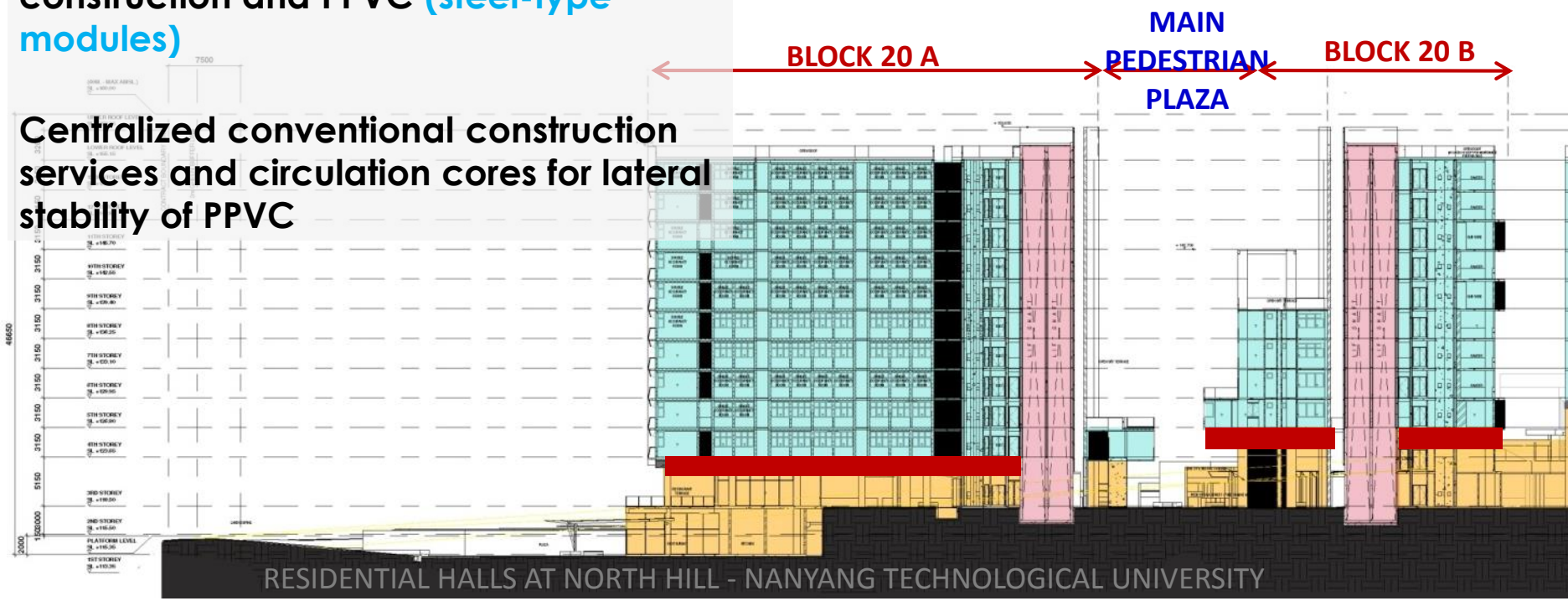
Conventional construction of podium floors to handle sloping terrain at site

Transfer slab between conventional construction and PPVC (steel-type modules)

Centralized conventional construction services and circulation cores for lateral stability of PPVC

LEGEND

- **PODIUM LEVELS** – CONVENTIONAL CONSTRUCTION
- **TYPICAL LEVELS** – **PPVC MODULES**
- **CORE AREA** – CONVENTIONAL CONSTRUCTION
- **TRANSFER SLAB**



RESIDENTIAL HALLS AT NORTH HILL - NANYANG TECHNOLOGICAL UNIVERSITY

Credit – P&T Consultants Pte Ltd

Project Brief – NTU1
Residential Halls at Nanyang Avenue (NTU1)





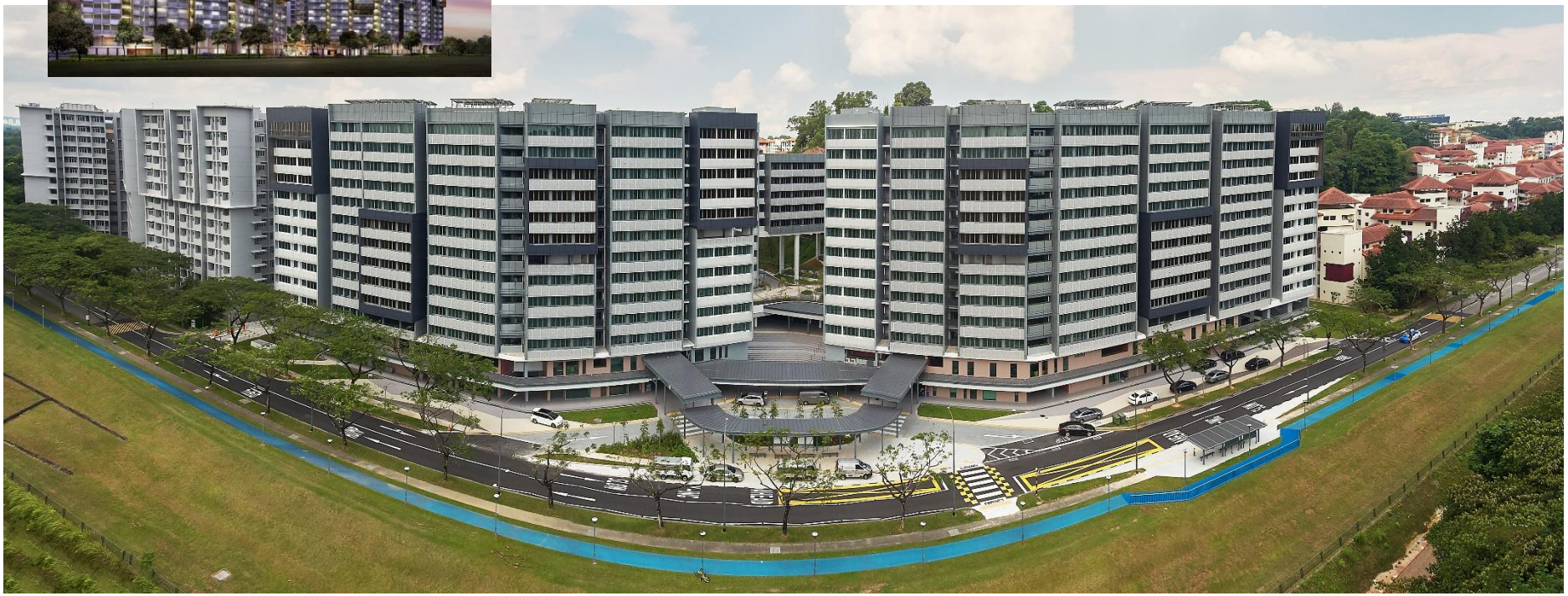

Project Brief – NTU2
Residential Halls at Nanyang Crescent (PPVC)

- Building Contract awarded Jun 2015
- PPVC modules completed and fully installed
- TOP obtained 22 June 2017

Project Information

Gross Floor Area	-	48,550 m2
No. of single occupancy rooms	-	1,233 (1233 pax)
No. of double occupancy rooms	-	294 (588 pax)
No. of apartments for Hall Fellows	-	12

Green Mark Platinum – Awarded by BCA (2014)



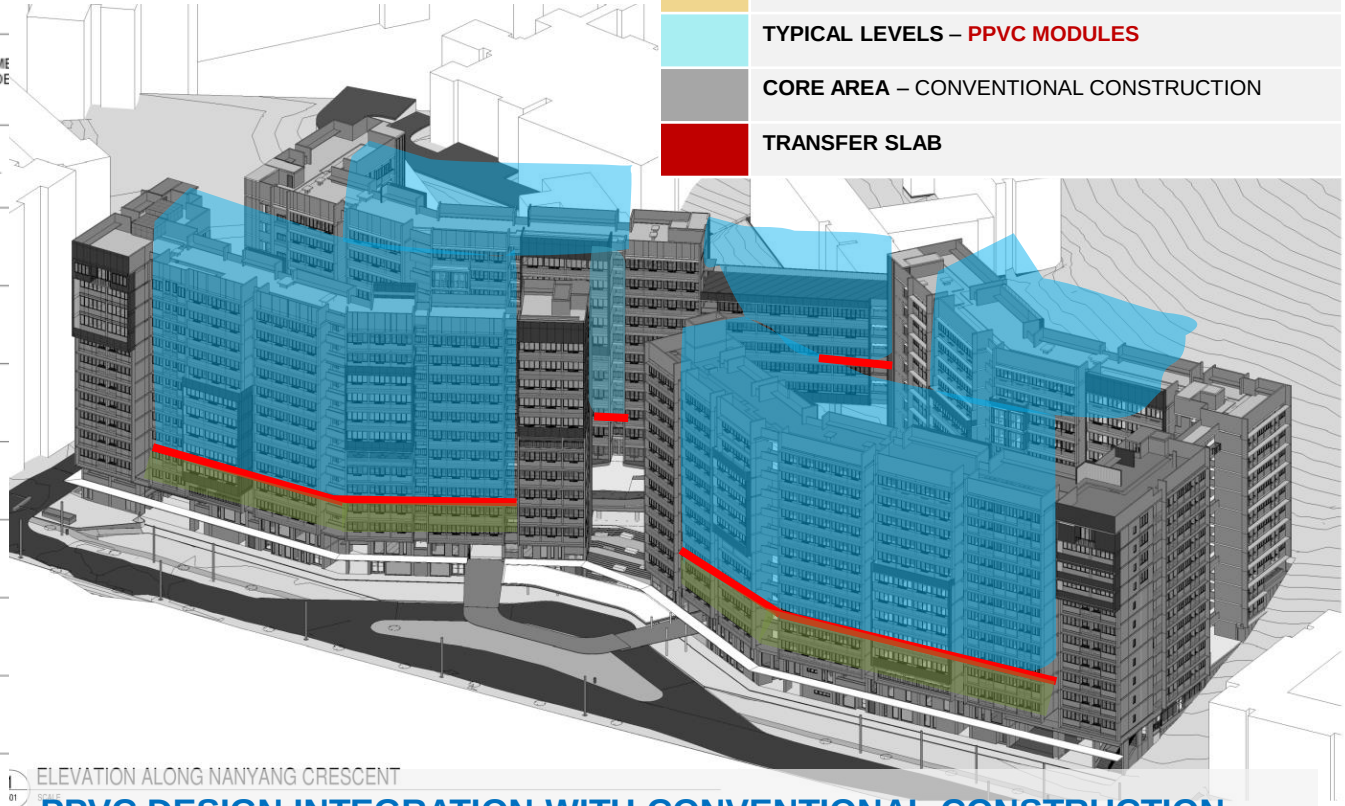
Saraca Hall Tamarind Hall Meranti Hall

Project Brief – NTU2

CIS & PPVC 3D View and Section

LEGEND

- **PODIUM LEVELS** – CONVENTIONAL CONSTRUCTION
- **TYPICAL LEVELS** – **PPVC MODULES**
- **CORE AREA** – CONVENTIONAL CONSTRUCTION
- **TRANSFER SLAB**



ELEVATION ALONG NANYANG CRESCENT

PPVC DESIGN INTEGRATION WITH CONVENTIONAL CONSTRUCTION

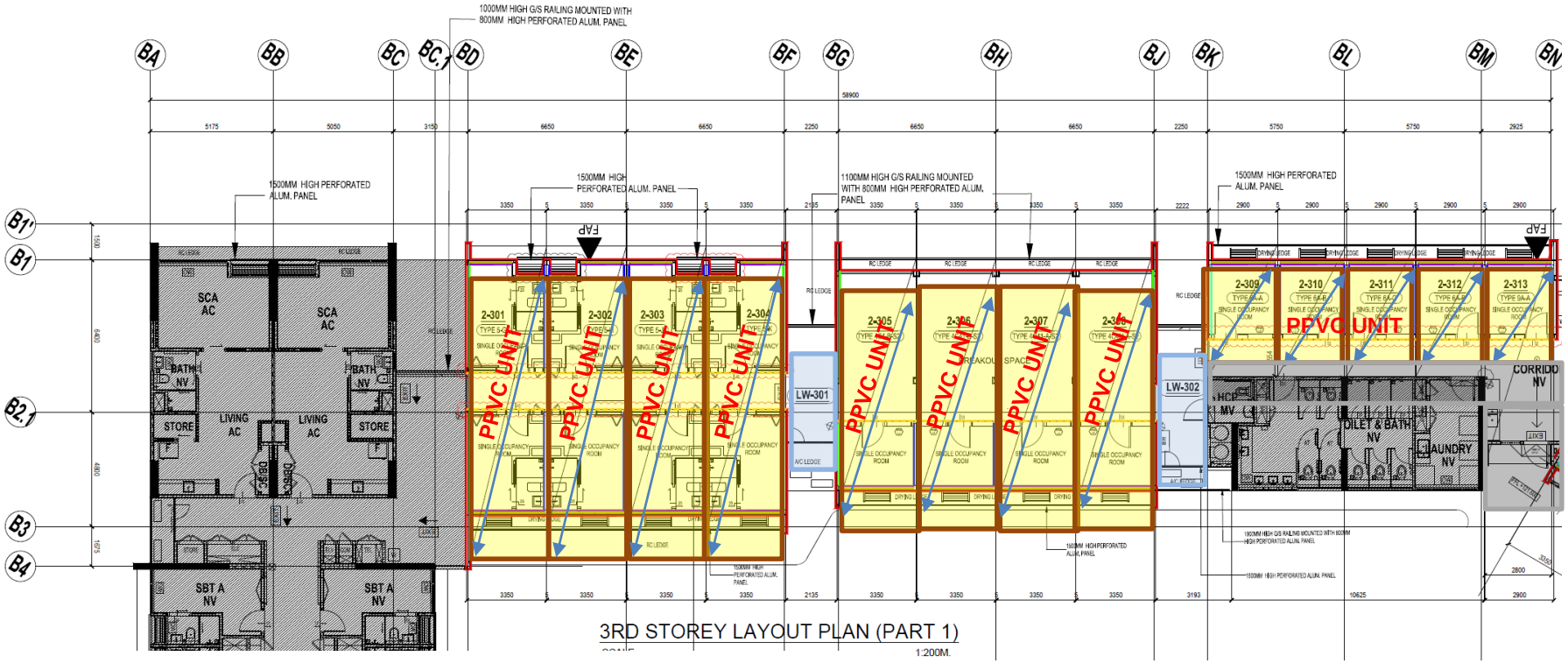
Conventional construction of podium floors to handle sloping terrain at site

Transfer slab between conventional construction and PPVC (steel-type modules)

Centralized conventional construction services and circulation cores for lateral stability of PPVC

Project Brief – NTU2

Typical Layout – Floor Plans



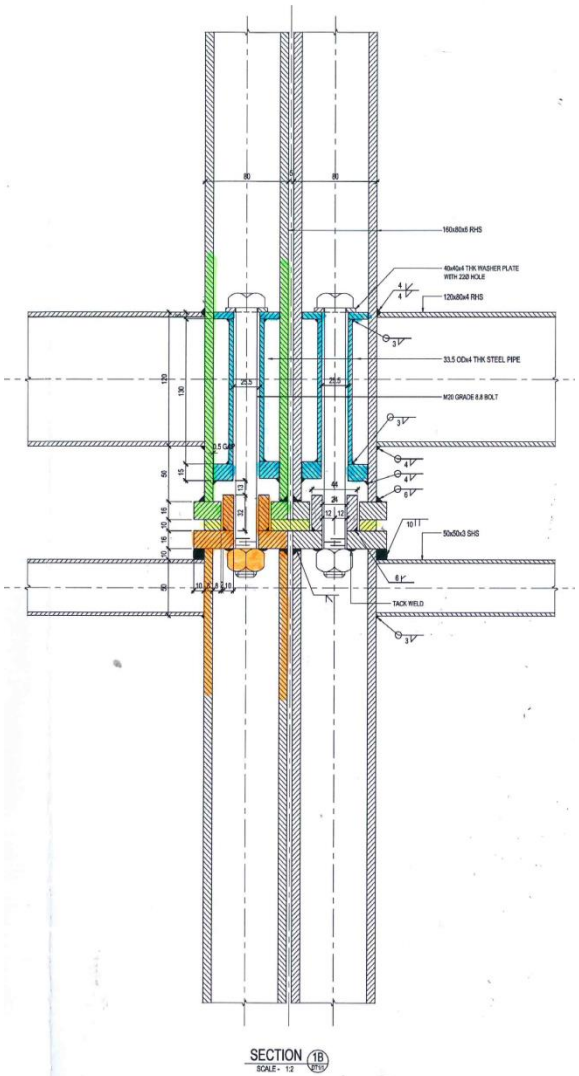
PPVC DESIGN MODULARITY

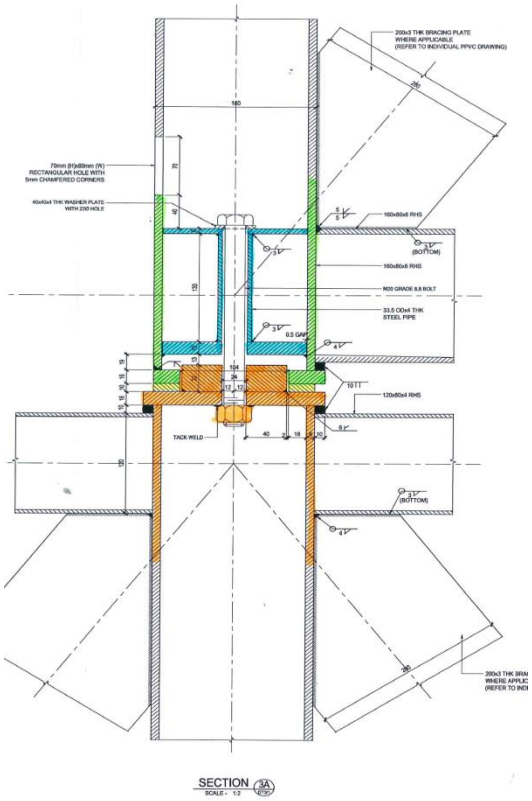
Size of module
Dimension and size of typical student hostel is suitable for PPVC, considering the transportation and hoisting of the module

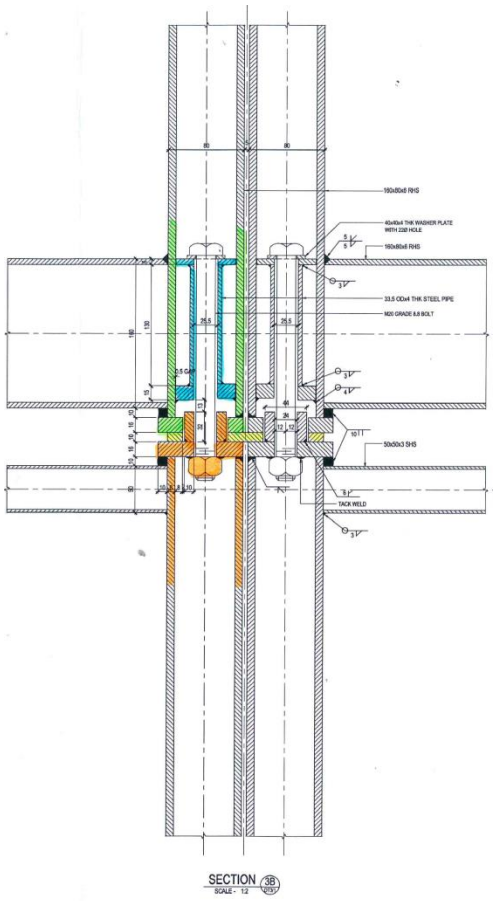
LEGEND

- **PPVC MODULES**
- CONVENTIONAL CONSTRUCTION
- SUB-ASSEMBLY (LINKWAY)

Project Brief – NTU2 – typical columns connection (Moderna System)







Project Brief – NTU2

Typical Room Layout

Total number of PPVC modules : **676**

Total number of rooms using PPVC: **1308**

Dimension of typical modules:

Type	Width (m)	Length (m)
1	2.80	8.15
2	2.80	9.16
3	2.80	10.76
4	3.25	10.70
5	3.25	10.67
6	2.80	4.90
7	2.80	8.15
8	3.25	2.65

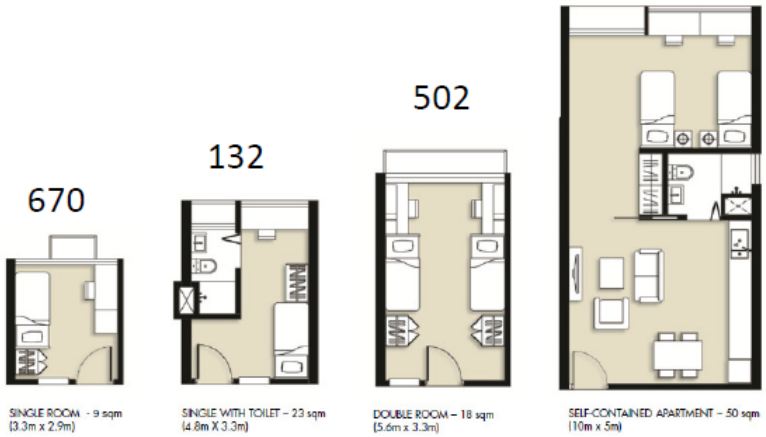
Maximum Width: 3.25m

Maximum Length: 10.76m

Largest Self-weight: 17.6 ton

Including structural steel, promat board, floor tiles and others

3



Project Brief – NTU2

Residential Halls at Nanyang Crescent Construction Stage (July 2016)

Residential Halls at Nanyang Crescent Construction Stage (Dec 2016)

Project Brief

PPVC – Statistics for Residential Halls at NTU

	NTU1	NTU2
Gross Floor Area (entire development)	54 000 m2	48 550 m2
Gross Floor Area (using PPVC)	29 400 m2	20 600 m2
Percentage GFA (entire development)	55 %	42 %
Percentage GFA (floor areas above podium levels)	68 %	53 %
Total number of modules	1213	676
Total type of modules (structurally)	38	60
Total type of modules (architecturally)	263	277
Typ module weight - ranges (room types)	6.6 t ~ 8 t	5 t ~ 17 t
ranges (apartment type)	12 t ~ 14 t	
Total number of ancillary attachments	502	108
Air-condition ledges	188	67
Linkways and weather ledges	314	41
Total steel tonnage estimated at	4442 t	3240 t
equivalent to (in terms of PPVC-areas)	150 kg/m2	157 kg/m2
equivalent to (in terms of per module)	3.66 steel t	4.80 steel t

Outline

- PPVC – what is?, objectives, schematics
- Project Brief
  - Development Projects in NTU
  - NTU1 – Resi Halls at North Hill
  - NTU2 – Resi Halls at Nanyang Crescent
- **Production Processes to Installation**
  - **PPVC method means…..**
  - **PPVC method – off-site location….**
  - **PPVC method comprises of…..**
- NTU's Experience
- Further Developments and Improvements
- Concluding Remarks

Production Processes to Installation

PPVC – the Mindset Change

PPVC method means -

1. Early mass manufacturing (**precision**) of complete usable floors of any development – **capacity** and **capability** of specialist
2. Early determination of firm requirements
3. Early designs, minimal changes, early approvals
4. Provide for longer preparation time ahead of actual construction and manufacturing
5. Provide land and facilities off-site for effective manufacturing
6. Logistics – manpower, supervision, transportation (limitation) off-site / on-site coordination,
7. **Mindset** change in
   a. consultancy and construction industry current practices
   b. regulatory requirements
   b. public acceptance of such product

Production Processes to Installation

PPVC method – the key players

NTU1

Main Contractor – Singapore Piling & Civil Engineering Pte Ltd
PPVC Specialist – Moderna Homes Pte Ltd
PPVC Design Engineer – Ronnie & Koh Consultants Pte Ltd

Factory (steel chassis production)

a. Hsinchu, Taiwan 376 boxes (Chu Rong Steel Industry Co Ltd)
b. Senai, JB, Malaysia 475 boxes (Kong Hwee Iron Works & Construction (M) Sdn Bhd)
c. Loyang Way, Singapore 132 boxes (Technics Steel Pte Ltd)
d. Zhangjiagang, China 230 boxes (Maristar Container Manufacturing Co Ltd)

Factory (fit-out processes)

a. Jln Terusan yard, Singapore
b. Jurong Port Road yard, Singapore

NTU2

Main Contractor – Santarli-Zheng Kheng JV
PPVC Specialist – Moderna Homes Pte Ltd
PPVC Design Engineer – KTP Consultants Pte Ltd

Factory (steel chassis production)

a. Zhangjiagang, China 676 boxes (Maristar Container Manufacturing Co Ltd)

Factory (fit-out processes)

a. Jurong Port Road yard, Singapore

Production Processes to Installation

PPVC method comprises of –

1. factory production of the steel chassis
    a. material cutting and elements sub-assemblies
    b. frames fabrication in 2D
    c. 3D assembly of all frames with boxing plates and bracings
2. factory fit-out of external and internal finishes
    a. fire boards and insulation for ceiling, walls and floors
    b. windows and glazing
    c. finishes for ceiling, walls and floors
    d. doors and frames; ironmongery
    e. M&E items – lights, power sockets, sprinklers, services penetration, electrical cabling
3. transportation and delivery to site
4. installation on-site
5. final integration fit-out on-site

PPVC MODULE PRODUCTION PROCESSES TO SITE INSTALLATION

Material Cutting

Material Assembly

2D Frame Fabrication

Frame Assembly

Welding

Trial Fitting

QA/QC Inspection

Delivery

Factory Fit-out

Site Installation

Production Processes to Installation

FABRICATION OF STEEL CHASSIS – mtd 2

Credit – KTP Consultants

Production Processes to Installation

FABRICATION OF STEEL CHASSIS – test fitting

Credit – KTP Consultants

Production Processes to Installation

PPVC method – QA / QC processes

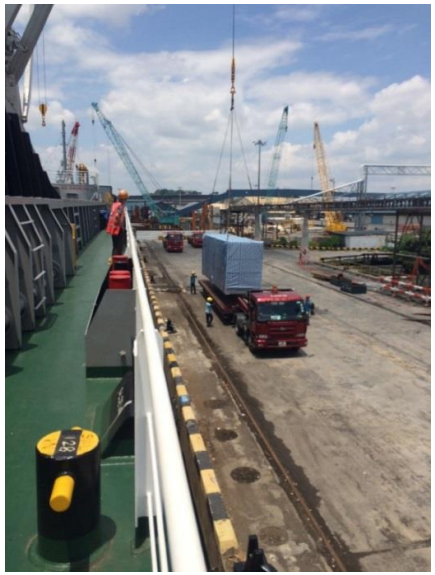
Production Processes to Installation

FITTING OUT AND FINISHES (at chassis factory)

Credit: KTP Consultants

Production Processes to Installation

PPVC method – shipment and delivery of completed module



Arrival at Jurong Port, Singapore

Arrival at Fit-out Factory – Jln Terusan

Production Processes to Installation

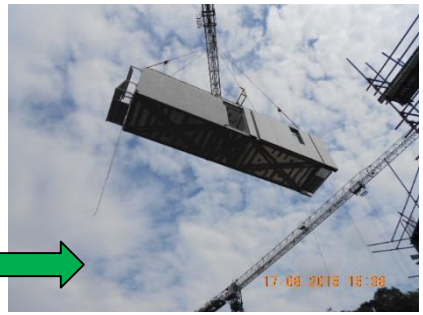
PPVC method – factory fit-out (M&E items – lights, power sockets, sprinklers, services penetration, electrical cabling)

Production Processes to Installation

PPVC method – factory fit-out (completed modules for delivery)

Production Processes to Installation

PPVC method – installation on-site

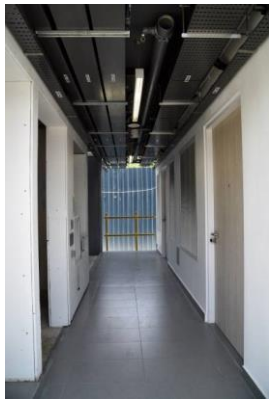


Other modules installation

On **17 Aug 2015 (for NTU1)**
successful lifting and installation of the first pair of modules

PPVC Mockup External View





Single Occupancy Student Room c/w attached Bathroom Interior


Double Occupancy Student Room Interior

Outline

- PPVC – what is?, objectives, schematics
- Project Brief
  - Development Projects in NTU
  - NTU1 – Resi Halls at North Hill
  - NTU2 – Resi Halls at Nanyang Crescent
- Production Processes to Installation
  - PPVC method means…..
  - PPVC method – off-site location….
  - PPVC method comprises of…..
- **NTU's Experience**
- Further Developments and Improvements
- Concluding Remarks

PPVC - NTU's Experience – an owner's perspective

- Authorities' Requirement and Compliances
  BCA (BP / ST / PI), FSSB, SEW

- Procurement Format
  Affects both consultancy services and construction
  Generic PPVC Design for Tender
  Adoption of PPVC Alternatives into Base (RC) Tender
  Concept Design for D&B (BCA's Guide for Early Contractor Involvement)

- Design Consideration for PPVC Concepts

- Contract Provision
  Cost breakdown (PPVC vs non-PPVC)
  Payment schedule (advance payment with bond?)
  Overseas production (QP / QSS / ITA) – expenses / time

- On the Ground – on-site / off-site

Authorities' Requirement and Compliances

- **Building Innovation Panel** – approval

  What constitutes the approval?

  What are the conditions imposed?

  Extent of rigorousness in the acceptance?

  < updates - see BCA circular 30 Nov 2015 on PPVC Manufacturing Accreditation Scheme by SCI and SSSS >

- **BCA (Building Plan)**

  Fire rating of the key steel structural elements √

- **FSSB**

  Fire compartmentation √

  Services penetration through walls √

  Services enclosed within the fire-rated compartment walls?

  < updates – FSSB circular? >

- **SEW**

  Not tested in NTU's projects for shallow floor traps

Authorities' Requirement and Compliances

- **BCA (Structures)**

  Rigorous analysis of the modular steel boxes, connection between boxes, connectivity to the rc structures, lateral and overall stability, collapse analysis, design codes acceptance

  Detail analysis using FEM for the key connecting plates,

  possible full assembly test of the key connection?

  Corrosion protection regime

  QP(overall project) + QP(PPVC design) = 1 QP only

  QP(PPVC supervision) as separate – acceptable

  RTO - full-time?; in future, to be steel inspection certified?

  < updates – see BCA circular 2 Nov 2015 >

  Provision for Periodic Building/Structure Inspection **access**

  < update – see BCA circular 22 July 2015 >

Procurement

- Construction Project intent/format will affect the procurement method for both consultancy services and construction work
- Varied PPVC systems available impact on the consultancy services in relation to consultants' acceptance of the system (design incorporation) and regulatory compliances by QPs
- Generic PPVC Design basis for Tender?
  - As adopted for NTU1
- Adoption of PPVC alternatives into Base (RC) Tender?
  - As adopted for NTU2
- Concept Design basis for D&B (PPVC+RC) Tender?

Design consideration for PPVC concept

- Modularity
- High repetition, low variation in types
- Façade details to be within box height and light-weight
- Box height limit by LTA's 4.5m (include low bed truck height)
- Heavy loads such as **>>**
  - **>** water tanks on roof top
  - **>** swimming pool; environmental decks with landscape
  - **>** maintenance gantry; other heavy usage

  are not suitable for PPVC (steel)
- RC areas still required for escape staircases, M&E services risers, refuse chute, M&E rooms, lift core, overall building stability
- Construction sequence and access; aviation height limits
- M&E services placement; sanitary FT/FW discharge pipes
- Built-in furniture – strengthening of dry walls and ceiling

Contract (Price Breakdown format)

- Schedule of Works (for detail price breakdown)

  Usual format regardless of what is inside the PPVC manufacturing process

  OR

  Specific separation of cost between non-PPVC (usual construction works) and PPVC specific.

- Other contracts consideration

  Schedule of payment.

  Advance payment for PPVC-related material (with bond)

  For overseas production, provision of RTO / ITA

  Provision of additional fees for original consultants and AC

On the Ground

- **On-site**
  1. various building orientation and clearance
  2. complicated podium levels – slows work progress to transfer floor levels (critical)
  3. tower cranes positioning; mobile cranes
  4. sufficient land space for truck delivery; turn around
  4. sufficient land space for ancillary attachment to module
  5. road access / traffic control / LTA public road limits

- **Off-site**
  1. oversea plant or local plant or complimentary
  2. **capability** and **capacity** – precision manufacturing
  3. material **source** and delivery (local code compliance)
  4. Independent Testing Agency engagement and processes
  5. customs and taxes; weather condition
  6. temporary holding spaces – short / long term lease?
  7. cost and time to set up specific manufacturing plant
  8. logistics – coordination and transportation

On the Ground - in the words of the contractor

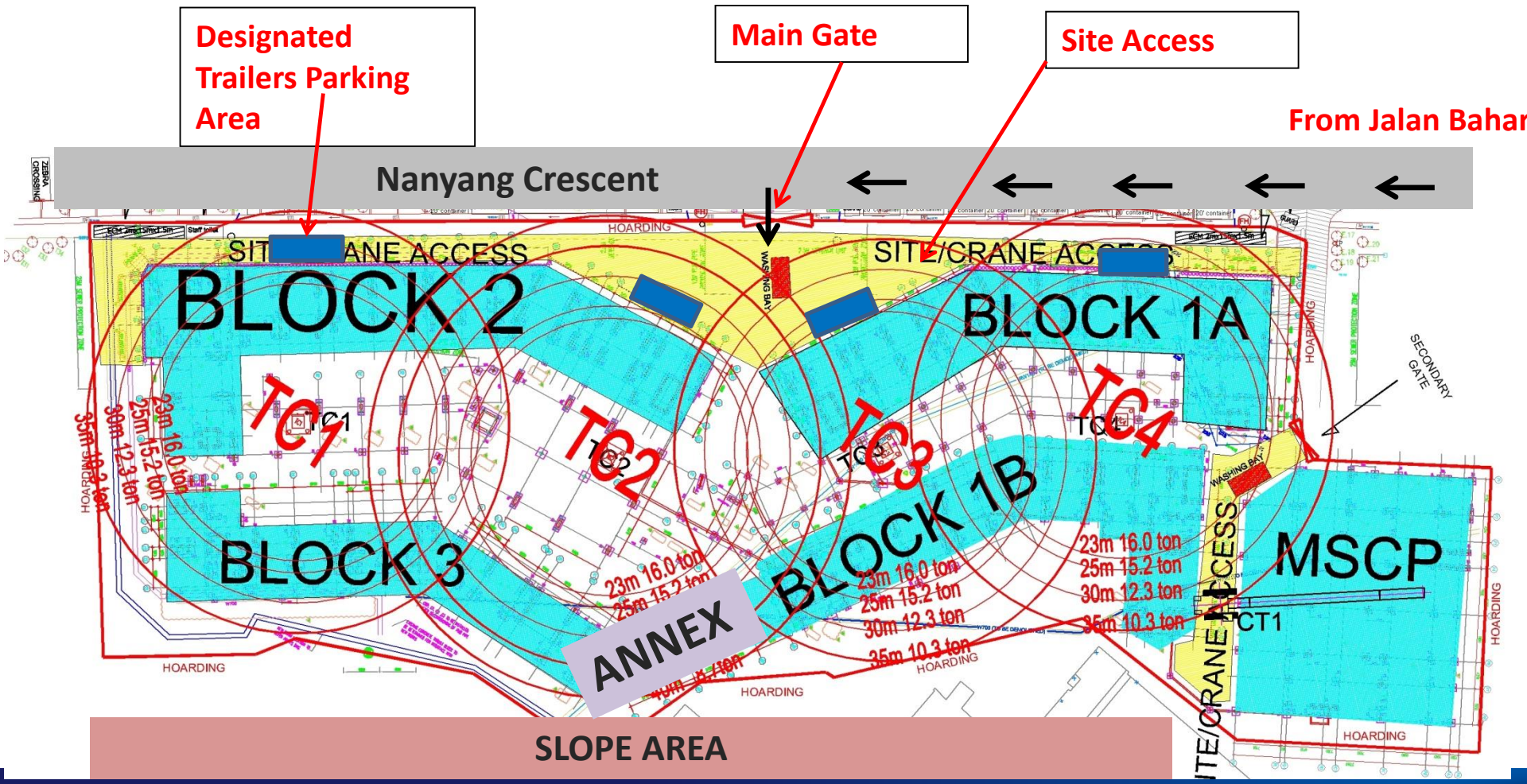
SANTARLI-ZHENG KENG JV

Challenges and Builder's Considerations of PPVC Adoption

- **Timeline** for PPVC Design and Authorities submission.
- **Size and Weight** of PPVC Module VS Crane Capacity (Cost of crane)
- Size of the modules VS **Logistic** (Shipping cost, LTA's dimensional limits)
- Selection of PPVC **specialist and Factory** (Location VS Capability VS Capacity)
- **Quantity** of Modules per shipment VS Fitting-up Yard Size Area.
- Scope of Works at Oversea factory, Local Fitting yard and at site.
- QA/QC at Oversea Factory and Local Fitting Yard (Cost of ITA, QP Sup, RE/RTO)
- **Protection** of Modules during shipping, transportation and installation.

On the Ground

Site & Tower Crane Layout – NTU2



Outline

- PPVC – what is?, objectives, schematics
- Project Brief
  - Development Projects in NTU
  - NTU1 – Resi Halls at North Hill
  - NTU2 – Resi Halls at Nanyang Crescent
- Production Processes to Installation
  - PPVC method means…..
  - PPVC method – off-site location….
  - PPVC method comprises of…..
- NTU's Experience
- **Further Developments and Improvements**
- Concluding Remarks

Further Developments and Improvements

- PPVC – steel modules with improved connections
- PPVC – steel modules with light weight concrete floors
- Other developments' adoption of PPVCs
  - Workers Dormitory by JTC
  - Nursing Home by MOHH
  - Staff Housing by MHA
  - Residential Development by Northern Resi Pte Ltd
- PPVC variants – use of concrete
  - Residential Developments – on going

- Larger capacity tower cranes allowed
- Larger dimensional limits allowed for road transportation
- Further defined accreditation of specialist contractor
- Clarification of fire safety provisions
- Clarification on structural provisions – supervision; materials; inspections

CONSTRUCTION OF 6 BLOCKS OF STAFF HOUSING, 3 BLOCKS OF INSTITUTION BUILDINGS AND ANCILLARY BUILDINGS ….

Credit: Moderna Homes Pte Ltd
(relevant slides used with permission)

CONSTRUCTION OF 6 BLOCKS OF STAFF HOUSING, 3 BLOCKS OF INSTITUTION BUILDINGS AND ANCILLARY BUILDINGS ….

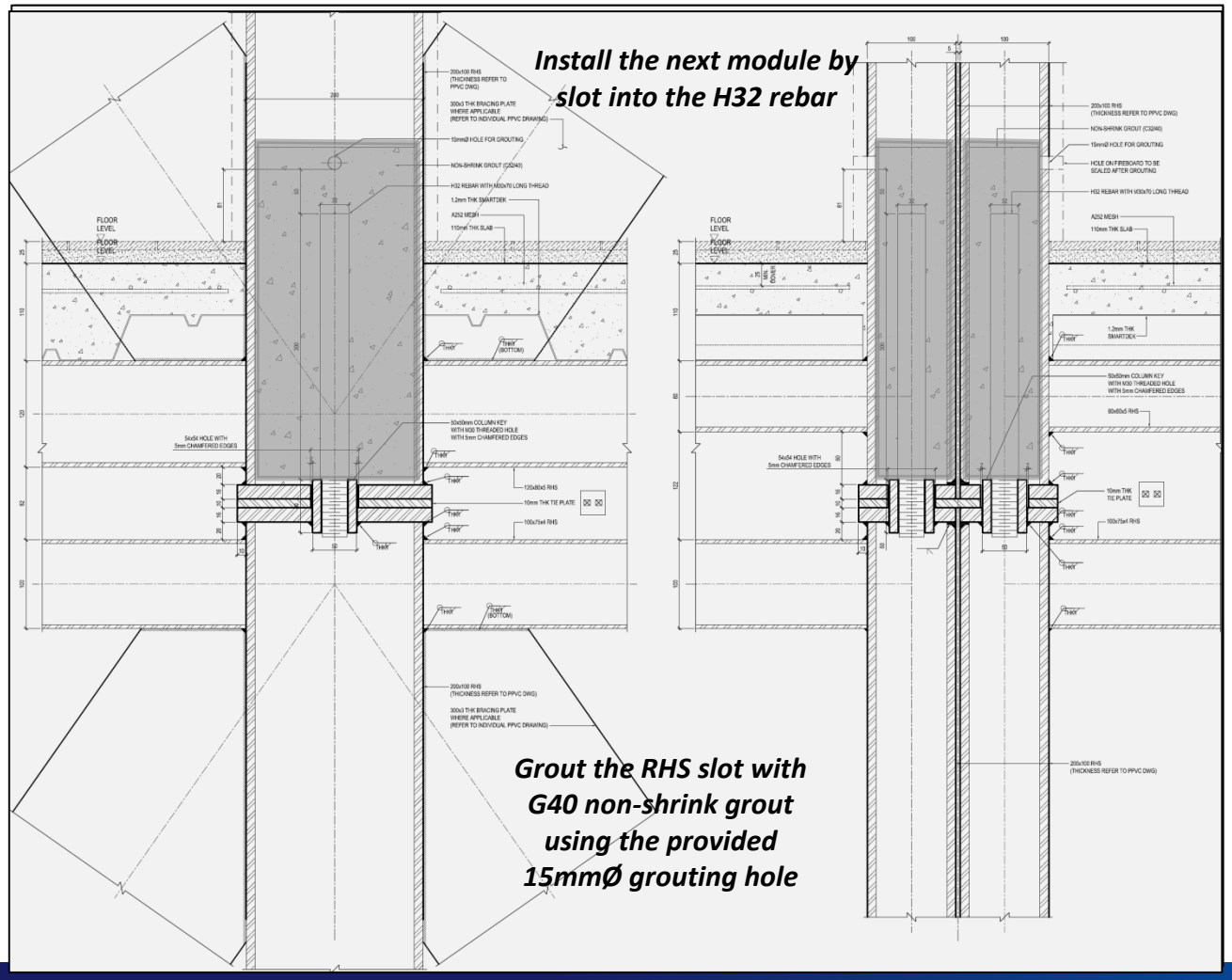
Typical PPVC Module Plan

Credit: Moderna Homes Pte Ltd

Size & Quantity of PPVC

Module / Block	Size (W × L × H) & Quantity (Nos)			
	LR (LRax) 2995x7645x2975	BR2 (BR2ax) 2995x10145x2975	BR1 (BR1ax) 2995x6545x2975	MBR (MBRax) 2995x5345x2975
H1	95	95	95	95
H2	95	95	95	95
H3	95	95	95	95
H4	95	95	95	95
Total Per Story	380	380	380	380
Grand Total	1520			

Section of Typical PPVC Column Connection at Typical Storey



WISTERIA CONDOMINIUM & MALL

Developer : Northern Resi Pte Ltd / Northern Retail Pte Ltd
Consultants : Surbana Jurong Consultants
Contractor : Singapore Piling & Civil Engineering P/L
PPVC Specialist : Moderna Homes Pte Ltd

Site area	9,760 m2
GPR	2.8
GFA	27,328 m2
No. of storey	12

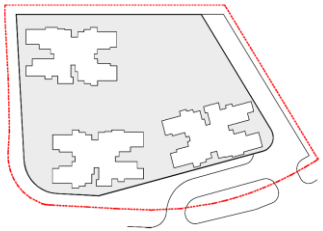
Completion 2Q 2018

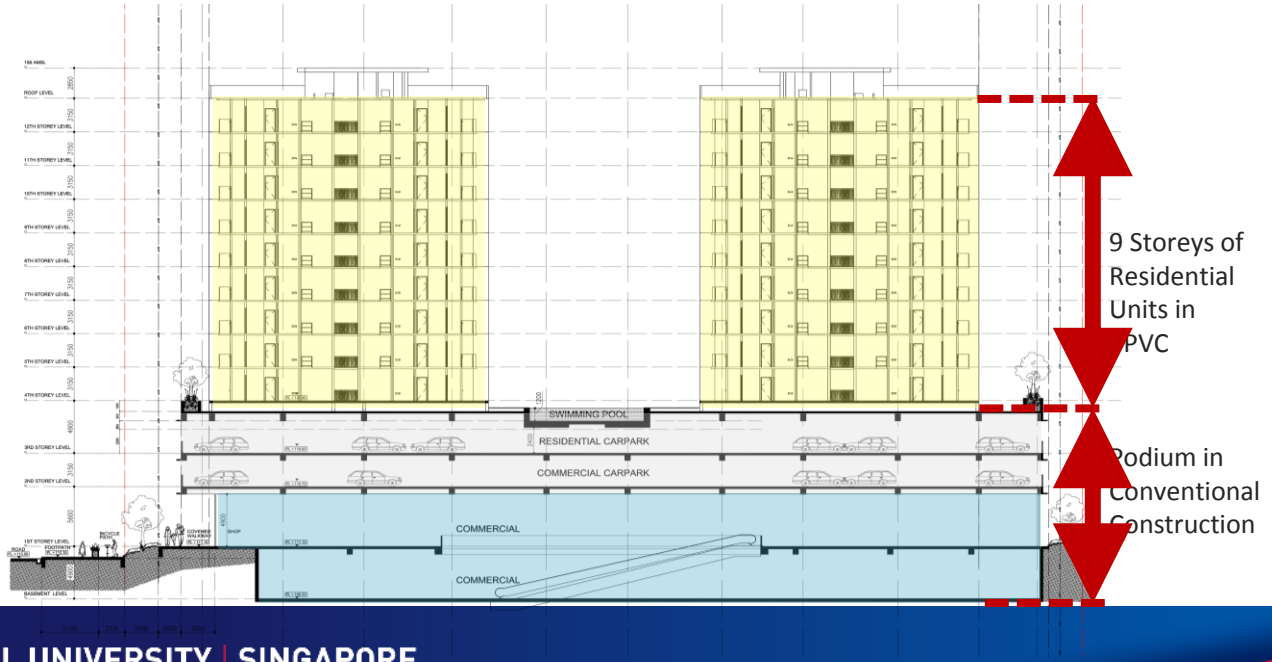
GFA Breakdown
Commercial (B1-L1) : 10,932 m2
Residential (L4-L12) : 16,396 m2

No. of Residential units : 216

Credit: Moderna Homes Pte Ltd
(relevant slides used with permission)

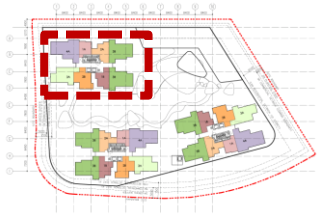
SCHEMATIC SECTION





CHALLENGES

FINDING BALANCE BETWEEN MODULE WEIGHT, SIZE AND JOINTS



- TYPE 1A - 41m²
- TYPE 1B - 51m²
- TYPE 2A - 59m²
- TYPE 2B - 66m²
- TYPE 3A - 83m²
- TYPE 3B - 90m²
- TYPE 4A - 109m²

PLAN of PPVC MODULE for TYPICAL STOREY

0 0.75 1.5 3 4.5 7.5M

Outline

- PPVC – what is?, objectives, schematics
- Project Brief
  - Development Projects in NTU
  - NTU1 – Resi Halls at North Hill
  - NTU2 – Resi Halls at Nanyang Crescent
- Production Processes to Installation
  - PPVC method means…..
  - PPVC method – off-site location….
  - PPVC method comprises of…..
- NTU's Experience
- Further Developments and Improvements
- Concluding Remarks

Concluding Remarks

- NTU has taken on the technical challenge to be the first to adopt PPVC construction method in Singapore
- There have been many challenges in all disciplines and fronts
- Nevertheless, the implementation in the first project is successful
- Further improvements have been made, through the learning process, in the second project – smoother implementation
- The efforts and commitments from the professional and contractors and the Authorities are to be acknowledged
- Based on the extensive experiences, there are already further development of such systems, locally.
- There is already Industry mindset change in the current construction practices with adoption of game changing technologies for productivity gains.
- **We wish you successful initiation and implementation of PPVC, in its various forms, in Hong Kong SAR**

Thank you