6 Case Studies

Case Study 1
Park Green

6.1 PARK GREEN EXECUTIVE CONDOMINIUM

Fig. 6.1 – Artistic Impression of Park Green

6.1.1 Background

Park Green is a executive condominium housing developments comprising two blocks of 17/18 storey and three blocks of 18 storey residential buildings with one basement carpark and communal facilities at Rivervale Link / Buangkok Drive / Sengkang East Avenue.

park green

Fig. 6.2 – Site Location

Project Team

Developer: NTUC Choice Homes Co-operative Ltd

Main Contractor (Design and Build): Tiong Seng Contractors Pte Ltd

Architect: Chao Tse Ann & Partners Pte Ltd

Structural Engineer: P & T Consultants Pte Ltd

M&E Engineer: United Project Consultants Pte Ltd

Project Manager: SLF Management Services Pte Ltd

Precast Supplier: Fermold Pte Ltd

Project Data

Contract Sum: $63.18 million

Contract Period: 36 months

Site Area: 17000 m^2

Gross Floor Area: 51000 m^2

Building Height: 55.5 m

6.1.2 Design Concept and Considerations

Based on the project objectives and assessment, the team had adopted the combined use of flat plate system with precast façade and wall elements for the main buildings of the development. Precast façades were extensively adopted as the load-bearing elements to support the load from the floors. Precast façade elements were detailed to serve as the finished exterior of the buildings as well as formworks for cast in-situ joints to form an efficient building envelope. With proper jointing details, most of the site work could be done internally without the need of external scaffolding system.

The architectural layout was kept simple yet functional to facilitate the use of precast elements. Other prefabricated components such as precast bay window, precast balcony, precast planter ledges, precast refuse chutes and precast staircases were integrated to the building system. Precision block wall was used internally to enhance buildability and to reduce construction time.

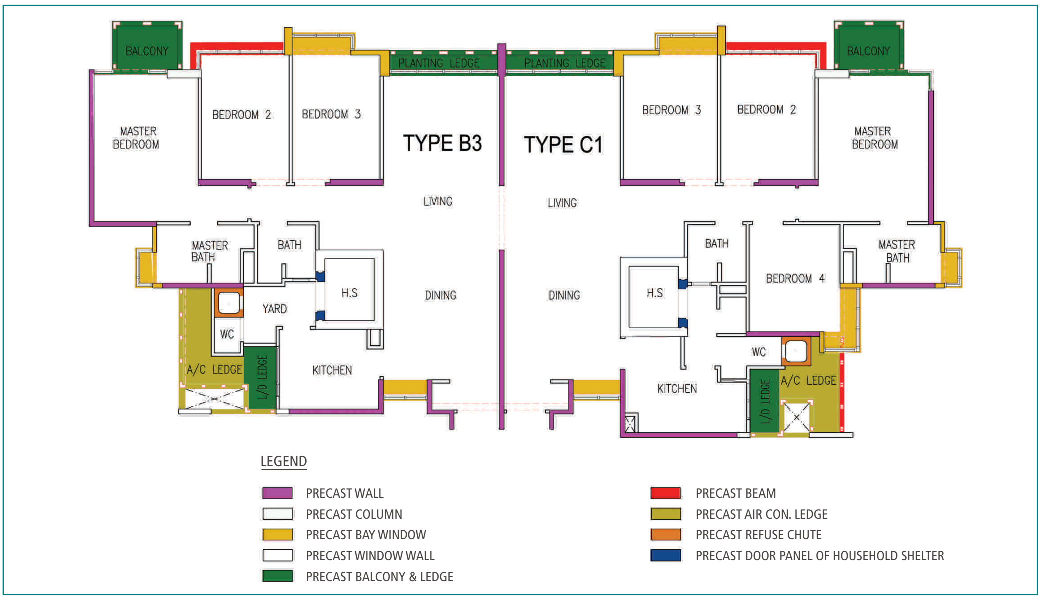

Fig. 6.3 – Floor layout showing the location of precast elements

The basement was designed as flat slab and the residential blocks were supported on piles. The 1st storey was designed as flat slab with transfer beam system.

Fig. 6.4 – With proper jointing, the need for external scaffolding system was eliminated

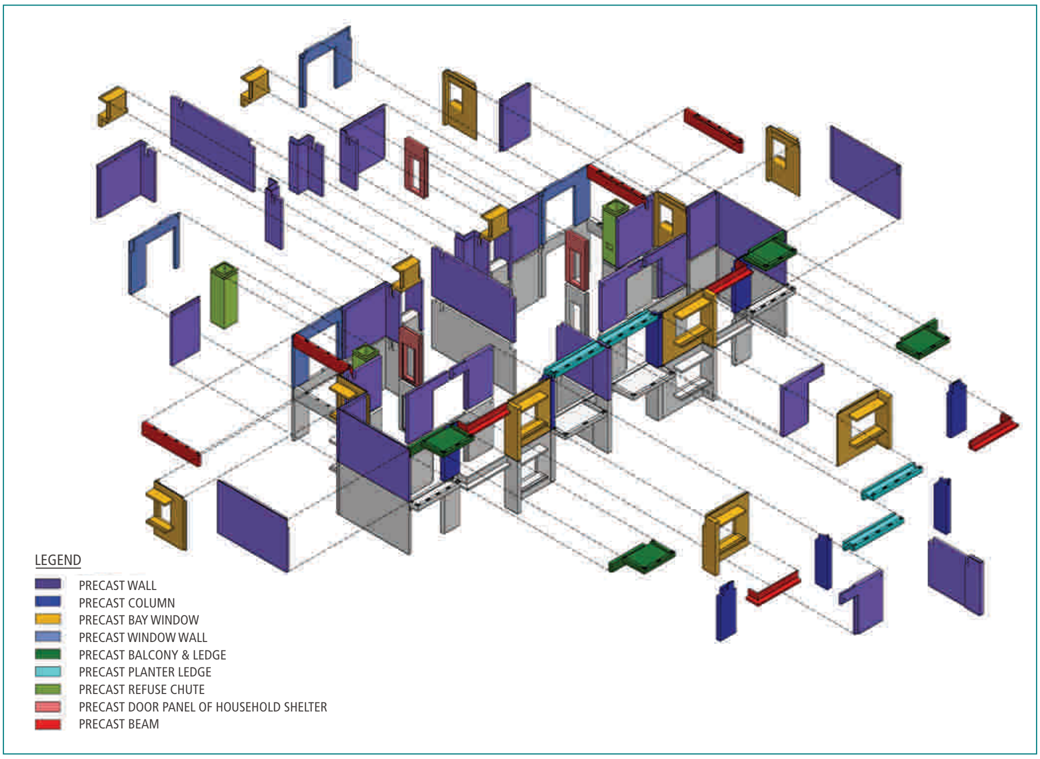

Fig. 6.5 – Isometric view of precast components used

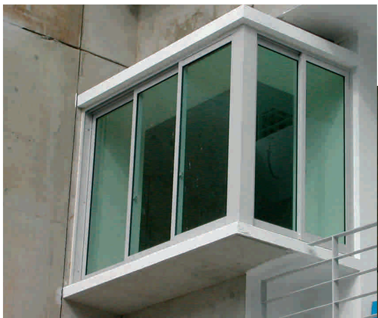

Fig. 6.6 – Precast bay window

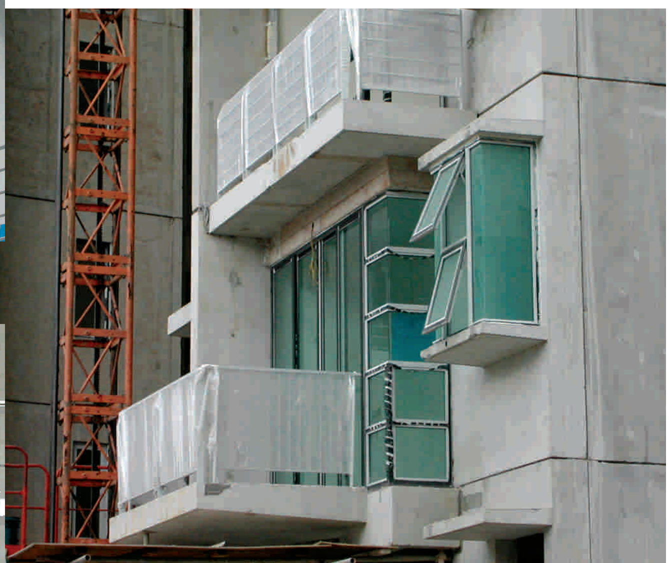

Fig. 6.8 – Precast balcony with metal railing

Fig. 6.7 – Precast air con ledges

6.1.3 Construction Considerations

The construction cycle achieved was about 8 days per floor. The typical floor cycle of construction involved was as follows:

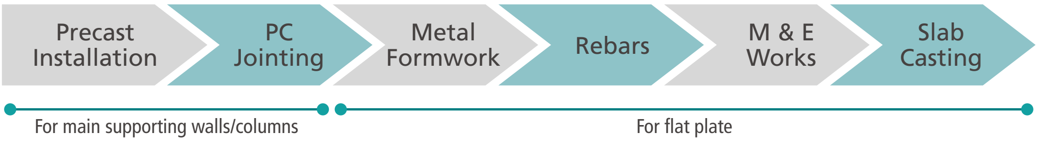

Fig. 6.9 – Lowering of precast wall panel during installation

As the façade walls were critical elements, the overall speed of construction was therefore dependent on the rate and manner at which these elements were installed. While it is preferred to cast and install big panels due to lower handling cost, constraints such as crane lifting capacity and transportation logistics would influence the panel division or sizing. In this project, maximum panel weight was limited to six tonnes.

Fig. 6.10 – Preparation for casting of in-situ flat plate

Fig. 6.11 – On-site precasting for simpler components

The team had adopted a combination of off-site and on-site precasting for different precast components. This was possible as there was sufficient space within centre of the development where swimming pools are situated. There were two main advantages of added site precasting. Firstly, by placing production next to place of installation the turnaround time from panel production to panel installation was reduced. The other advantage was that there would be direct savings as compared to off site precasting, in land and logistics costs. However, only simpler components were cast on site, the more intricate precast wall elements were done in the precast yard to ensure quality finishes.

6.1.4 Challenges Faced and Solutions

The key to providing aesthetically pleasing architectural expressions using precast technology lies with the design considerations for precasting. Essentially, precast solutions take advantage of repetitive use of mould. Different panel sizes, in particular precast facades have to be coordinated, modularised and integrated into the structural system for maximum benefits and minimum cost. Hence, the project team had to work hand in hand to achieve an efficient and cost effective building envelope that comes with intricate architectural expressions. Besides, good site management was of utmost importance to ensure that the construction processes were well co-ordinated. Requisite precast panels had to be made available on time for installation to pre-empt delays to subsequent site activities.

Fig. 6.12 – Contemporary clean-cut design

Fig. 6.13 – Use of precast façade elements as building envelope

As the building was designed with precast façades as the envelope and supporting structure, the precision and accuracy of these facades became important. The out of tolerance if undetected, may result in problems in connecting the precast façade panels at later stage. Hence, there was a need for greater accuracy for precast façades at design and during installation. Besides, the locations of the M & E services within these walls, sizes and locations of windows, skirting etc had to be predetermined at an early stage for prefabrication as well as to pre-empt any misalignment during installation.

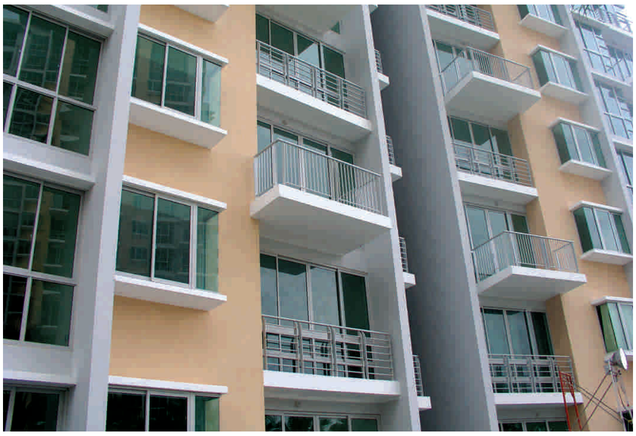

Fig. 6.14 – Precast balcony and planter box at alternate floor level

Fig. 6.15 – Recesses incorporated in precast wall to conceal M & E services at later stage

The elimination of external scaffolding system had imposed some limits on the availability of work access. Hence, it was important for the designer to work with the builder on the connection details and installation method for some external components such as precast balcony and planter ledges.

Fig. 6.16 – Use of precast staircase and landing

As a whole, the team had adopted an integrated approach in the design and construction. Architectural, structural, M & E and interior finishing requirements were carefully worked out and integrated in the construction process. This resulted in better design functionality and higher site productivity. The details of the precast components were meticulously crafted taking into consideration all factors including logistics, quality standards and site management. With the dynamic involvement of the project stakeholders, high buildability and good quality workmanship of the building development were successfully attained using precast technology.

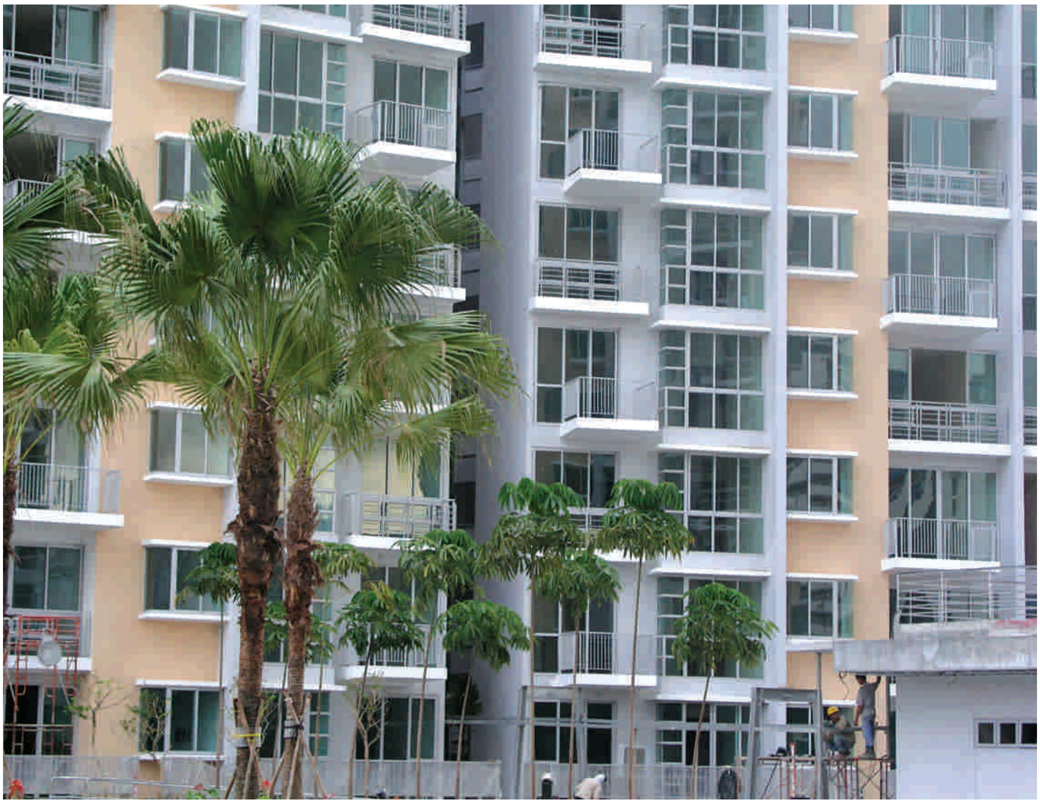

Fig. 6.17 – High buildability and good quality workmanship attained using precast technology

Case Study 2
The Jade

6.2 THE JADE

6.2.1 Background

The Jade is a 31-storey building with one basement located at Bukit Batok Central. It is bounded by Bukit Batok MRT station, the Westmall and HDB flats.

Fig. 6.18 – Artist Impression of The Jade

Fig. 6.19 – The Jade under construction
Two tower cranes were deployed for the site construction

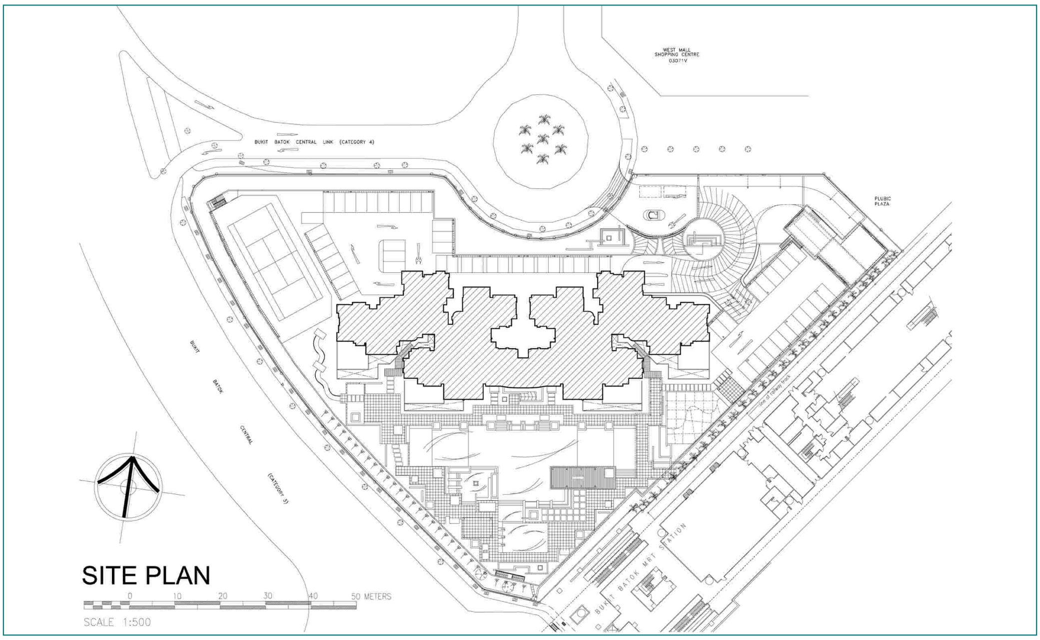

Fig. 6.20 – Site Location

Project Team

Owner: Sim Lian (Bukit Batok Central) Pte Ltd
Main Contractor (D&B): Sim Lian Construction
Architect: Design Link Architects
Structural Engineer: Engineers Partnership
M&E Engineer: Beca Carter Holling Ferner
Precast Supplier: Poh Cheong Pte Ltd

Project Data

Contract Sum: $43.4 million
Contract Period: 29 months
Site Area: 8705.5 m^2
Building Area: 1735 m^2
Plot Ratio: 3.5
Total Floor Area: 30489.25 m^2
Building Height: 120 m

6.2.2 Challenges Faced

The constraints posed by the site were as follows:

- The site area was small with very limited working space
- The site was very close to the existing MRT line
- The earth was generally made up of rock bed

The proximity of the MRT station posed a great challenge as stringent criteria and restrictions are imposed by LTA. Monitoring devices need to be installed to ensure that the existing MRT structures are not affected (or damaged) by the on-going construction. The tower cranes were also not allowed to tower over the MRT station for safety reasons, which posed some restrictions on the crane usage and boom length.

6.2.3 Design Concept and Considerations

In view of the constraints, the project team had initially decided to adopt in-situ flat plate system supported on cast in-situ columns with brickwall. With more in-depth study, the use of precast facades was found to be a good and viable alternative as

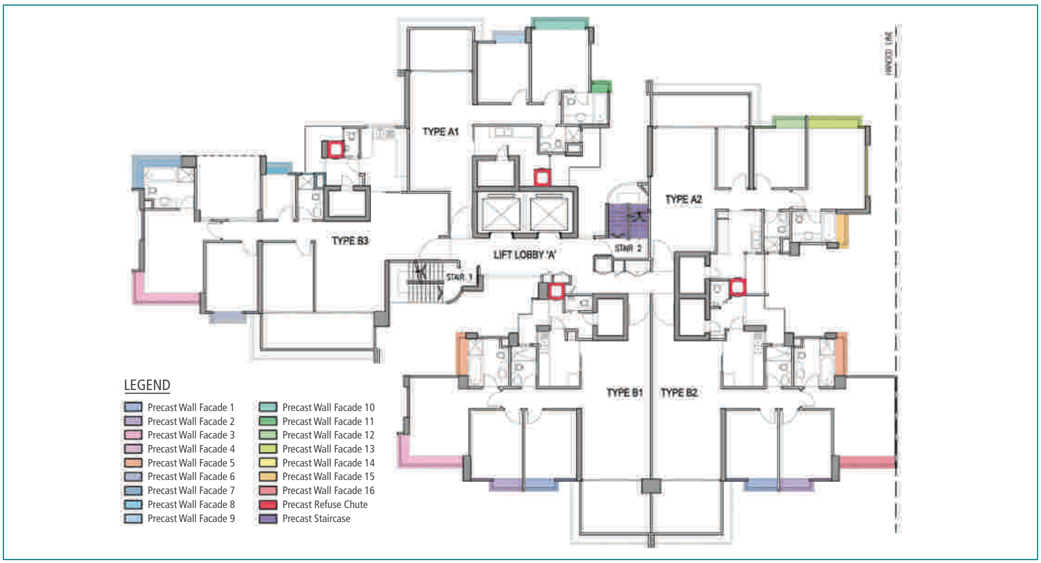

Fig. 6.21 – Simplicity in Layout

compared to the use of brickwall. The team had finally opted to use precast facades so as to achieve better quality wall finishes on the exterior of the building as well to reduce construction time, noise and inconvenience to the general public. The layout plan was kept simple and floor heights were repeated to facilitate the use of precast elements. Prefabricated components such as precast refuse chutes and precast staircases were also used.

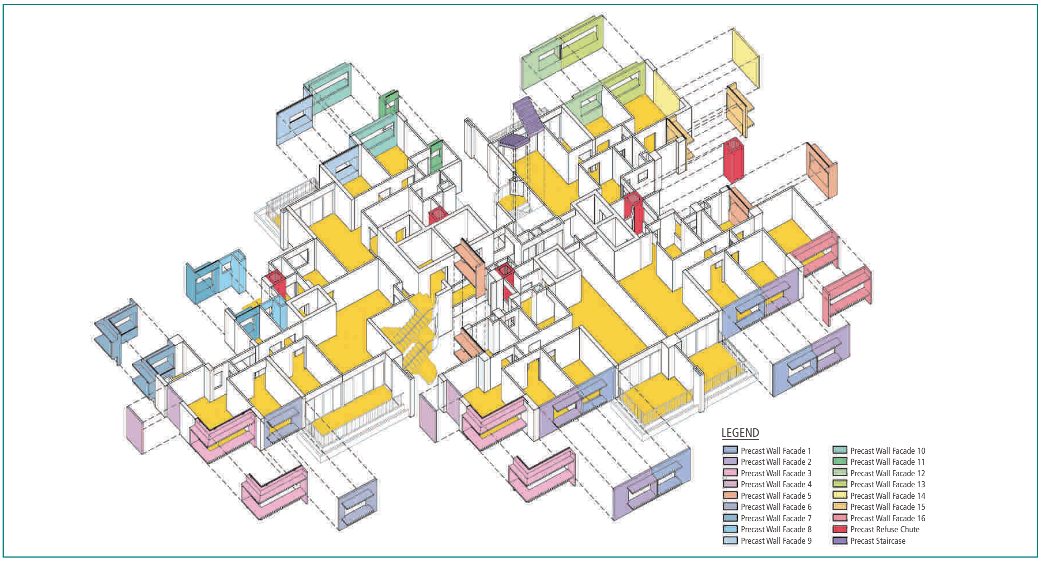

Fig. 6.22 – Isometric view of the precast façades used

The basement was designed as flat slab supported on piles and the residential blocks were all founded on piles.

For this project, the precast facades were non load-bearing. They were designed to serve as the finished exterior of the building as well as forms for cast in-situ columns whereby formwork could be eliminated.

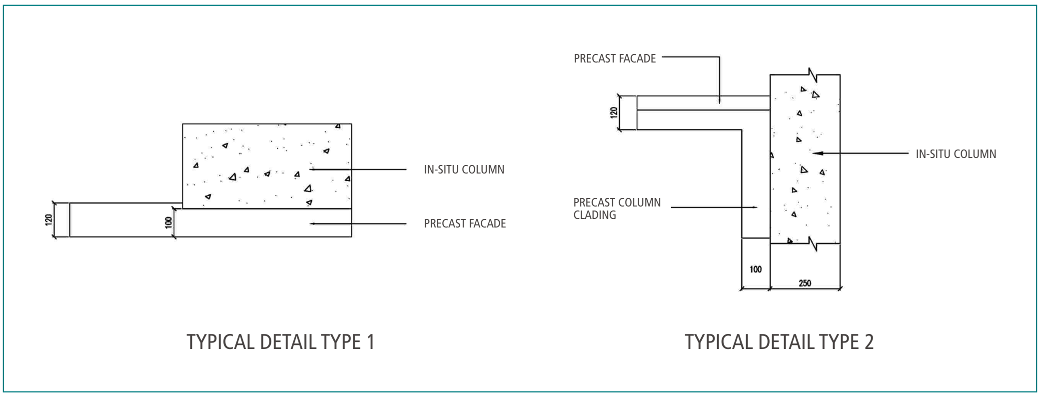

Fig. 6.23 – Examples of precast façade as the form for cast in situ column

As for the vertical and horizontal joint treatment, the architect had adopted the following vertical waterproofing details between the precast façade with in-situ column for Detail Type 1 & 2.

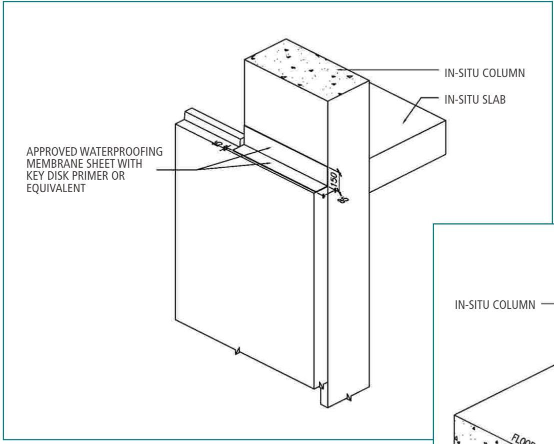

Fig. 6.24 – Isometric View for Type 1

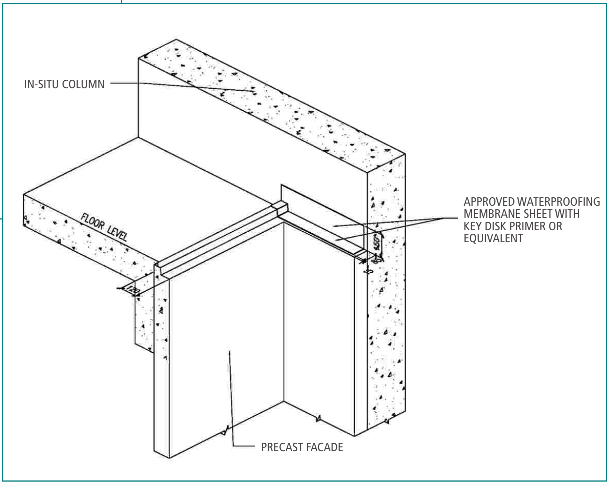

Fig. 6.25 – Isometric View for Type 2

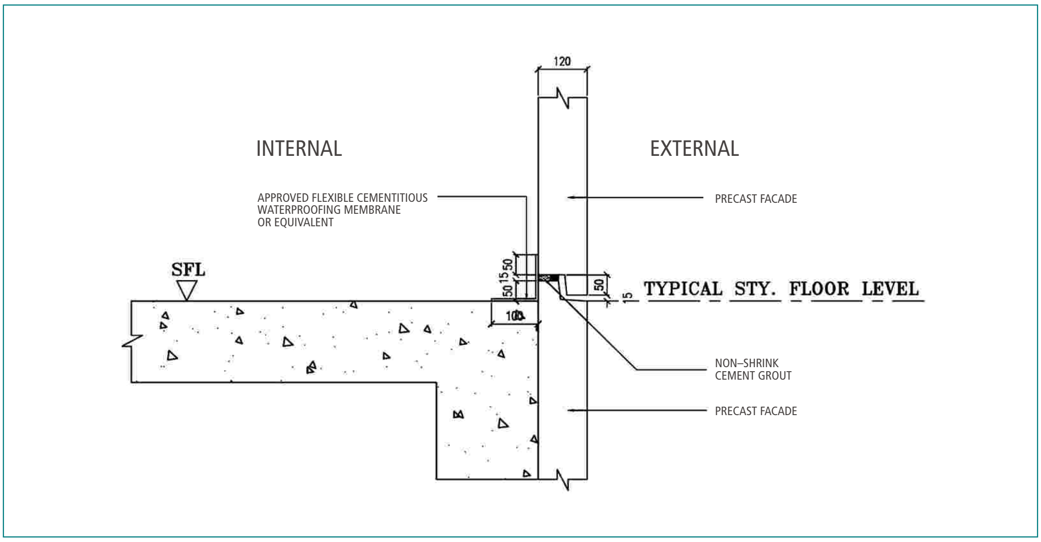

Fig. 6.26 – **Horizontal Waterproofing Details**

6.2.4 Construction Method and Sequence

Metal formworks were used for the building construction. The construction cycle achieved was about 10 days per floor. The combined use of precast elements such as façades with flat plate would entail requirements pertaining to precast panel installation to be incorporated in the planning. For this project, the team had adopted site casting for simpler, flat wall panels and off-site casting for more intricate façade panels. The production and delivery schedule of the precast elements were planned and blended with the site progress for the in-situ flat plates and columns.

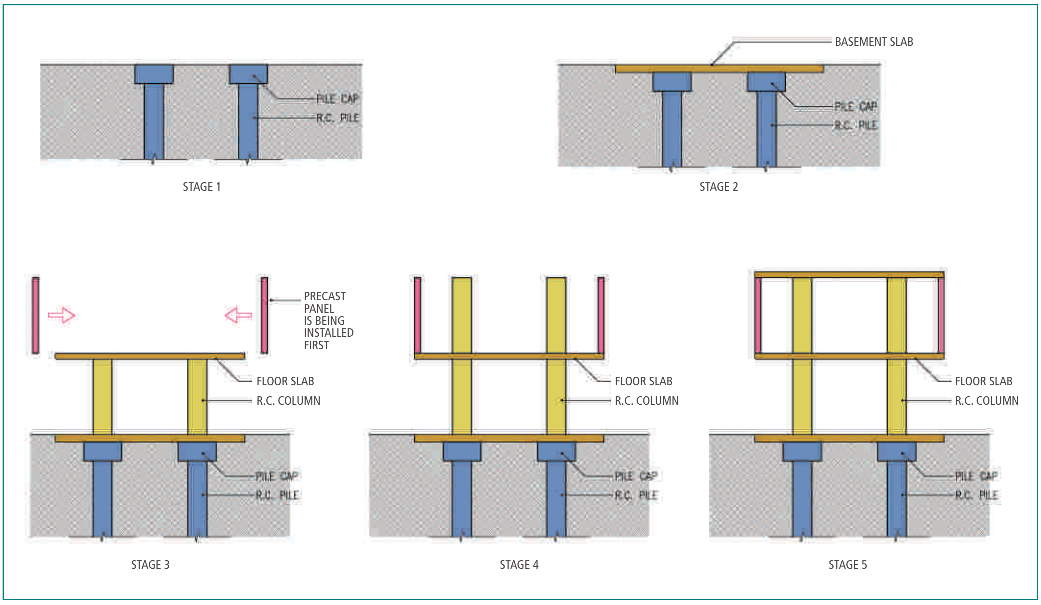

Fig. 6.27 – **Sequence of construction**

Twelve-tonnes crane was used for lifting the precast components of about 4.5 tonnes. Due to the restriction of the swing of the boom of the tower crane, the crane could only be above the completed structures by two floors.

Fig. 6.28 – Installation of different non load-bearing precast façade wall elements

Fig. 6.29 – Overview of the building envelope using non load-bearing precast façades

Fig. 6.30 – Closer view of the building completed

The team had successfully adopted a combined use of cast in-situ columns with non load-bearing precast facades as the external envelope of the building. The typical external brickwall concept was abandoned for the better wall finishes that could be achieved using precast facades. With good site planning and co-ordination, the casting and delivery of the precast façade elements were done in tandem with the progress of in-situ construction. The use of precast facades as integrated formwork for cast in-situ columns had also reduced the construction time thereby achieving higher productivity and quality for the project.

Fig. 6.31 – Better wall finishes can be achieved using precast façades comprising window wall units and bay windows

Case Study 3
Newton.GEMS

6.3 NEWTON.GEMS CONDOMINIUM

6.3.1 Background

Newton.Gems is a 30-storey residential development with a basement at Newton Road/Lincoln Road. This project comprises two identical towers with a total of 190 units.

Fig. 6.32 – Artistic Impression of Newton.GEMS

Fig. 6.33 – Newton.GEMS under construction

Fig. 6.34 – Computer modelling of Newton.GEMS

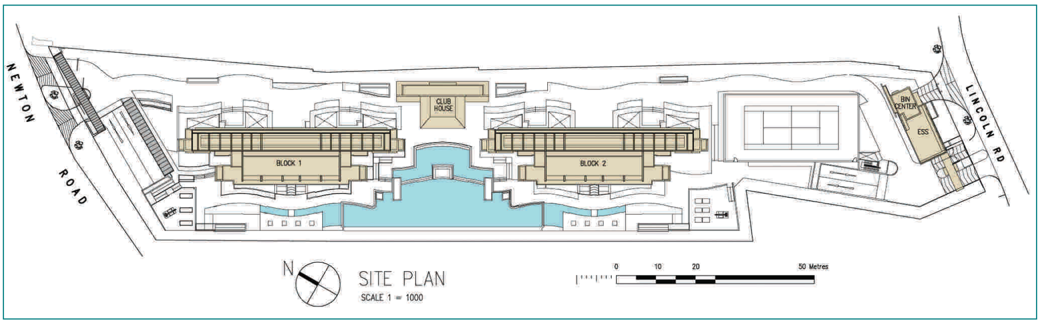

Fig. 6.35 – Site Location

Project Team

Owner: Great Eastern Life Assurance Pte Ltd
Main Contractor (D&B): Shimizu Corporation
Architect: Architects 61 Pte Ltd
Structural Engineer: Meinhardt (Singapore) Pte Ltd
M&E Engineer: Squire Mech (Pte) Ltd
Precast Supplier: Fermold Pte Ltd

Project Data

Contract Sum: $61.8 million
Contract Period: 26 months
Site Area: 9754.10 m^2
Total GFA: 28,818.97 m^2
Building Height: 120 m

6.3.2 Challenges Faced

The site was bounded by private residential buildings and next to the Royal Hotel. The proposed building is rectilinear with length to width ratio of about 4 and has an aspect ratio (that is height/width ratio) of 8.15. Narrowest and widest section of the building itself measured about 6m and 14m respectively at the typical floor. Apart from the intricate design of such a slender building, the site constraints had posed many challenges to the project team. They were: -

Fig. 6.36 – Slender elevation of the building

- **Limited site access**

The site generally had very limited site access. Available access was along narrow strip of 6m to 8m clear space on two sides of the building. Coupled with ongoing basement construction activities, the availability of access were at times limited to one side only to be used for panels delivery as well as for the use of other heavy vehicles such as ready mix trucks.

Fig. 6.37 – Limited site access for panel delivery

- **Potential environmental disturbance to local communities**

Being "sandwiched" between nearby residential units and a hotel, there was environmental impact consideration such as noise and dust to be taken into account. Conventional metal formwork system would generate relatively high noise level during fixing, casting of in-situ concrete as well as striking of formwork which may pose some limits on working hours and hence affect the site progress.

6.3.3 Design Concept and Considerations

With the site constraints and design complexity, the team had worked together to blend an optimal use of precast concrete components with cast in-situ elements to overcome these limitations. Maximum prefabrication off-site was intended to enable much work to be done with minimum working space at site. The adoption of precast façade and appropriate joint details had enabled the installation of precast panels to be done from building interior, eliminating the need to have external scaffolding. With less wet trades and debris generated using prefabrication, more clear space could be used for the critical access. Besides, noise generated during precast panels installation was usually within acceptable level, which would help to minimise disturbances to neighbouring occupants.

Fig. 6.38 – External scaffolding is not required for full precast façades

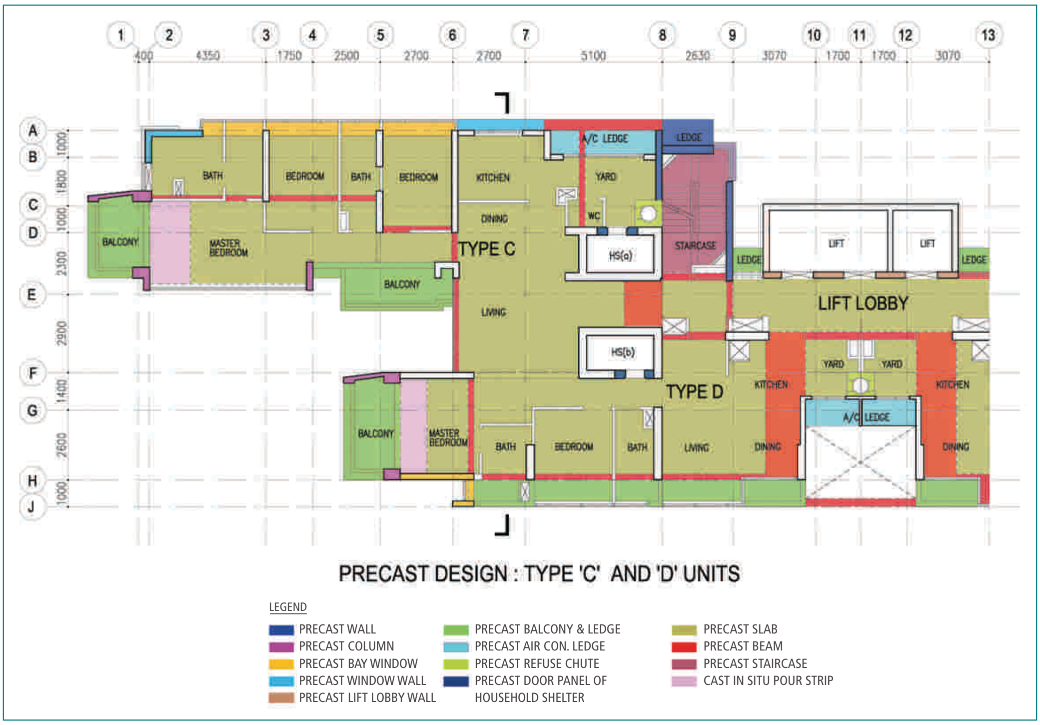

Fig. 6.39 – Floor layout showing the different precast concrete components used

• Vertical Precast Concrete Components

Cast in-situ columns and shear walls were designed and located on the interior of building for structural stability. Such stability was further enhanced using coupled shear walls via coupling beams to transfer shear. Precast load-bearing elements including columns, shear walls, bay windows and staircase cores were adopted to form the building envelope supporting structures. Other vertical components such precast lift lobby wall panels, household shelters wall panels with door openings, and precast refuse chutes were used to integrate with the cast in-situ elements.

Fig. 6.40 – Bay window integrated with load-bearing vertical elements

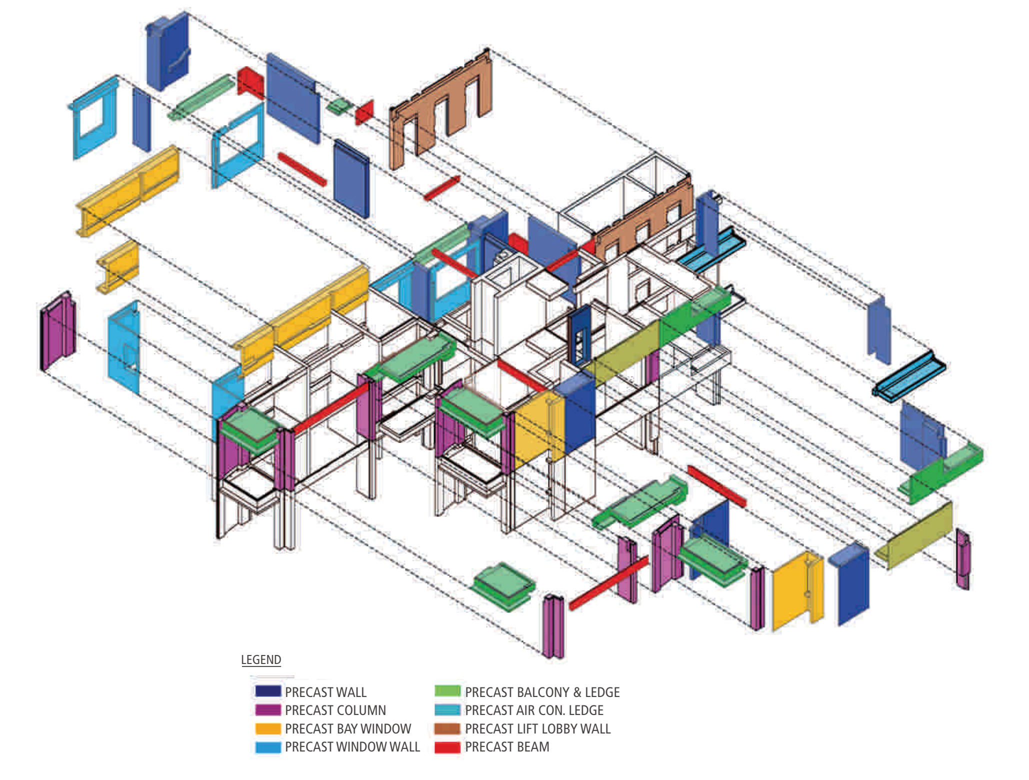

Fig. 6.41 – Isometric view of precast building components used

- **Horizontal Precast Concrete Components**

As vertical elements were not aligned in X-Y directions, coupled with drops as well as cantilevers at building exterior, transfer of horizontal floor loads would have to be done using floor beams. These beams served to stiffen horizontal plate for lateral resistance of building. Almost the entire horizontal elements were precast; precast beams (including bay window spandrel and coupling beams), precast full slabs and half slabs frames into the columns and walls system. Other horizontal components consisting of precast balconies, ledges parapets, down hang beams, sun shading ledges, staircase landings and flights were also used.

Fig. 6.42 – Precast beams profiled with drop level

Fig. 6.43 – Non load-bearing window wall integrated with beam to form an enclosed window panel

- **Variety of Exterior Face Shapes, Profile and Groove Line Details**

Exterior vertical load bearing elements were profiled with recesses to cater for aluminium curtain walls and windows interface. Likewise, exterior horizontal elements including bay windows spandrels were also profiled for weather protection around the window joints. By using precast system, it would be easier to produce profiled panels to finished dimensions by designing moulds that allows for projecting ledges to be cast with mould face-down. Vertically cast methods as necessitated using in situ construction would be cumbersome, and frequently honeycombing occurs around deeply profiled edges and recesses unless formworks are intricately designed.

Fig. 6.44 – The fabrication of the precast mould takes into account the blockouts, recesses, groove lines etc. to create the necessary profiles and eliminate "re-work" at site

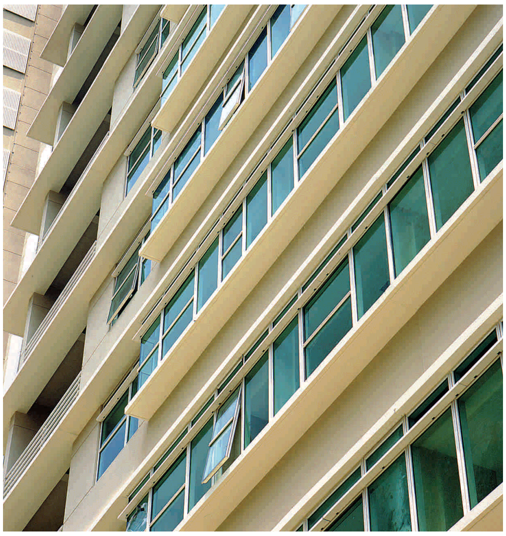

Fig. 6.45 – Deep profiled precast bay windows, sun-shading ledges for aesthetic and functional purpose

- **High Level Roof Trellis with Intertwined Features**

The roof level trellises or crown structure measured approximately 156m from the roof level. With a narrow strip of about 6m footprint of floor slab, it would have been a daunting task to put up formwork support and bracing system for constructing high level in-situ columns and trellises without external scaffolding system. The team had adopted the use of precast concrete components to do away with such need. The whole roof structure was fully prefabricated and erected in planned sequence.

Fig. 6.46 – Photo showing part of the crown structure at about 15 m above the building roof level

6.3.4 Construction Considerations

The two towers were almost identical, with minor variations at some corners of a few floors. Based on the configuration of floor layout and the maximum tower crane lifting capacity of 12 tonnes at 20m radius, precast panels were designed to the maximum size and within the transportable limit. Heaviest components used weighed 11.5 tonnes.

Crane time availability was critical as precast components were used for almost the entire building, except for some shear walls and internal column. For this project, a total four (4) tower cranes were used. At the peak of construction, the cycle time was about 6–8 days per floor. Other than installation of panels, major crane usage during construction involved was the casting of in situ walls and columns. Hence, segregation of these two activities within the same zone requires careful interfacing work plan. For example, when panel installations were carried out at one construction zone, in-situ work activities that do not require the usage of crane could be scheduled for the other areas, to ensure smooth continuity of works for different trade.

Fig. 6.47 – Two cranes for each block

In this project, most of the floor slab elements were precast full slabs so that there would be minimal in-situ concreting works. This method allowed for small work units

Fig. 6.48 – The mould for the casting of precast full slab. Rebars installed before casting

Fig. 6.49 – Casting of pour strip after installation of precast floor slab

to be carried out simultaneously within the same floor, as the floor plate was immediately usable upon panel installation as working platform. The panel jointing work can be divided into several discrete locations.

The precast panel installation followed the conventional sequence of work: vertical elements were installed, and propped followed by horizontal elements installation. Except for some non-structural elements, most panels are connected through wet joints to ensure water tightness control. Precast works precede in situ works so as to allow interfacing sections to be cast together with in situ concrete.

For M&E services, conduits and cast in items for socket outlets were cast into the panels. Services connections were provided for in the false ceiling space. In this way, there was no cast-in conduits required within the precast full slabs. This eliminate the risk of conduits' damage by drilling works during provision of props' anchorage to floor slab for vertical panel installation.

Overall, the project team had successfully integrated the use of prefabrication with cast in-situ construction. Good design co-ordination, construction method and site management right from the conceptual stage had enabled them to realise the full benefits of precast works.

Fig. 6.50 – The integration of prefabrication and cast in-situ construction