HOUSING & DEVELOPMENT BOARD

PRECAST PICTORIAL GUIDE 2014

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CHAPTER 1

TO GET YOU STARTED

1.1 Reinforcements shown in the pictorial guide are the minimum reinforcement required and shall only serve as reference. The user of this guide must check the adequacy of the reinforcements to meet their design requirement.

1.2 For the nomenclature of the precast concrete components naming, refer to Figure 2.A of Chapter 2.

1.3 For safety and durability, the elements at the peripheral of the building line are to be precast. For standalone beams at 2nd storey, they shall be constructed by the cast in-situ method. Precast beam shall be adopted when they are integrated with precast façade such as K1F.

1.4 All components plus lifting frame (if required) shall not exceed 8 tonnes. Consultants shall also check this weight against the tip load and the specifications of the lifting equipment.

1.5 Floor-to-floor height is usually 3.6m from 1st to 2nd storey, and typical floor-to-floor height shall be 2.8m. The floor-to-floor height of the topmost floor (to the lowest point of roof) is also 2.8m.

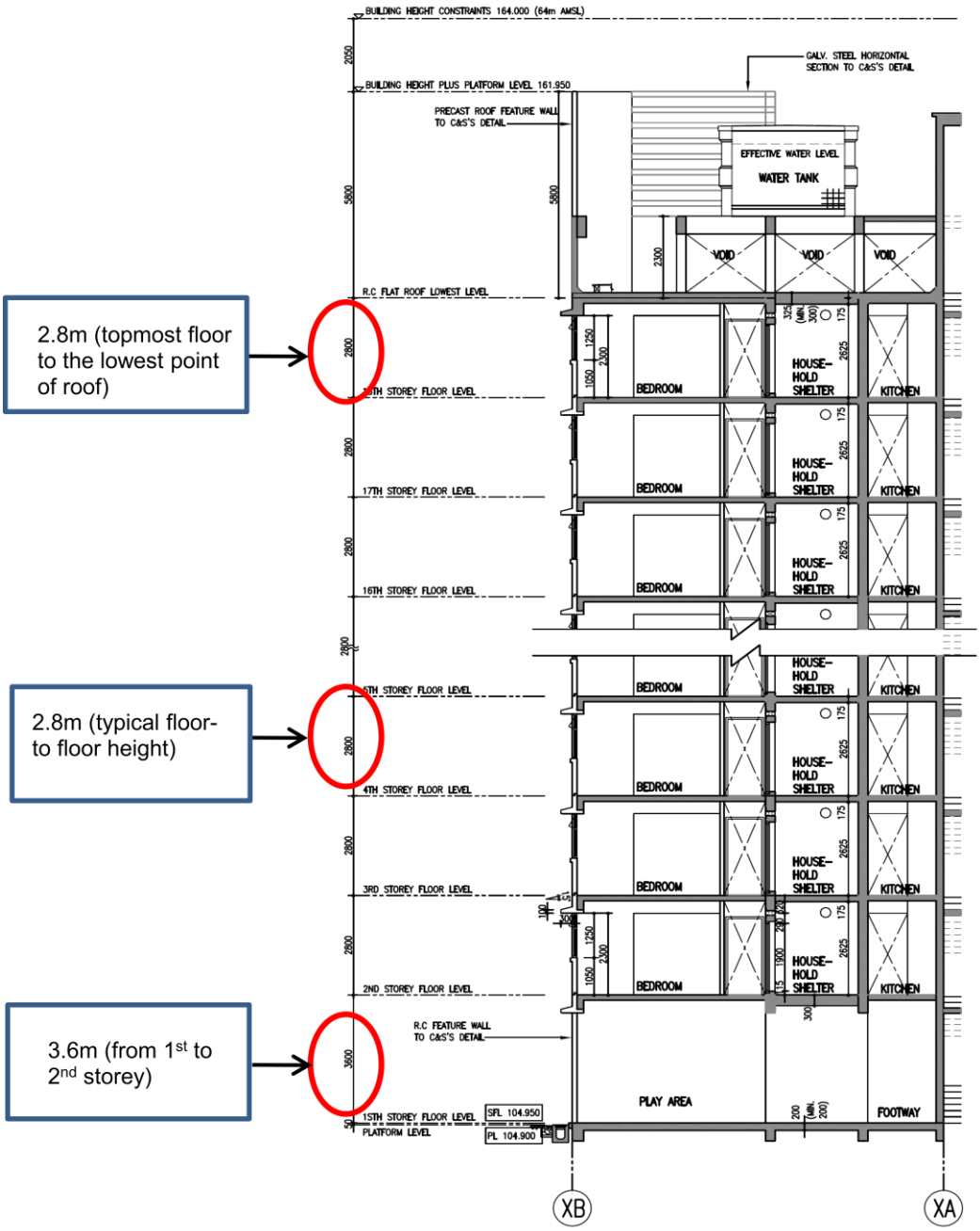


Figure 1A – *Typical floor-to-floor height*

1.6 Precast components are categorised into 3 categories (refer to Annex B for the components in each category):

Category 1: Precast components that can be standardised fully across all projects.

Category 2: Precast components that can be standardised partially across all projects.

Category 3: Precast components that can be standardised within individual project.

1.7 At the connections for precast components, there exists a 14mm gap for vertical joints.

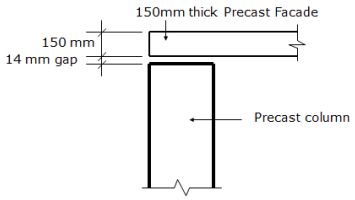
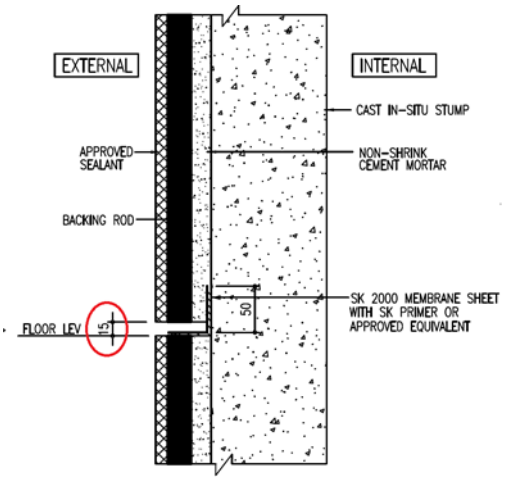


Figure 1B – *14mm vertical joint*

1.8 For horizontal joints between precast components, the joint is 15mm or 20mm (from structural floor level to joint).

Precast wall – 15mm horizontal joint



Precast column – 20mm horizontal joint

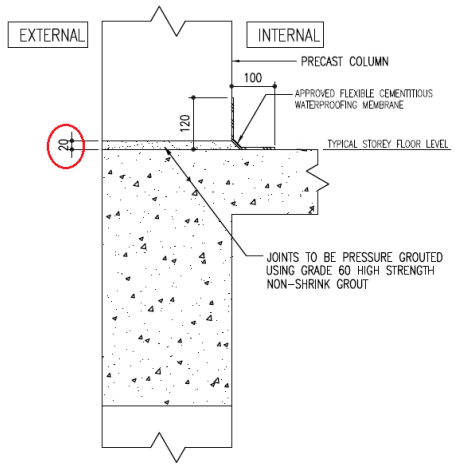


Figure 1C – *15mm or 20mm horizontal joint*

1.9 Consultants are to use at least 100 repetitions as the guideline for component repetition to ensure cost-effectiveness of the project (Refer to Annex C – The rationale behind 100 repetitions and the right way to approach this number).

CHAPTER 2

UNIT

2.1 Figure 2A shows a typical storey residential floor part plan, with the thickness of the components in a unit indicated.

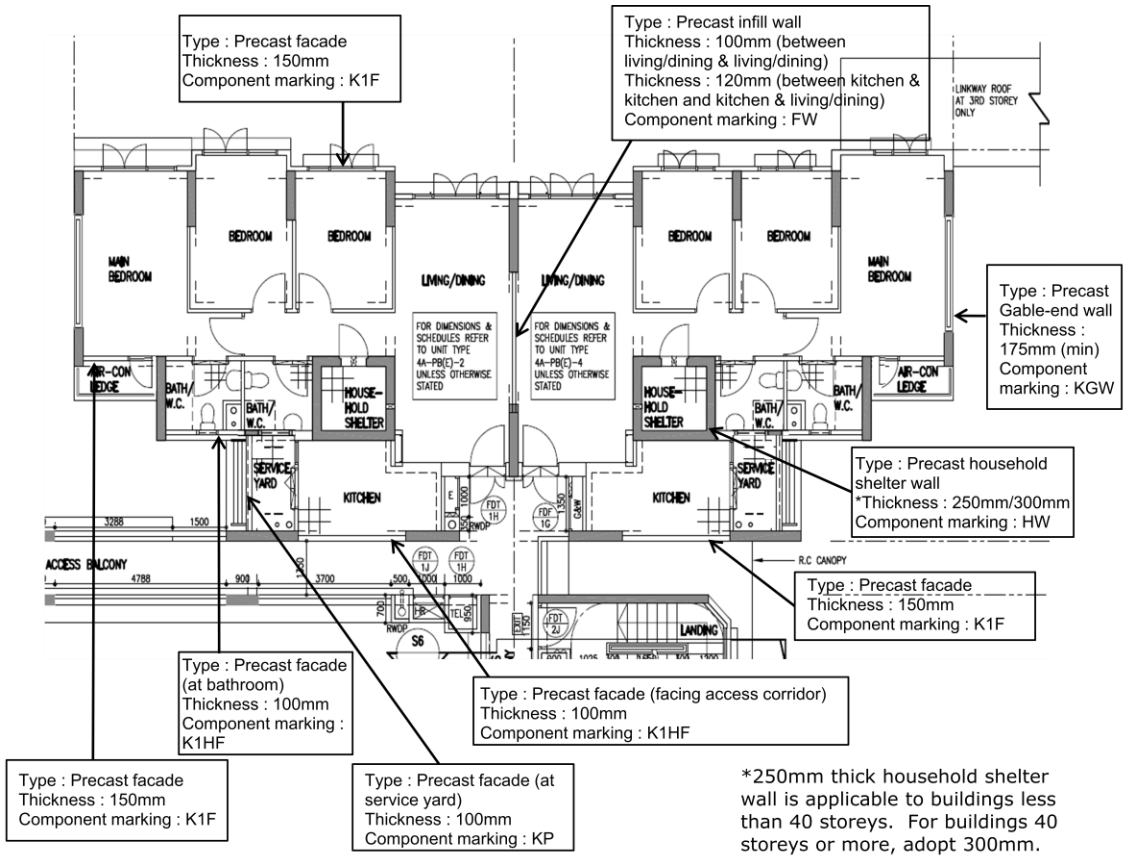


Figure 2A - *Typical storey residential floor part plan 1 – with thickness indicated*

2.2 Figure 2B shows a typical storey residential floor part plan, with facade connection joints (for joints detail refer to the guide drawing – connection and waterproofing details for precast façade/typical details of precast façade). The components within a unit including planks panelling, with the standard nomenclatures, are also indicated.

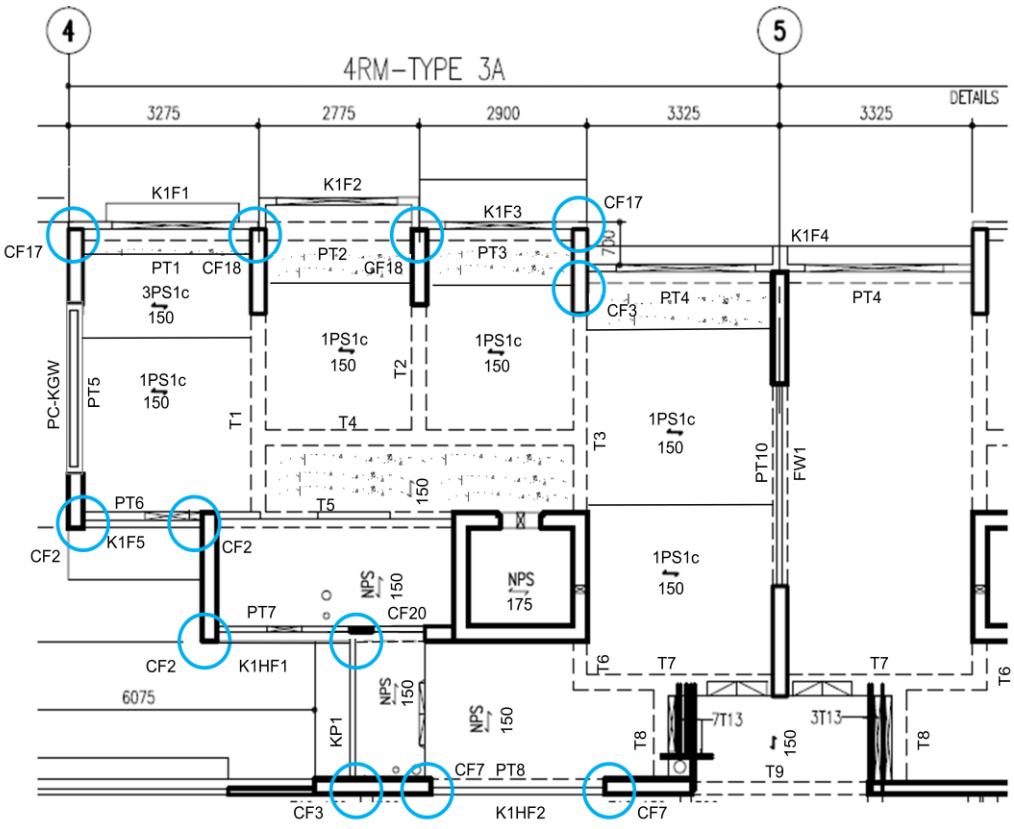


Figure 2B– *Typical storey residential floor part plan 2 – Joints and components*

2.3 For precast façade integrated with beam, the façade thickness is part of the beam width (See Fig. 4F in Chapter 4 for illustration).

2.4 The longest dimension of any parapet and façade shall be kept to a maximum of 7m.

2.5 The shorter length of any L-turn façade including facade with corner window (mullion to end of concrete framing) shall not exceed 1m. For facade with corner window, the concrete frame of the window facade shall be at least 200mm by 200mm (depend on wall or column size).

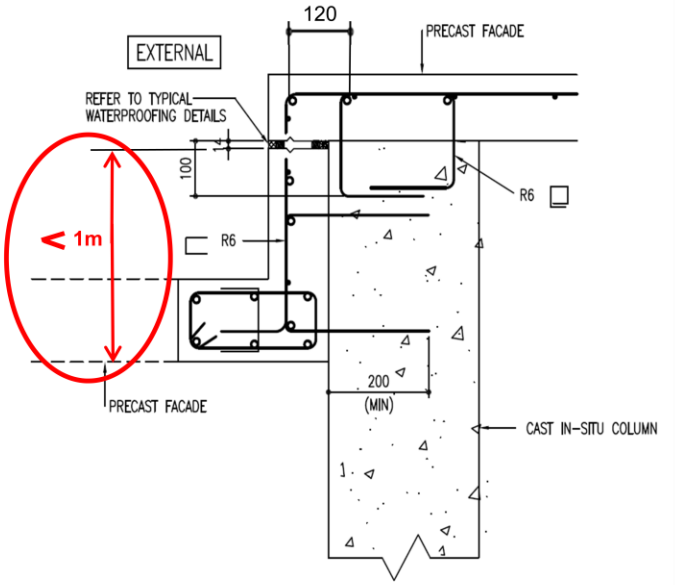


Figure 2C – *L-shaped façade*

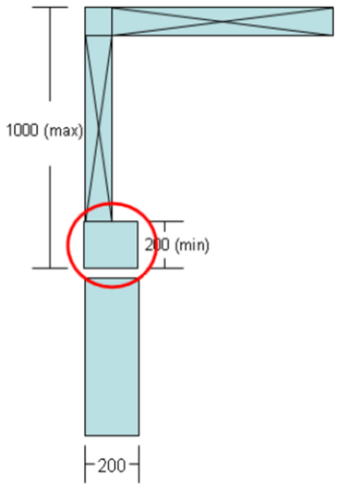


Figure 2D – *Corner window facade*

2.6 There shall be adequate concrete framing for cast-in windows frame. A 300mm concrete framing is required for clad-over and abutting connection.

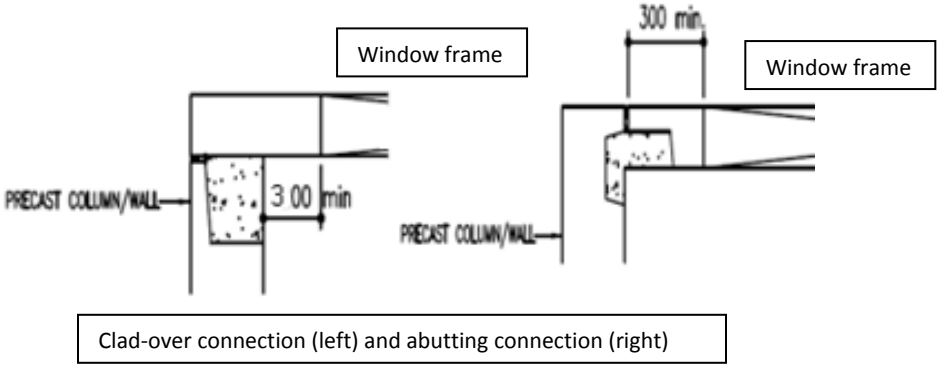


Figure 2E – *Concrete framing for cast-in window frame*

2.7 Canopies over windows shall have a minimum 100mm overhang (See Annex A – FAQ A5 for further information).

Figure 2F – *Minimum 100mm overhang canopies*

2.8 Window coping shall be minimally sized to both edge of the cast-in window frame.

2.9 The design for canopy should be functional, simple to construct and regular. i.e. there shall not be double, irregular, such as curved or angled canopies (See Annex A – FAQ A6 for further information).

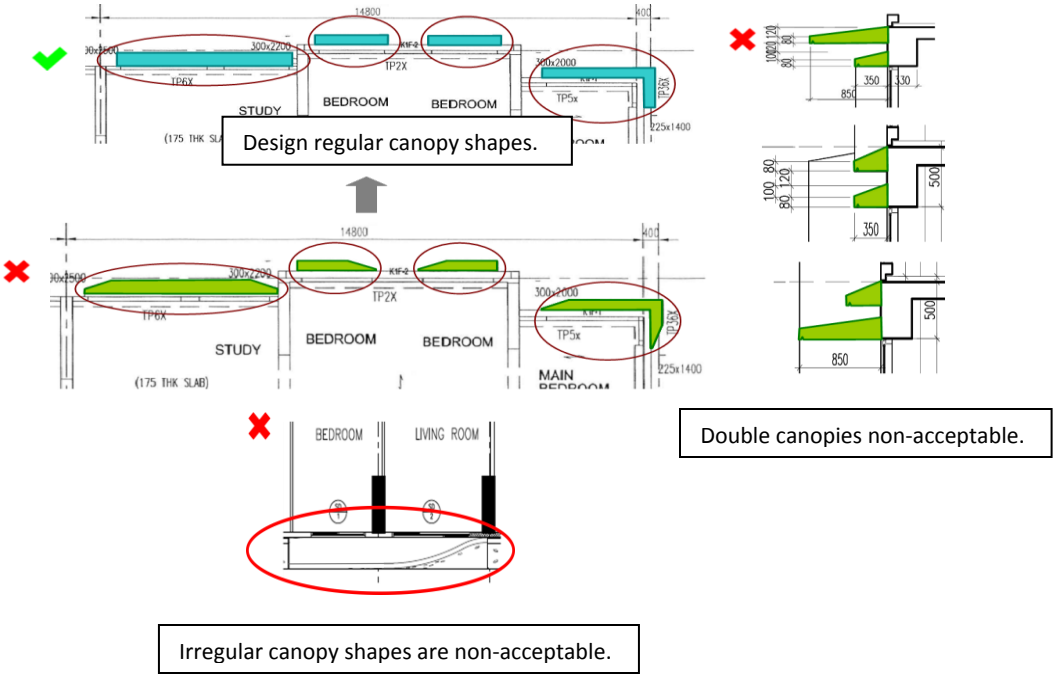
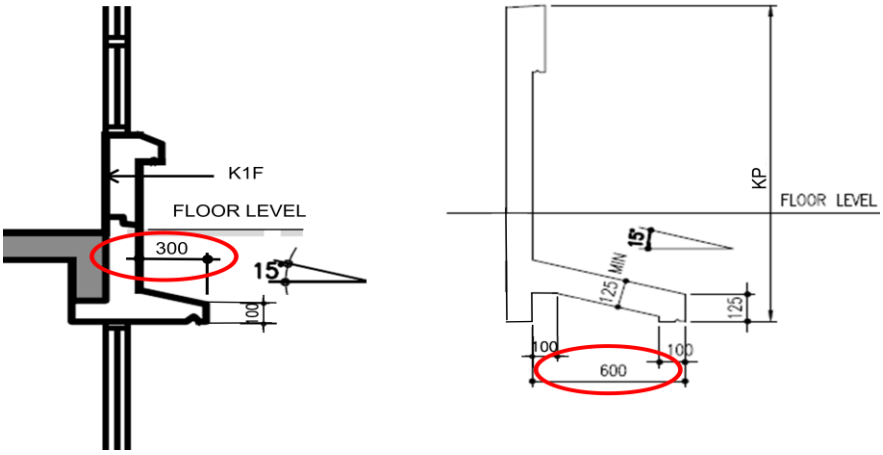


Figure 2G – *Types of acceptable and non-acceptable canopies*

2.10 Groove lines shall not be continuous across panels and must be kept at least 25 / 100mm (See Annex D – Points to note when having groovelines) from the edge of each component.

2.11 Canopy width (from external of facade wall to edge), shall be kept at either 300mm or 600mm. For K1F facade, to adopt flat soffit profile. For KP to adopt sloping soffit profile for 600mm canopies.

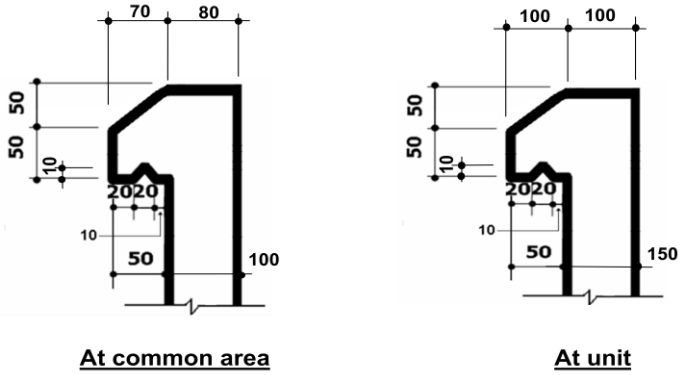


300mm canopies to adopt flat soffit profile.	600mm canopies to adopt sloping profile.

Figure 2H – *Canopy length and profile*

2.12 Slope for canopies shall be standardised for the same length of canopies.

2.13 Coping shall adopt the standard detail in the guide drawing.



At common area **At unit**

Figure 2I – *Standard coping detail*

2.14 Coping for KP at service yard shall adopt the following profile :

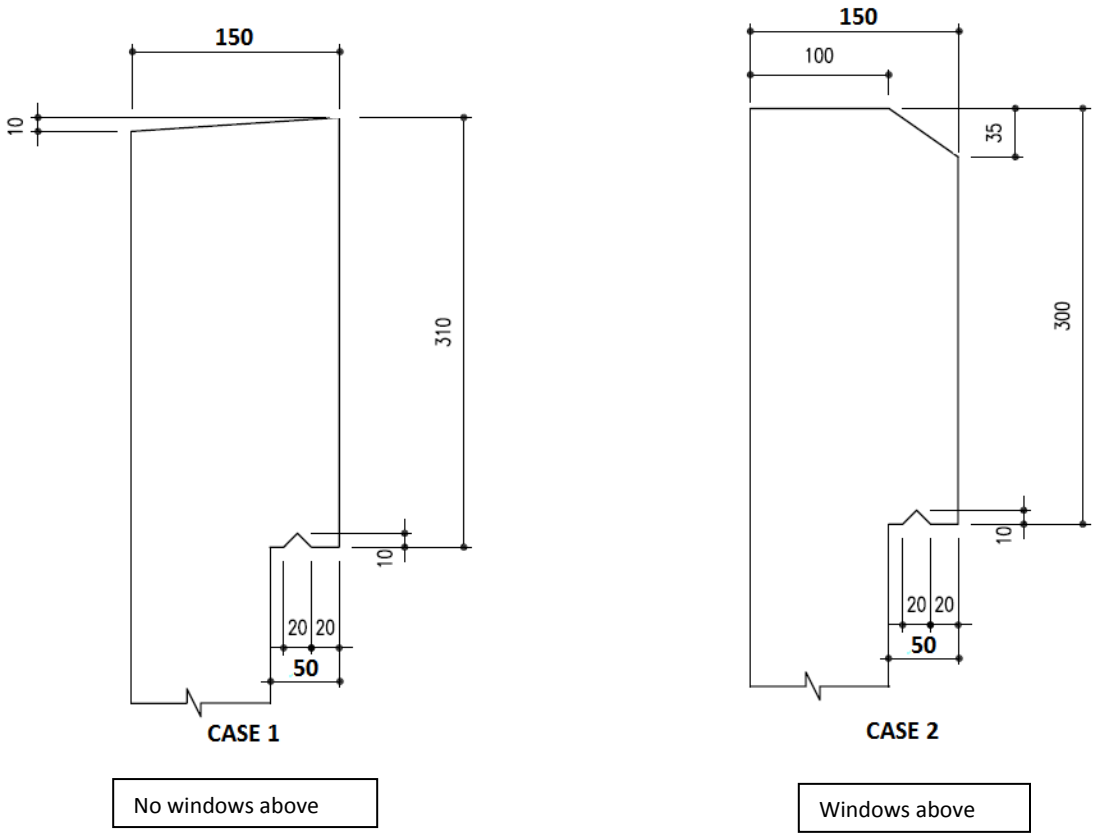


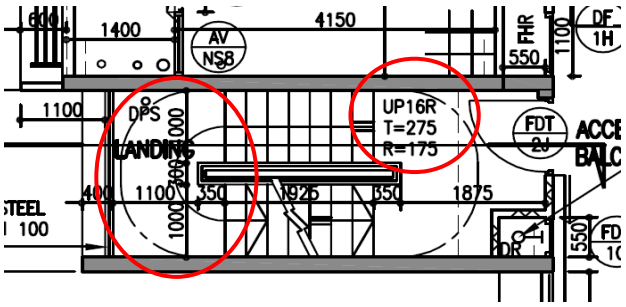
Figure 2J – *Coping profile for KP at service yard*

CHAPTER 3

COMMON AREA

3.1 Items 2.3 to 2.5 & 2.9 to 2.13 in Chapter 2 – Unit, are also applicable to the common area.

3.2 Staircase (residential and MSCP) dimensions must be as stipulated in the design guide drawings – precast staircase.



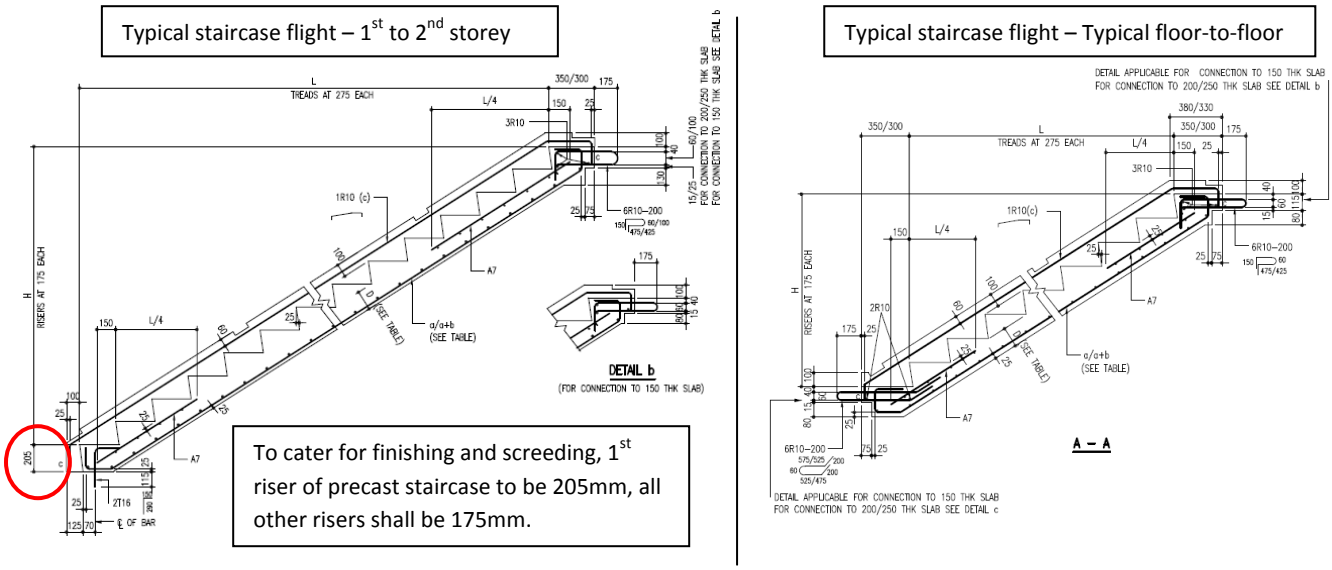


Figure 3A – *Staircase dimensions stipulated in guide drawings*

3.3 For floor height other than the typical 2.8m, adjustments to the stairwell structural floor level (SFL) may be necessary to accommodate the standard staircase risers, e.g. raise 50mm at first storey stairwell SFL for 3.6m floor-to-floor height (See Annex E for detailed explanation).

3.4 The 600mm protrusion of the lift wall shown in Figure 3B shall be non-structural.

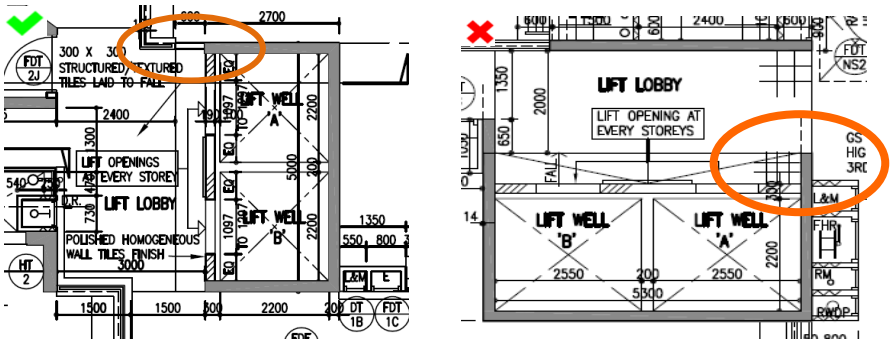


Figure 3B – *Protrusion of lift wall to be non-structural*

3.5 Precast refuse or recyclable chutes are to follow dimensions stipulated in the guide drawings – Precast Refuse Chute.

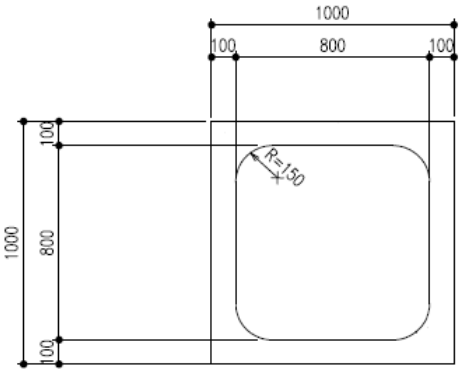


Figure 3C – *Dimensions of refuse or recyclable chutes*

3.6 Precast refuse or recyclable chutes shall be stand-alone and shall not be integrated with other components.

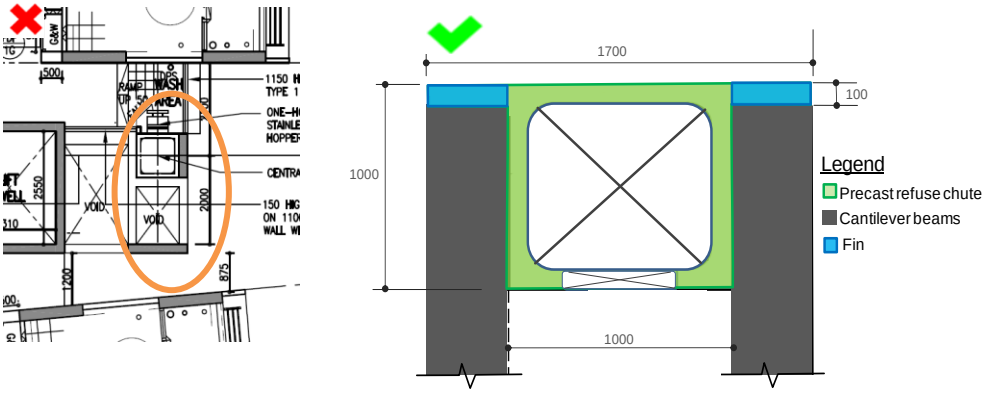


Figure 3D – *No integration of chutes with other components*

3.7 Service ducts used for the same type of services shall be standardised, and only C-shape, E-shape or F-shape ducts shall be adopted.

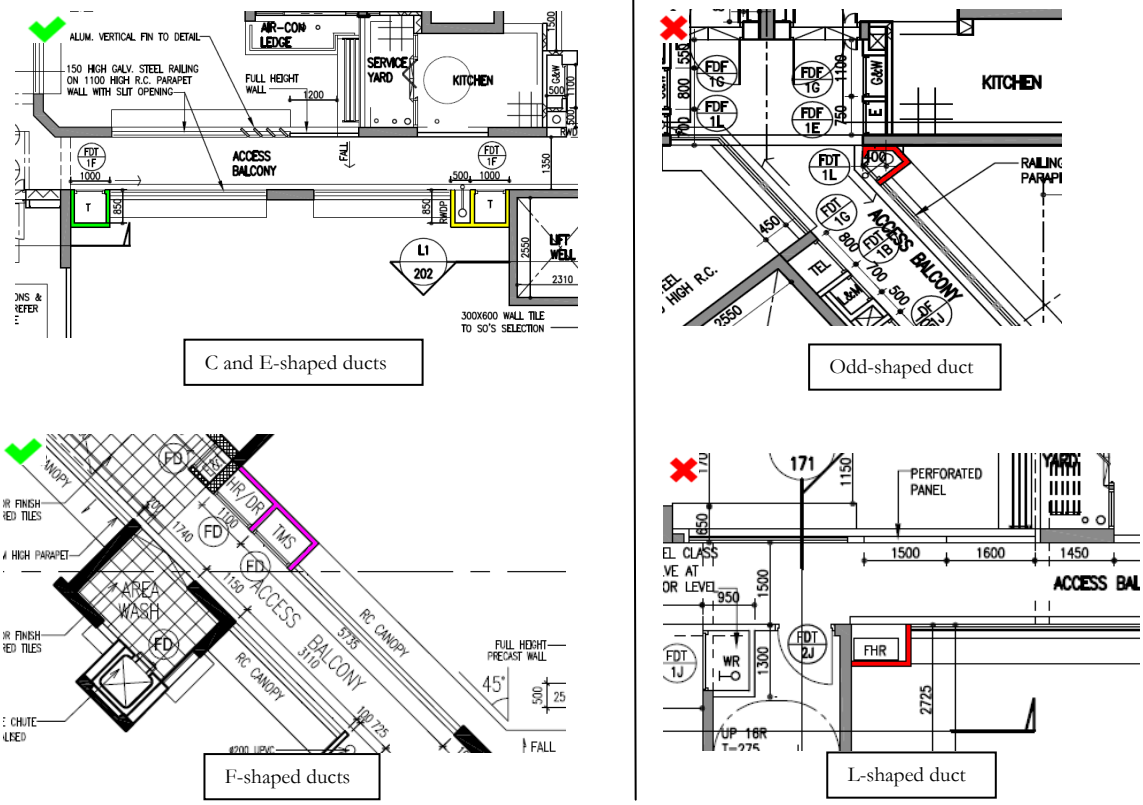


Figure 3E – *Only C-shape, E-shape or F-shape ducts shall be adopted*

3.8 Selection of water tanks shall be based on the types provided in the guide drawings– precast water tank and precast ring water tank. The configurations of water tank components can be selected to optimise the water tank design.

Type of base water tank segment	1 	2 	3 
Height (m) – includes 200mm thick base	2.04	0.6	1.1
Type of ring segment	A 	B 	
Height (m)	1.3	1.55	

Figure 3F – *Types of segments for water tank design*

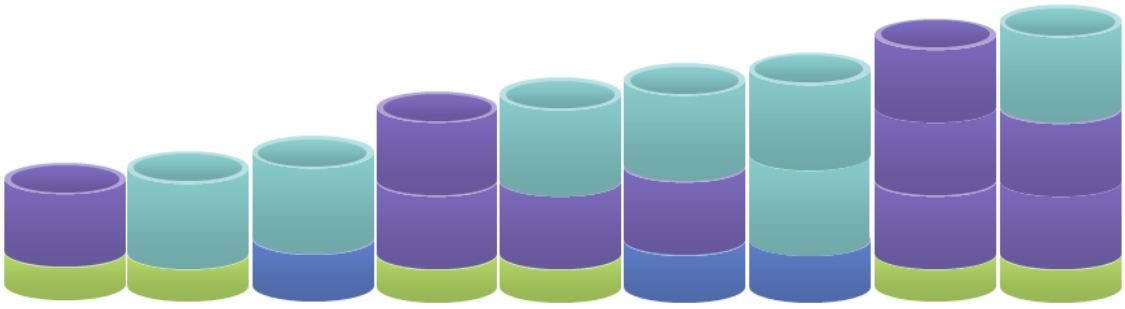


Figure 3G – *Mixing and matching segments to achieve different configurations and capacities*

	Standard Tank		Domestic Tank											
Sizing	With suction tank	Without suction tank	2-ring				3-ring					4-ring		
Base types	1	1	2	2	3	3	2	2	2	3	3	2	2	2
Body segments types	NA	NA	A	B	A	B	2A	A+B	2B	A+B	2B	3A	2A+B	A+2B
Max water level from base (m)	**1.5**	**1.43**	**1.27**	**1.52**	**1.77**	**2.02**	**2.57**	**2.82**	**3.07**	**3.32**	**3.57**	**3.87**	**4.12**	**4.37**
Design Load (with tank cover and filled with water) – kN	**260**	**260**	**300**	**330**	**370**	**400**	**470**	**510**	**540**	**580**	**610**	**650**	**690**	**720**

Figure 3H– *Maximum water level and design load for different types of water tanks*

Note: For other C&S design considerations for water tank, consultants are to refer to section 19: Reinforced concrete water tank of the C&S guide.

3.9 Canopies shall not pull around columns along access corridors, as it will give rise to potential alignment issues. Canopy shall terminate at the edge of the column.

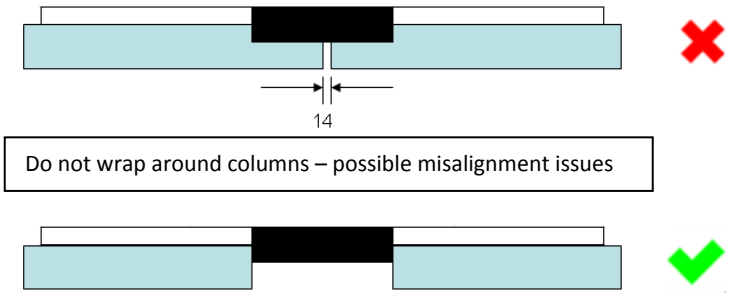


Figure 3I – *Termination of canopy at edge of column*

3.10 The use of different plank types at the different locations of the MSCP, are shown in the following typical deck floor plan. For more details, consultants shall refer to the guide drawings – MSCP deck details.

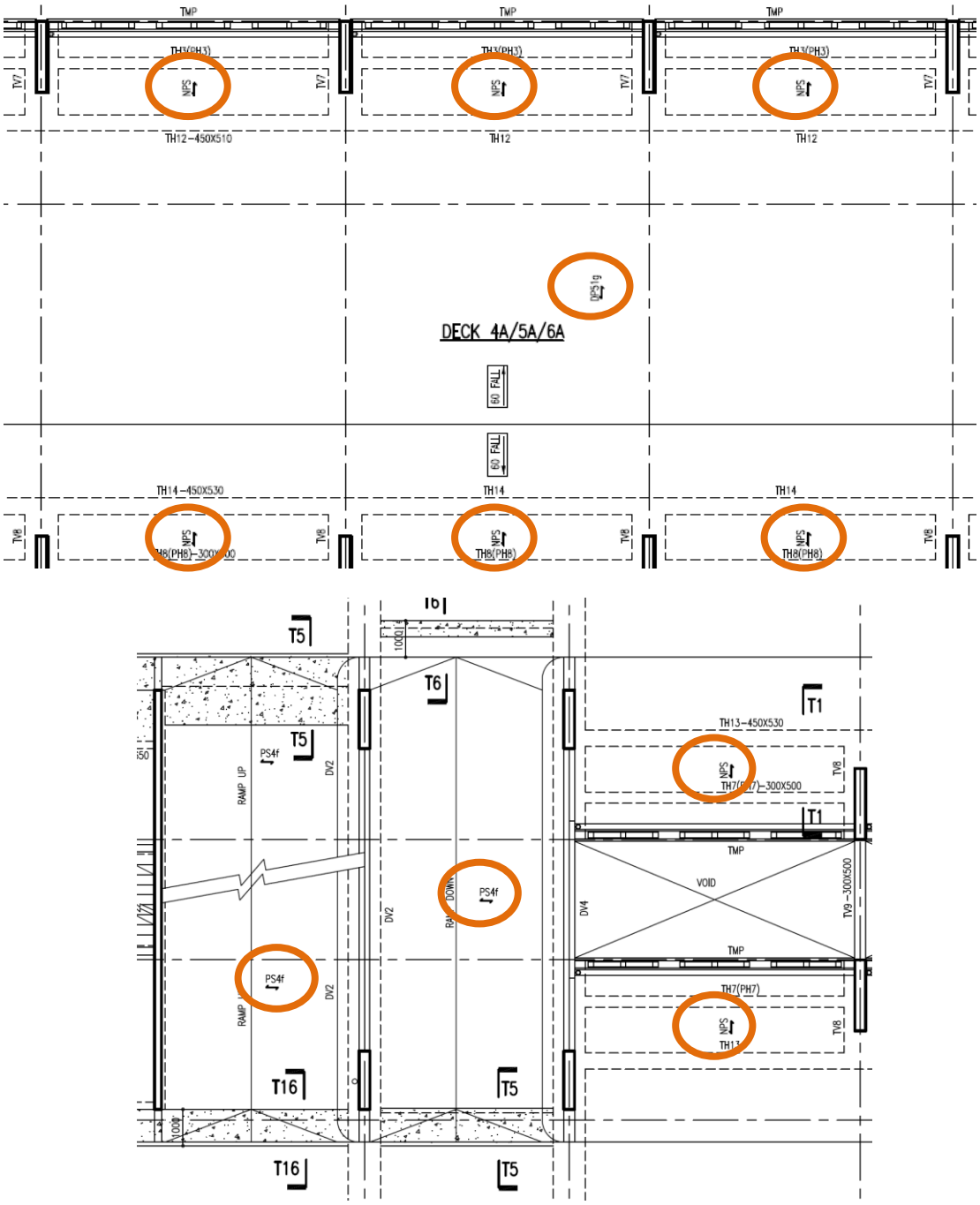
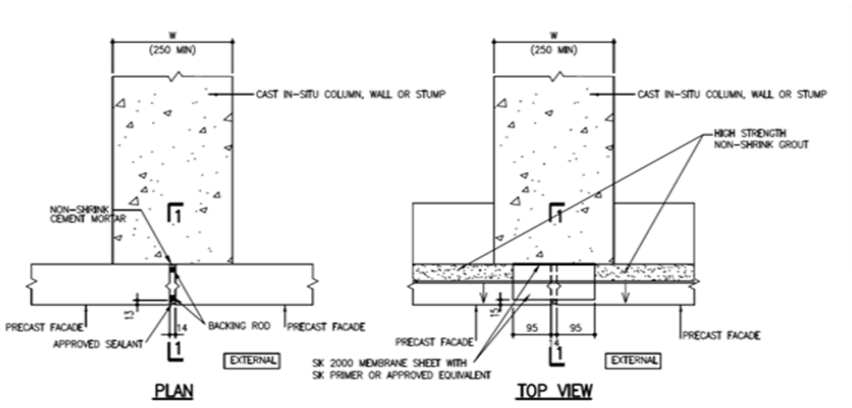


Figure 3J– *Use of different plank types at MSCP*

CHAPTER 4

JOINTS & CONNECTION DETAILS

4.1 Horizontal joints shall be kept open so that water flowing through the vertical joints is allowed to discharge. Typical details are shown in the Figure 4A.



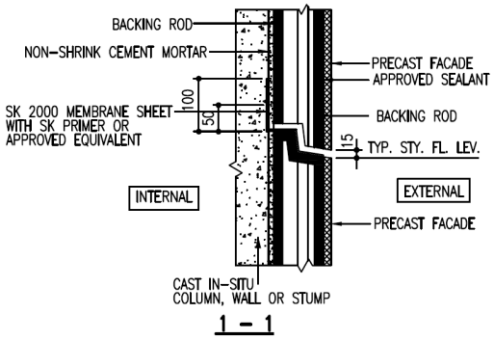


Figure 4A – *Open drain at horizontal joint*

4.2 Figures 4B to 4D illustrates the different types of vertical connection details.

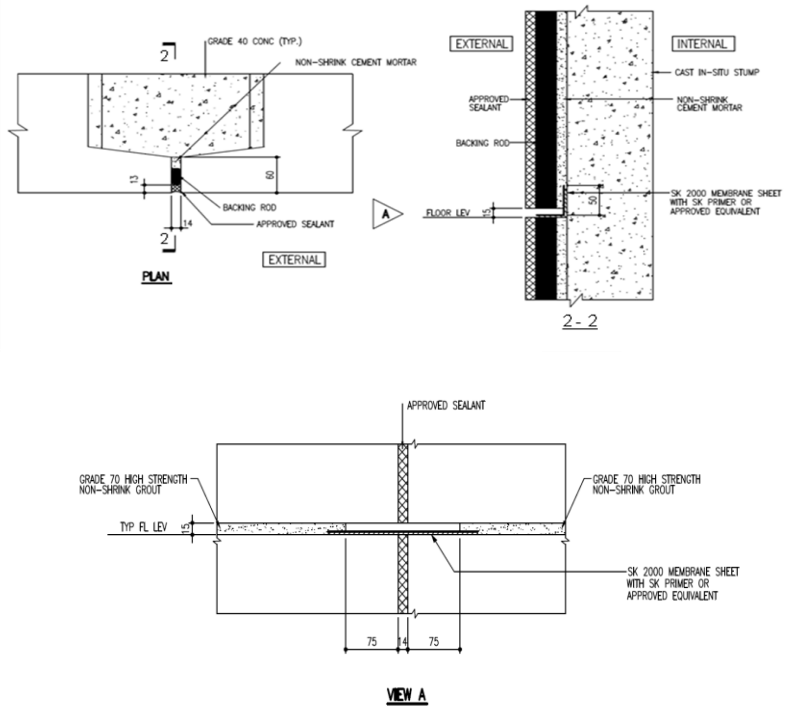
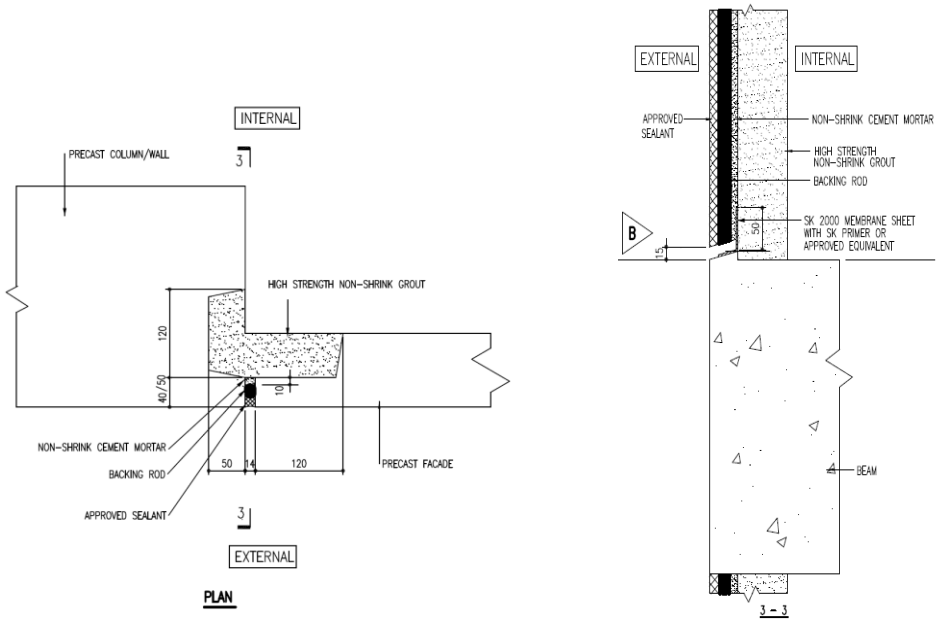


Figure 4B – *Vertical connection details for precast wall*



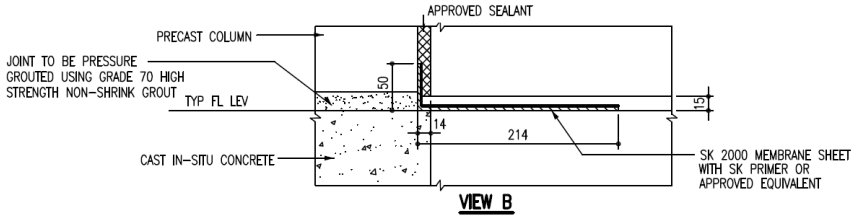


Figure 4C – *Vertical connection details between precast wall/column and precast façade*

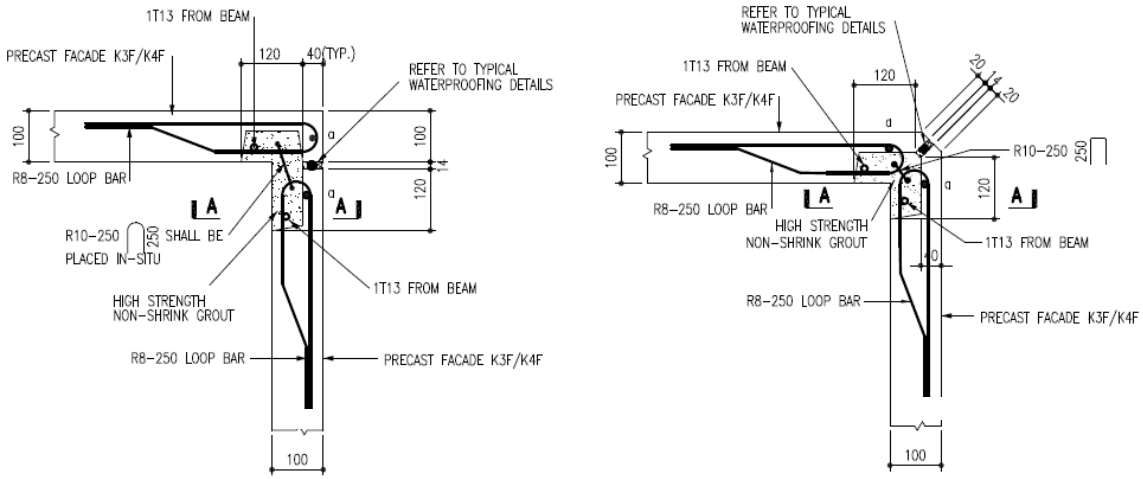


Figure 4D – *Vertical connection details for half height precast façade (K3F / K4F)*

4.3 Figures 4E and 4F illustrates the different types of horizontal joint details between precast components.

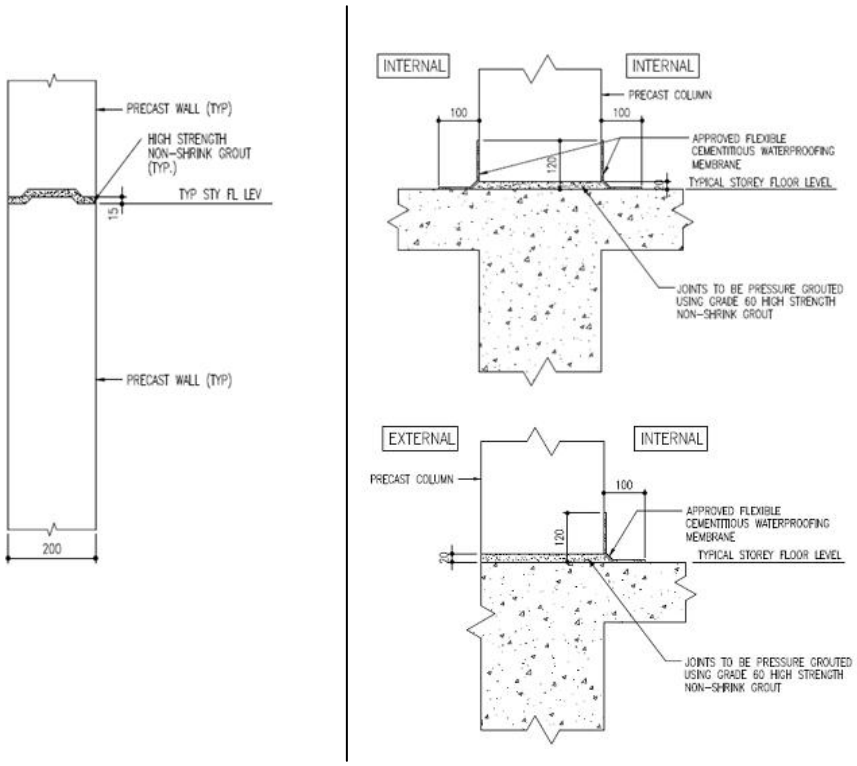


Figure 4E – *Horizontal connection details for precast wall and column*

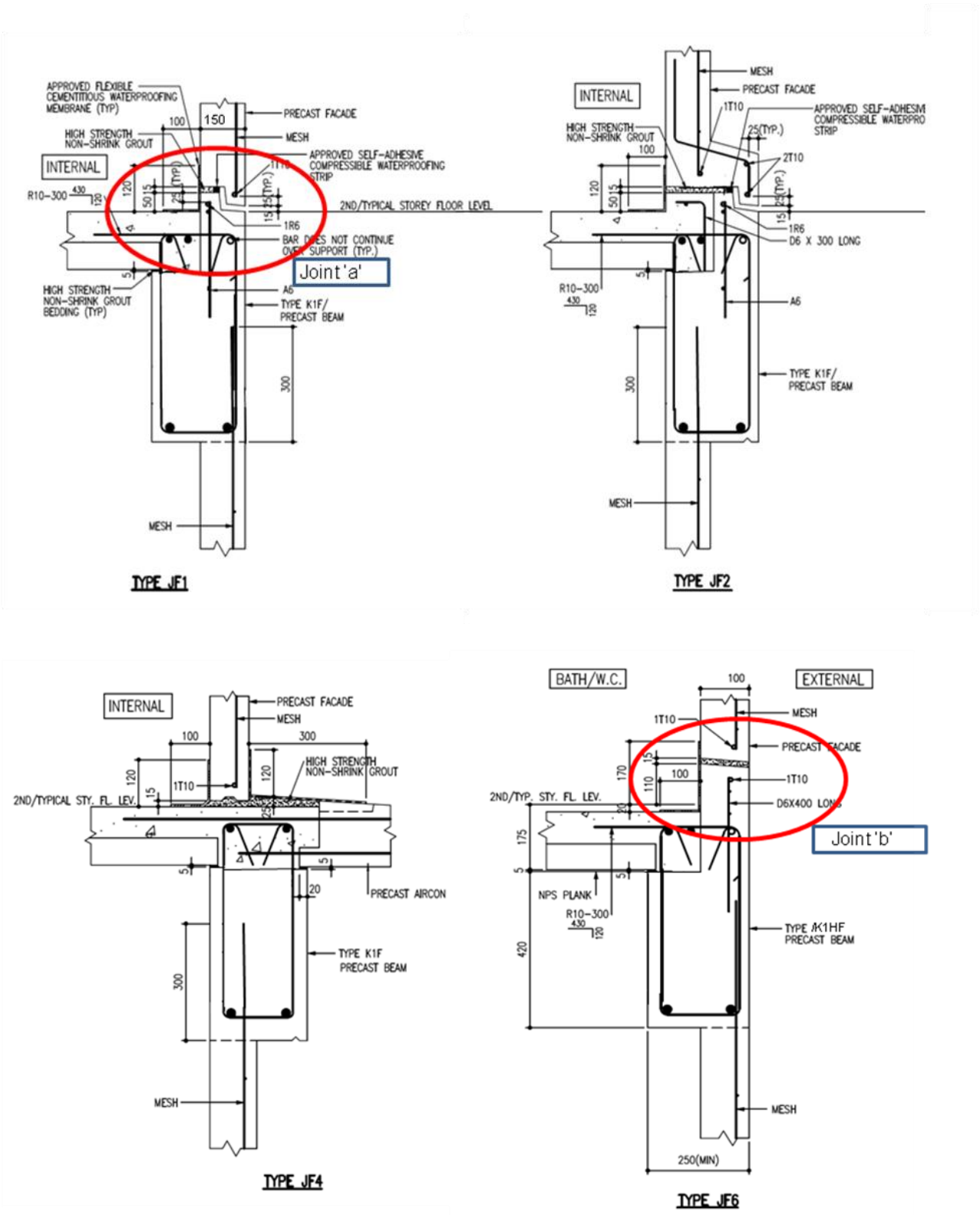


Figure 4F – *Horizontal connection details for precast façade*

4.4 Step-joint detail shall be used for 150mm thick façade (see joint 'a' of Fig 4F).

4.5 Sloping detail shall be used for 100mm thick K1HF façade at toilet (see joint 'b' of Fig 4F).

4.6 Façade shall be flushed to the external face of the beam (shown in type JF1 and type JF6 in Fig 4F).

4.7 Façade acting as column non-structural clads must be 120mm thick such that step-joint profile can be adopted. For non-structural column clads, an open drain must be maintained.

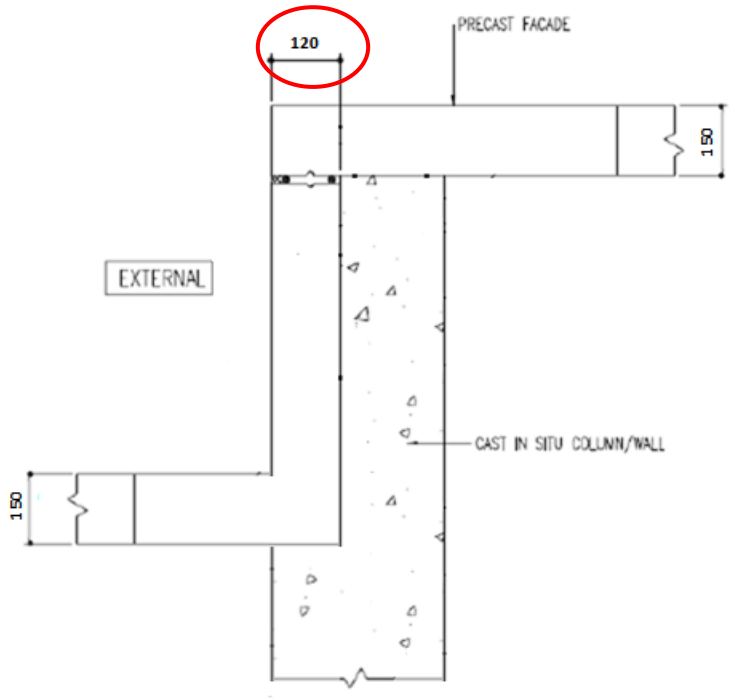


Figure 4G – *Façade acting as non-structural column clad must be 120mm thick*

CHAPTER 5

PRECAST COMPONENTS

5.1 Precast columns shall be 2-tier if it is not integrated with other components. 3-tier columns shall not be employed unless specifically design to address the handling stress during erection.

5.2 Typical details of the 2-tier column are shown in Figure 5A.

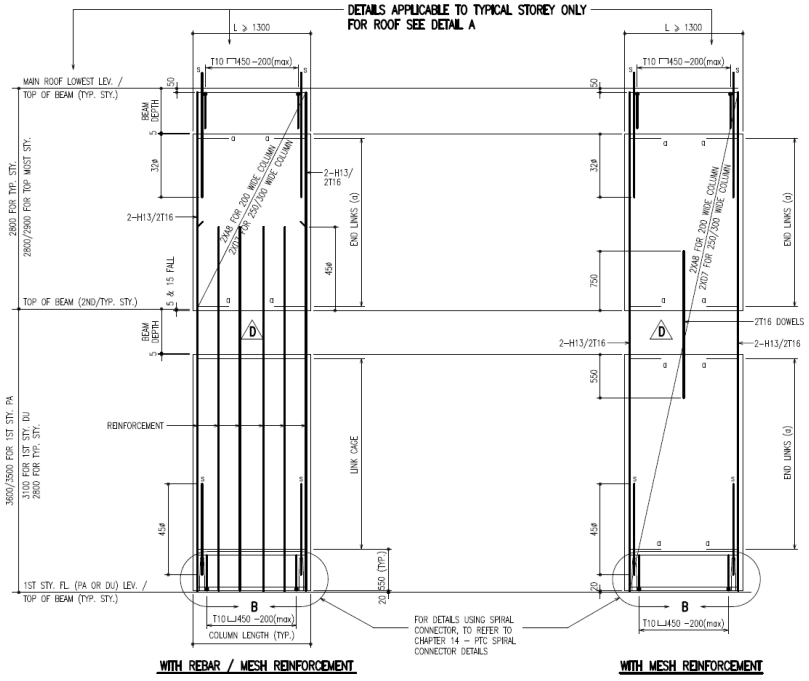


Figure 5A – *Typical details of 2-tier precast column (sectional view)*

5.3 Columns are to be integrated with gable-end wall to form a plane element (PC-KGW with column 1-tier). The base of the gable-end wall for the integrated component shall also be pressure grouted. Consultants are reminded to check the weight of the integrated component against the tip load and the specifications of the lifting equipment.

5.4 External structural vertical components shall not protrude out of the building line. For non-structural vertical components protruding out of the building line, the protrusion shall not be more than 600mm. This is to achieve a safe working environment during installation.

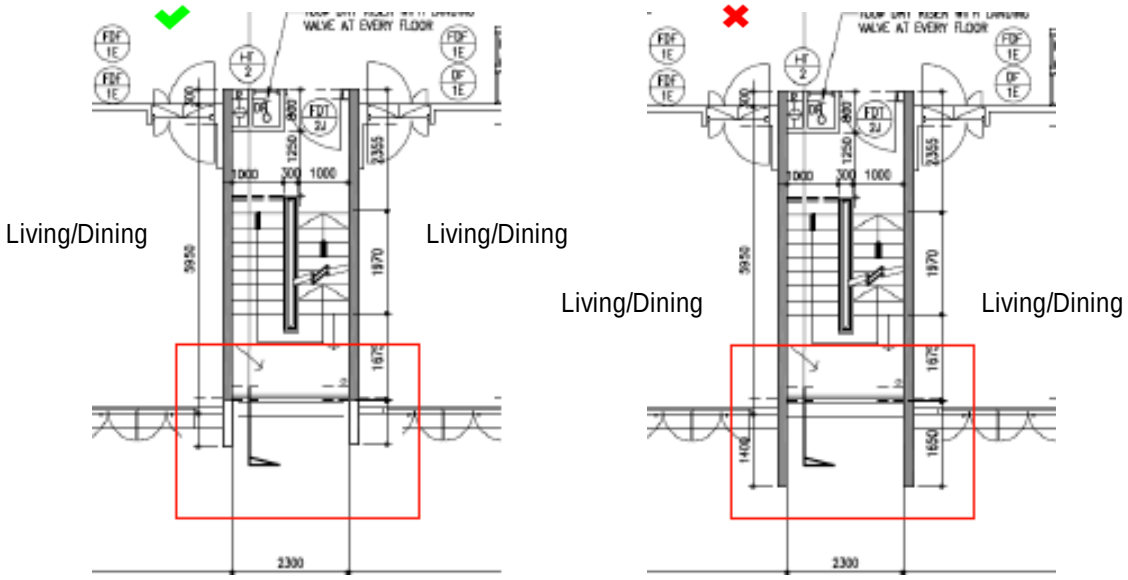
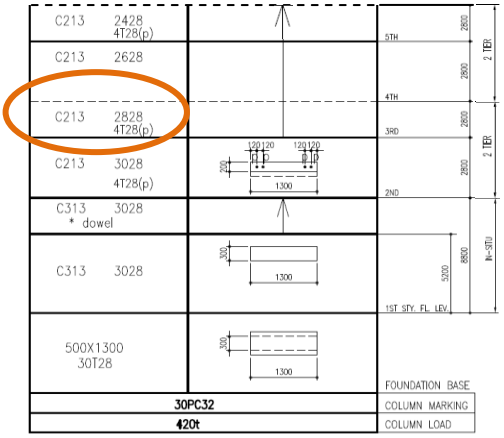


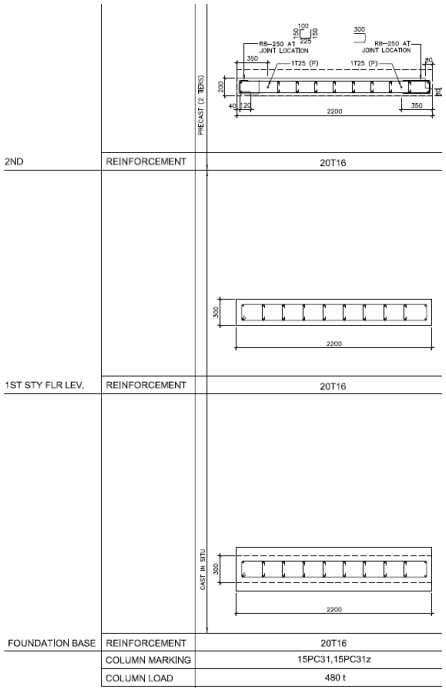
Figure 5B – *Non-structural vertical components shall not protrude out of building line by more than 600mm*

5.5 Columns shall use pre-fabricated cages, while walls, precast household shelters and slabs shall employ mesh for the reinforcements.

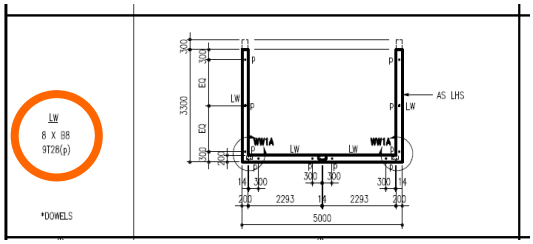
✔ *Pre-fabricated cage for columns*



✖ *Loose bars used for columns*



✔ *Mesh for walls*



✔ *Mesh for precast household shelters (detailing to follow latest guide line from BCA)*

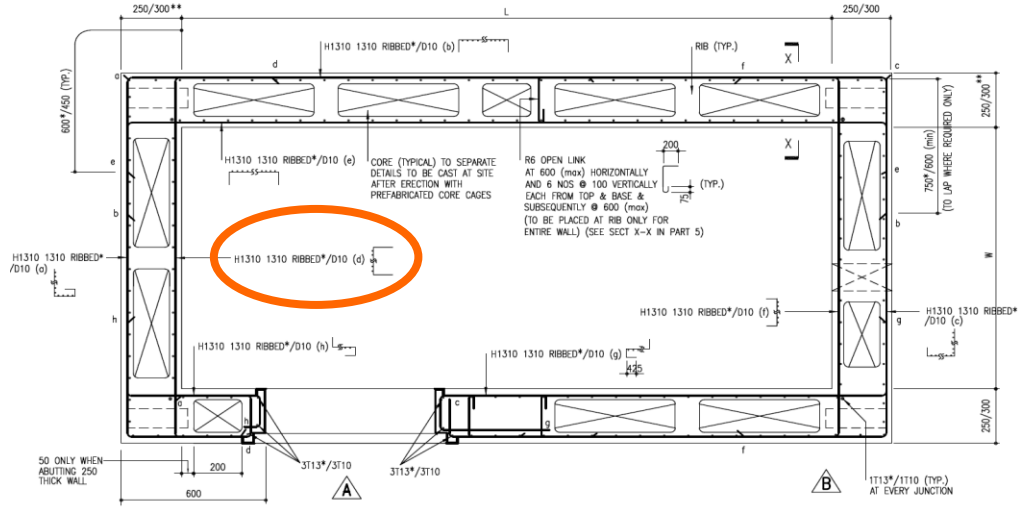


Figure 5C – *Pre-fabricated cages for columns and meshes for walls and household shelters*

5.6 Consultants shall not lay pre-stressed planks side-by-side when one pre-stressed plank is less than or equal to two-third of the length of the adjacent plank. A strip of wet-pour at least 200mm shall be introduced between the planks to avoid differential cambering (refer to guide drawing – standard slab details).

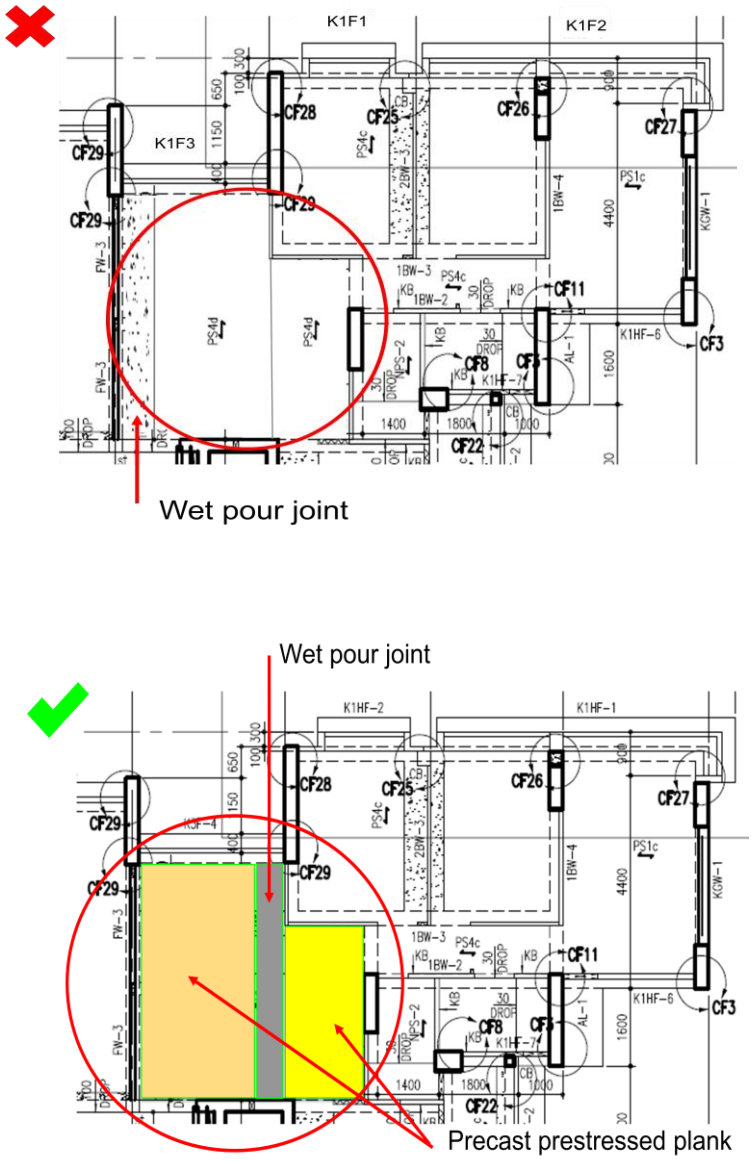


Figure 5D – *Use of wet pour to avoid differential cambering*

5.7 In general, all reinforcements shall be contained within the dimension of the precast components. There shall not be any bars protruding out from the precast component, which will cause obstruction during installation.

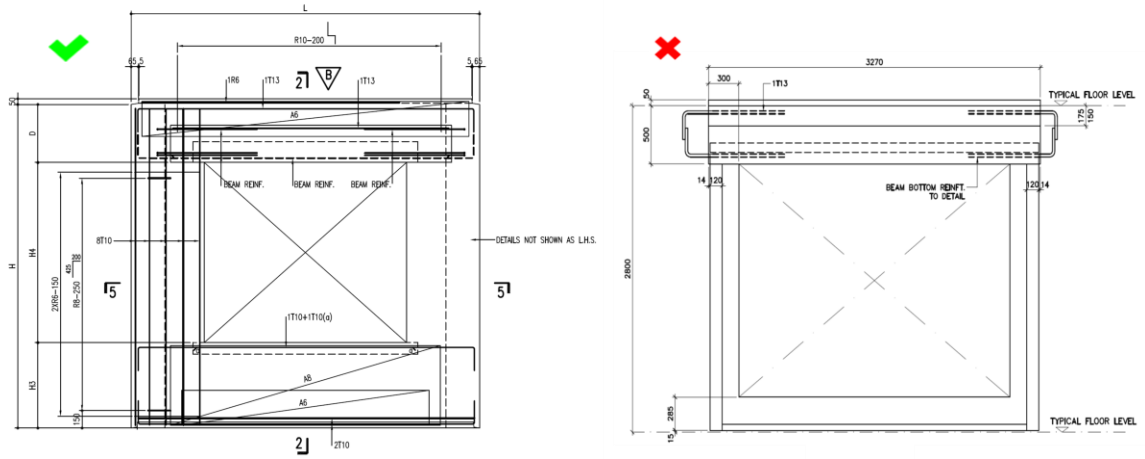


Figure 5E – *Precast component shall have no protruding bars*

Annex A – Frequently Asked Questions

A1. I have a layout as below (see Fig. A1). The kitchen wall component has portions facing both internal and external. What type of joint should I adopt?

For kitchen wall component which has portions facing both internal and external, step joint shall be adopted (Joint 'a' in Figure 4F). An in-situ kerb shall be constructed to fit the step joint of the portion facing internal.

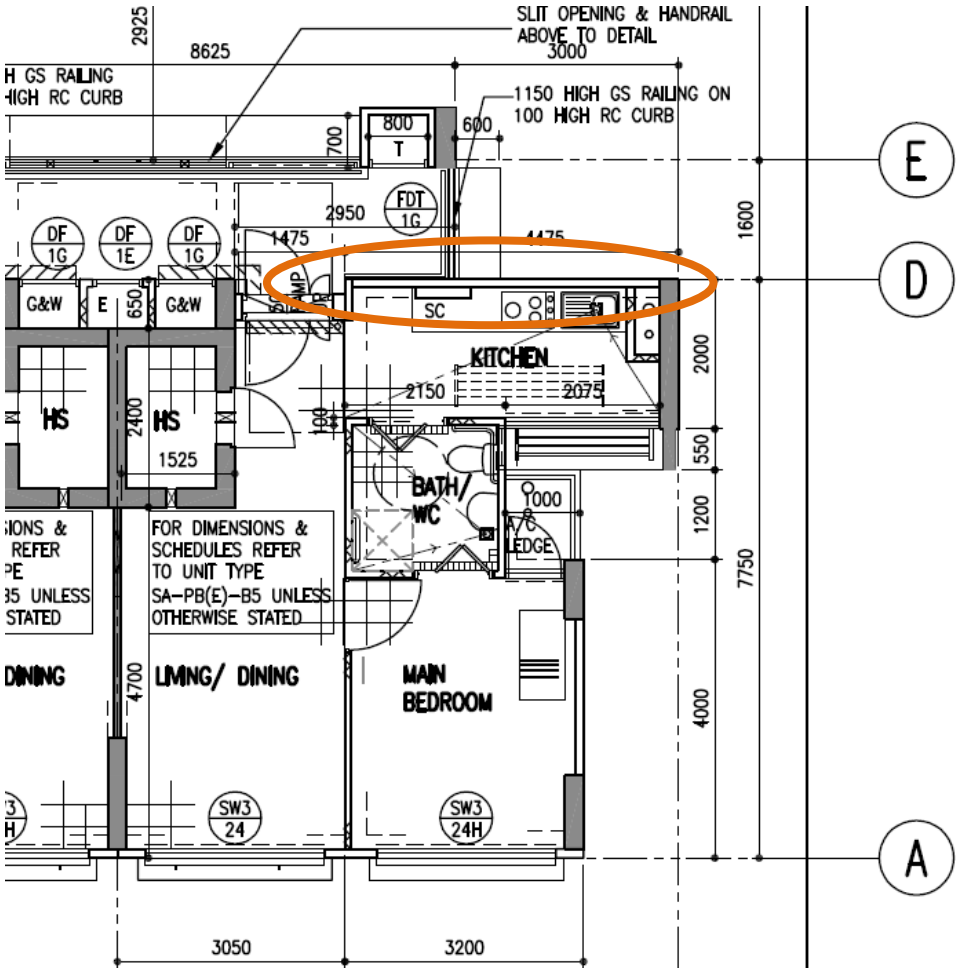


Figure A1 – *Kitchen wall component facing both internal and external*

A2. Is aluminium sill required for cast-in window (CIW)?

No aluminium sill is required for CIW.

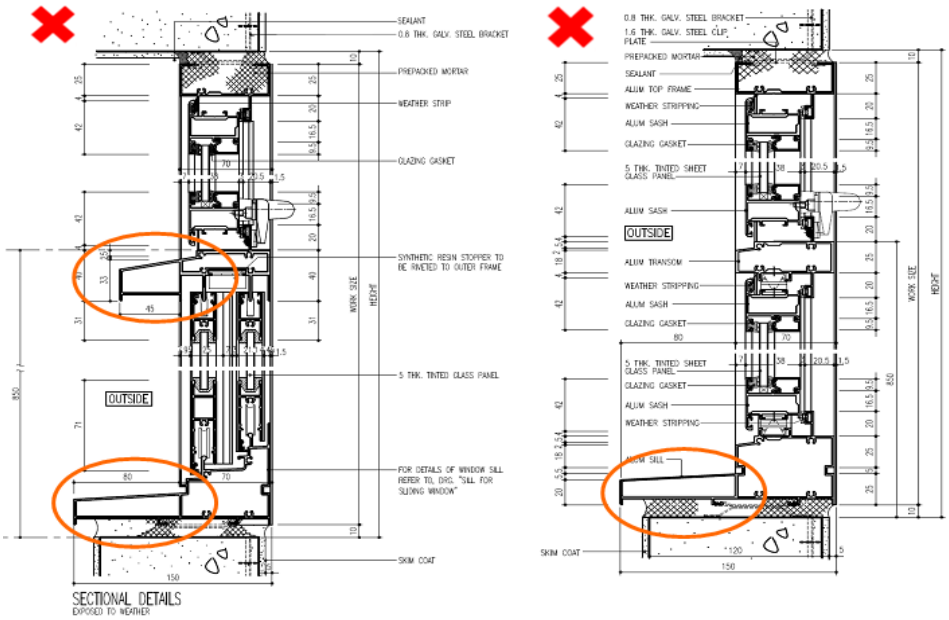


Figure A2 – *No aluminium sill required for CIW*

However, there should be a 20mm water-stop all round for CIW at external face.

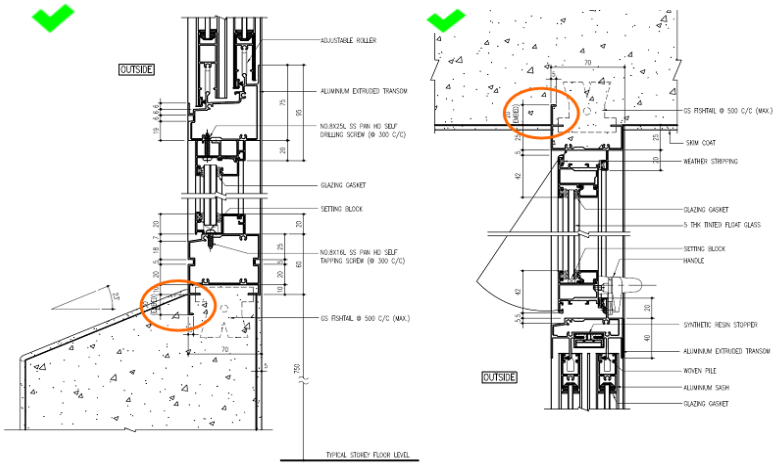


Figure A3 – *Section through cast-in window frame showing 20mm water-stop all round*

A3. I have some precast components which I am unable to meet the 100 repetition guide. What should I do about it?

The precast component repetition schedule shall be submitted as early as possible to the precast review team. If the repetition falls under 100 because of architectural treatment of the façade, the consultants would be required to study and revise their design.

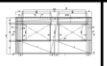
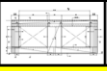
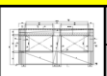
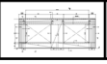
SCHEDULE OF PRECAST ELEMENTS							
Precast \ Block		890A	890B	890C	PROVISION	LOCATIONS	REMARKS
K1F1		45	45	12	102	4-RM	
K1F1X		45	45	12	102	4-RM	
K1F-2		30	30	8	68	4-RM	Similar profile except K1F-3 with fins. Mould can be shared.
K1F-3		30	30	8	68	4-RM	
K1F4		15	15	13	43	3-RM	Insufficient 3-room units to meet the repetition. Handed façade unavoidable due to unit layout.
K1F4X		15	15	13	43	3-RM	
K1F5		30	30	26	86	3-RM	Insufficient 3-room units to meet the repetition. Handed façade made the same to enhance repetition.

Figure A4 – *Component without 100 repetitions must be justified*

A4. My project layout requires fins to be provided at service yards and air-con ledge due to security, are there any issues with that?

We have no issues with provision of fins at service yards and air-con ledge, as long as the fins are solely for functional purposes (e.g. security or fire break) and shall be 100mm thick.

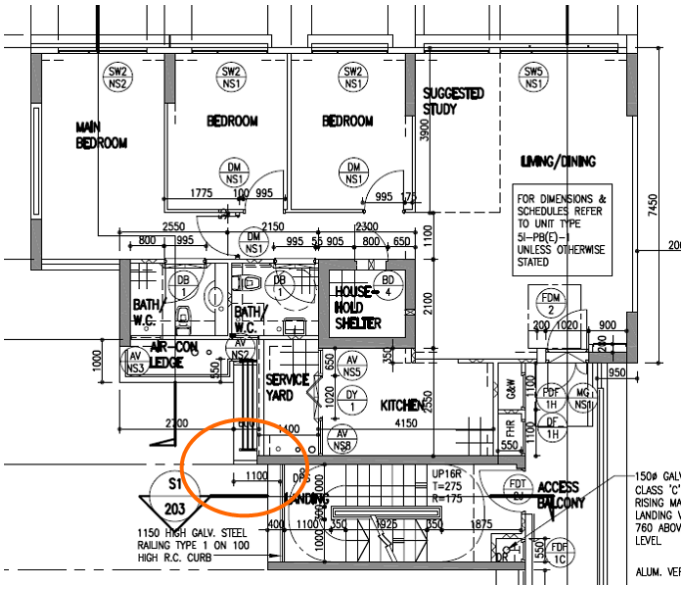


Figure A5 – *Provision of 100mm thick fin for fire break*

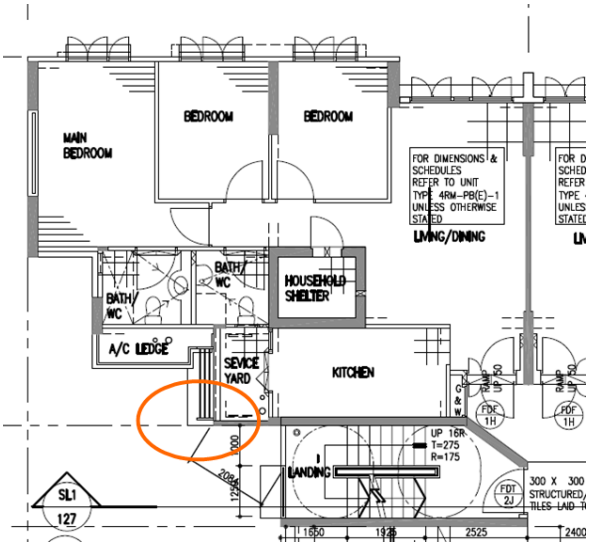


Figure A6 – *Fins without functional purposes shall not be provided*

A5. Item 2.8 states that canopies over windows shall have a minimum 100mm overhang. Can the canopies ends at the edge of the window frame?

No. 100mm minimum is required for the water drip line to be effective, to minimise wind driven rain to enter through the window.

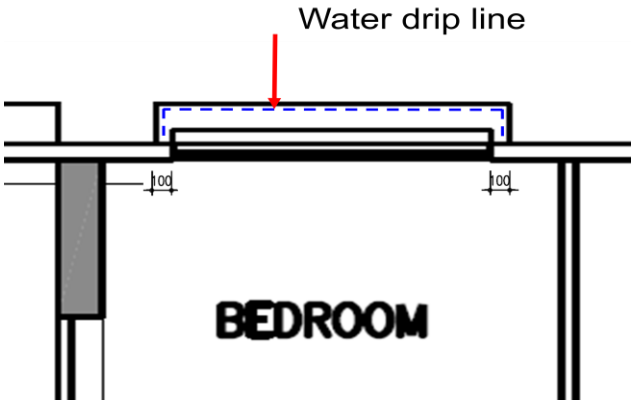


Figure A7 – *Canopies over windows shall have a minimum 100mm overhang*

A6. I need to make use of the canopy to accentuate my architectural design intent. Item 2.10 states that canopies are for functional purposes, are there any exceptions to this?

Canopies are solely for functional purposes, in the event where it is absolutely necessary to be modified to enhance the architectural design, it will be dealt with on a case-by-case basis.

However, consultants shall note that, by modifying the canopy, it would not be allowed if it adversely affects the precastability of the component (e.g. double canopy). It would also not be allowed if the consultants are unable to meet the 100 component repetition.

A7. Item 2.12 stated that the canopy width (from beam to edge), shall be kept at either 300mm or 600mm. I need the canopy to fulfil the household shelter setback requirement. Can I have a canopy that is 400mm?

No. The canopy width requirement is for component standardisation. Household shelter setback requirement should be considered before the architectural layout has been fixed.

A8. I have a floor height that is 4.5m, which is not the typical 2.8m, and not the 3.6m you showed in your example. How much am I supposed to raise to accommodate the standard staircase risers?

See Annex E for detailed explanation on how the 3.6m case is worked out, and you can work out for your 4.5m case easily.

A9. Do I use the KP shown in Figure 2H for the corridor?

No. You should use the profile in Fig. A8.

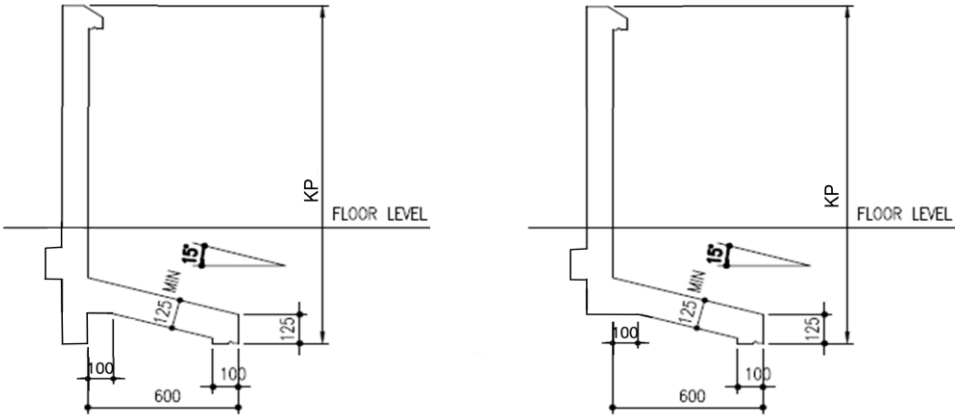


Figure A8 – *KP profile at corridor*

A10. Item 2.4 stated that the longest dimension of any parapet and facade shall be kept to a maximum of 7m. Can I have a parapet or facade that is longer than 7m?

No. For ease of handling, you should keep the dimension to less than 7m.

A11. Item 2.5 stated that the shorter length of any L-turn facade shall not exceed 1m. Can I have a L-turn facade exceed 1m?

No. For ease of casting, demoulding, storage, transportation and handling, you should keep the dimension to less than 1m.

Annex B – Standardisation & precast component categories

B1. Objective

The objectives of standardisation in precast component production are to lower cost of mould fabrication, efficient use of precast land area and to increase productivity.

When consultants enhance the repetition in upstream design, fewer moulds would be required during the downstream production, leading to cost savings. With fewer types of moulds, the production and storage area will also be reduced. Finally, repetition in precast design will lead to a more repetitive work flow which would translate to higher productivity for precast production.

B2. Precast component categories

HDB approach standardisation by dividing the precast components into 3 categories, as explained below:

Category 1 components include:

a) Precast staircase;

b) Precast refuse chute;

c) Precast ducts;

d) Precast water tank;

e) Precast segmented ring tank;

f) Precast suction tank; and

g) Precast secondary roofing slab.

Category 2 components include:

a) Precast planks;

b) Precast wall;

c) Precast column;

d) Precast gable end wall;

e) Precast infill wall;

f) Precast beam; and

g) Precast household shelter.

Category 3 components include:

a) Precast façade; and

b) Precast parapets (service yard & access corridor).

Annex C – The rationale behind 100 repetitions and how to approach this number

C1. Objective of repetitions

The guideline of 100 repetitions is to achieve a certain level of standardisation in precast component production to lower cost of mould fabrication, lead to efficient use of precast land area and to increase productivity.

C2. Rationale of 100 repetitions

Each mould can cast at least 250 numbers of the same type of precast component. The more the mould is utilised, the cheaper the average cost of the component is.

However, HDB is mindful of the needs for aesthetic and creative design in public housing. In order not to let standardisation stifle creativity, and achieve a balanced approach to achieve cost-effective, yet functional and elegant public housing development, HDB does not require the design to fully utilise every precast mould.

100 repetitions per precast component type is the balanced figure that will allow for creativity, yet maintain the cost-effectiveness of the projects.

C3. The right way to approach this number

There are three factors to consider when approaching the 100 repetitions, A) the size of the project, B) component type per floor and the cycle time, C) the sharing of mould for similar type components.

Size of the project. The size of the project is important when considering the 100 repetitions. For example, if a project has less than 100 numbers of 3-room units, it would be unrealistic to expect 100-repetition for all its façade components.

However, if a project has more than 1000 units, it would be inadequate to merely meet the 100 repetition, as the consultant could further balance the aesthetic with repetition for better cost effectiveness.

Component type per floor and the cycle time. The objective of standardisation is to reduce the number of moulds. Therefore, the 100 repetition shall be considered in light of the component type per floor and the cycle time. For instance, if one same component type has twenty numbers per floor, but it is only repeated over five storeys, the component type would meet 100 repetitions.

As the cycle time is about 12 days per floor, it is not possible to use one mould to produce twenty components for that component type. Each mould would then be underutilised, producing less than 100 of the component type per mould.

Sharing of mould for similar type components. Some similar component types are able to share the mould for production. Sharing of mould means that there should be no extensive modification of the mould, for example, change of grooveline position or removal and addition of groovelines.

Consultants shall not design architectural treatments, like groove lines, nibs and fins, which would drastically affect the repetition of the components. For example, handed façade are to be made the same or as similar to enable the sharing of moulds.

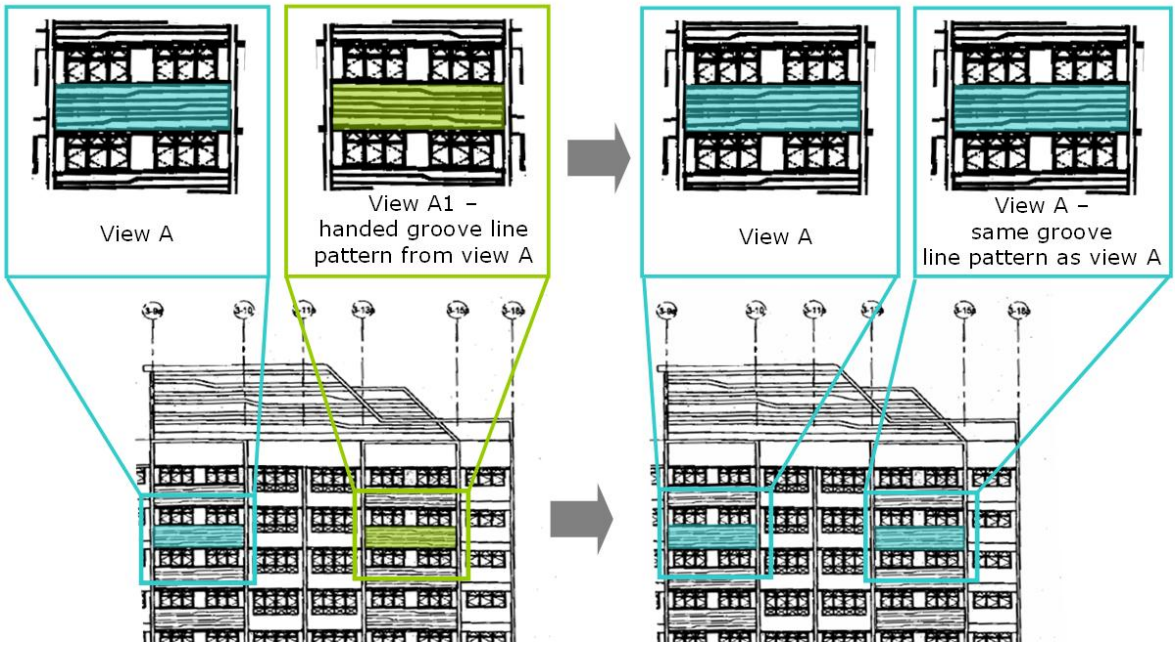


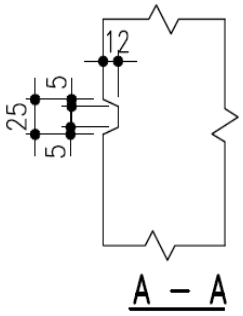
Figure C1 – *Handed façade to be made the same or similar*

In the interest of maximising repetition and the sharing of moulds, Consultants shall always consider painting of the façade as architectural treatment before resorting to treatments like groove lines, nibs or fins.

Annex D – Points to note when having groovelines

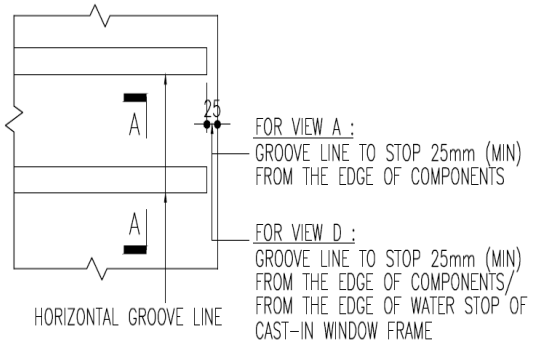
D1. Standard grooveline details

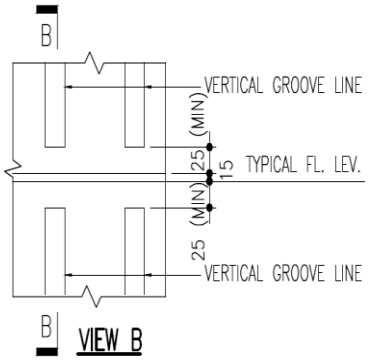
To achieve standardisation, all groovelines shall only adopt one single type of grooveline detail, shown below.

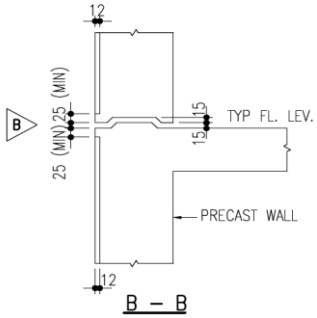


D2. 25mm from edge of component and cast-in windows

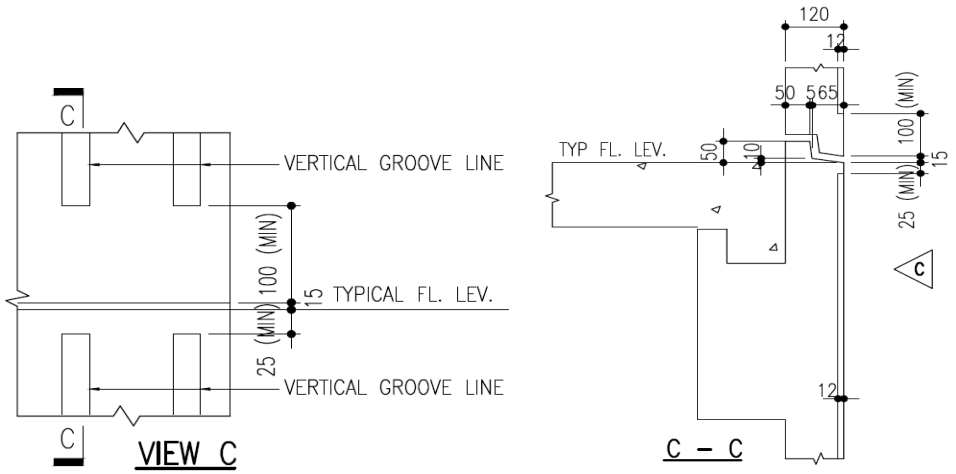
Groovelines shall be terminated 25mm from the all edges of components to avoid alignment issues. Groovelines shall also be terminated 25mm from edge of water stop of cast-in window frames.







D3. 100mm when there is a waterproofing detail



D4. Adequate concrete cover

Consultants must ensure that the presence of groovelines does not compromise the concrete cover requirements for design.

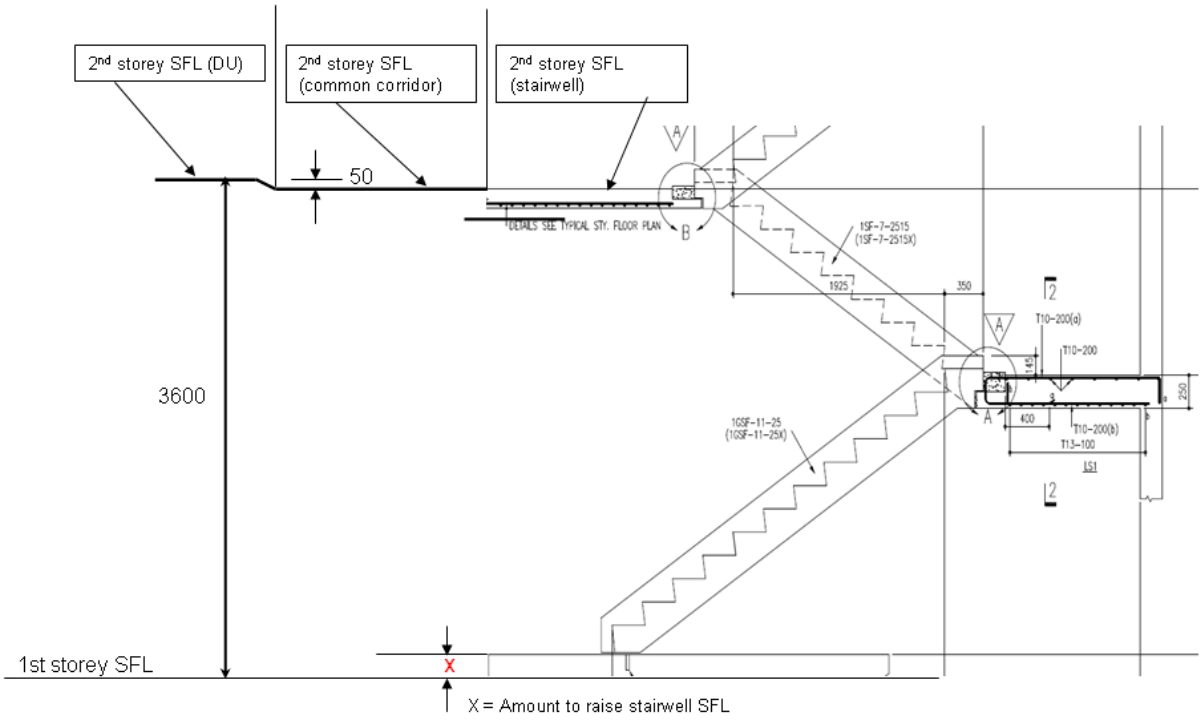
Annex E – Analysis and explanation with example to accommodate standard precast staircase flight

* Note that all levels (Structural Floor Level (SFL) and Finished Floor Level (FFL)) in this example only serves as an illustration, and the actual level in each case shall be based on the individual's layout and design.

E1. Objective

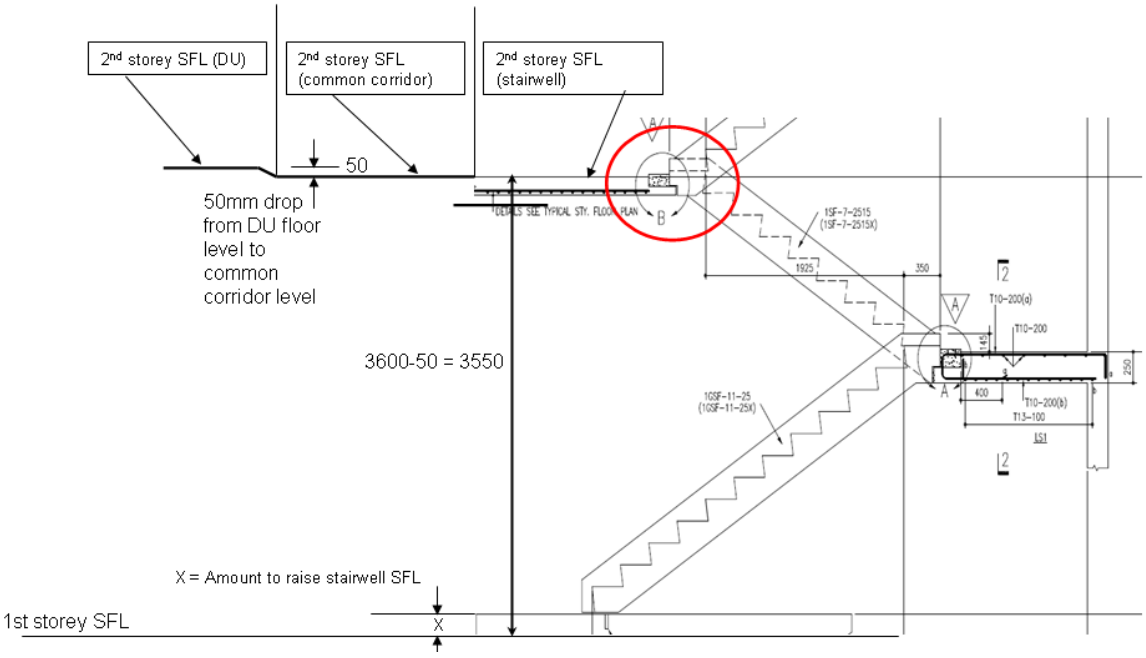
Determine X, the amount to raise stairwell SFL in order to employ standard precast staircase flight.

In this example, the 1st to 2nd storey height (SFL to SFL) is 3600mm.



E2. Calculation and explanation

For a 3600mm floor-to-floor height (1st to 2nd storey),

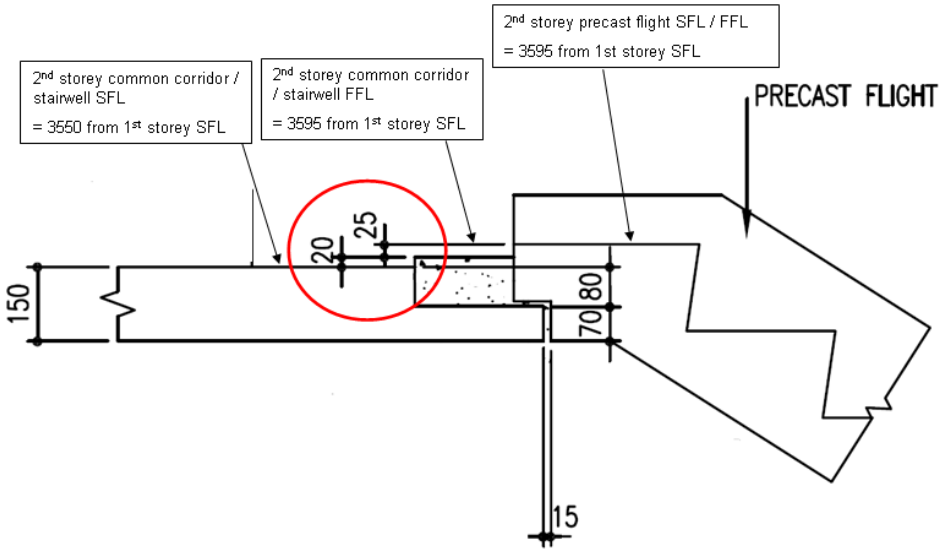


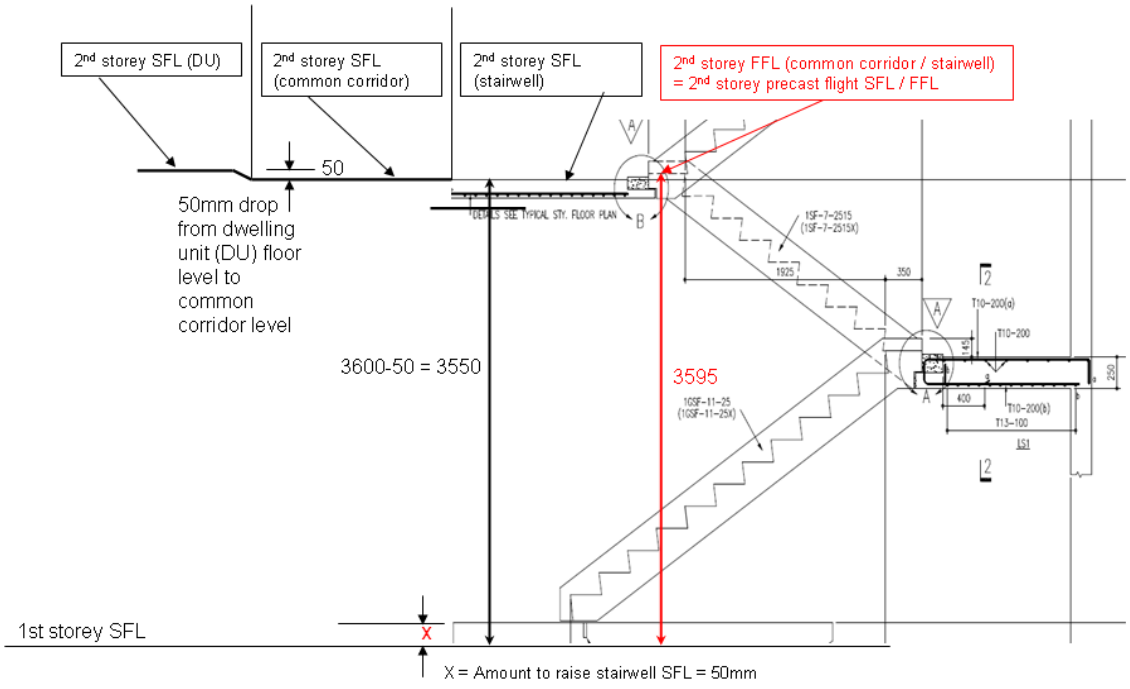
1st storey SFL to 2nd storey common corridor/stairwell SFL = **3550mm**
(50mm drop from 2nd storey DU floor level to 2nd storey common corridor/stairwell level)

Now, finishing at 2nd storey stairwell level is 45mm.
Note that, since there is no finishing for precast staircase flight
staircase precast flight SFL (2nd storey) = staircase precast flight FFL (2nd storey)

However,
stairwell FFL (2nd storey) = stairwell FFL (2nd storey) + 45mm finishing
staircase precast flight SFL/FFL (2nd storey) = stairwell FFL (2nd storey)
Therefore, height from 1st storey SFL to precast flight SFL/FFL = 3550 + 45 = **3595mm**

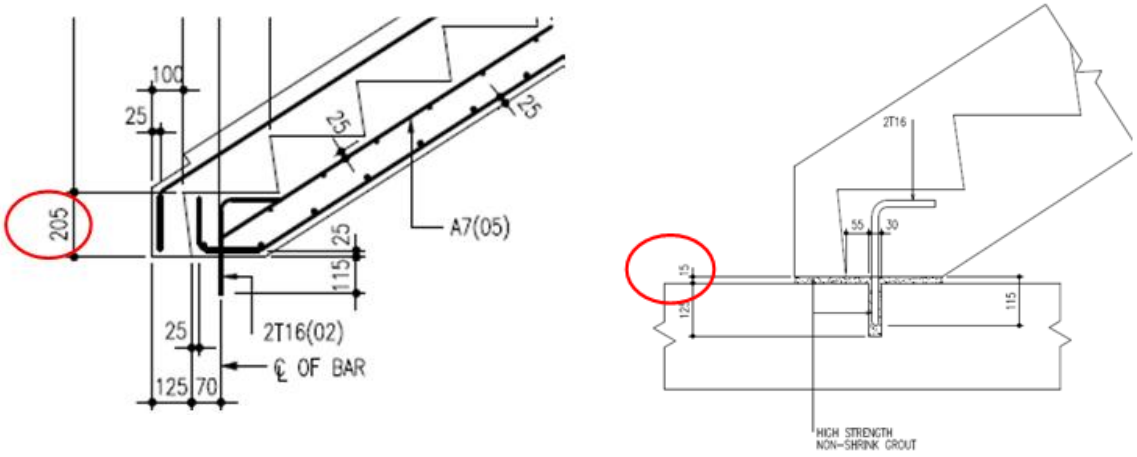
This is explained in the diagrams as follow:





1st riser of staircase flight from 1st storey is to be 205mm. This is to account for finishing at the 1st storey stairwell slab. The first riser (after finishes) will be 175mm.

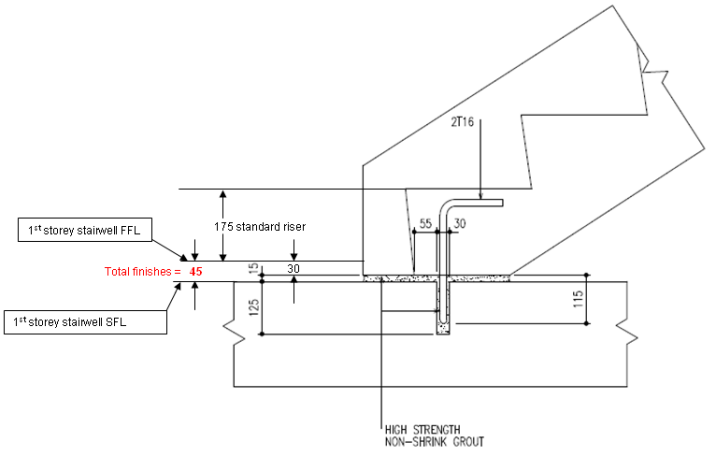
There is also a 15mm high strength non-shrink grout joint to be accounted for.



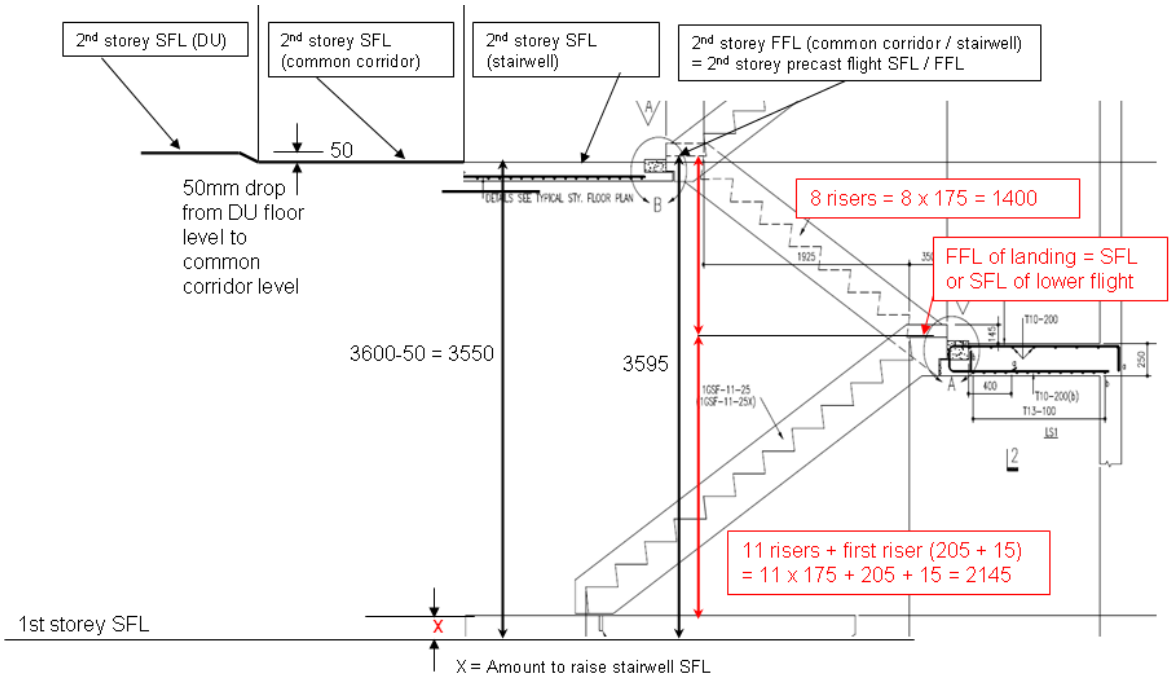
The total finishes at 1st storey slab is hence

205 – 175 + 15 = 30 + 15 = **45mm**.

Therefore, the FFL of the 1st storey is 45mm higher than the SFL of the 1st storey.



Notice that this height of finishing is identical to that at the 2nd storey stairwell.



Therefore, for a 2 flight staircase, with floor-to-floor level (DU area) of 3600mm, raise 1st storey stairwell SFL by **50mm** to accommodate the standard staircase flight.

Annex F – HDB's waterproofing system

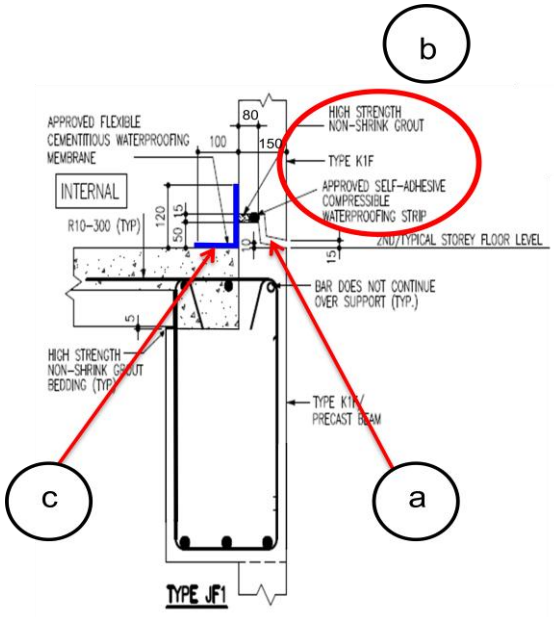
F1. Background

Precast components, when jointed on-site, would have horizontal and vertical joints which are prone to water seepage. Waterproofing details are hence instrumental, and a good understanding and appreciation by the consultants is required.

F2. Typical horizontal joint waterproofing system

A typical precast horizontal joint waterproofing system consists of three lines of defence against water seepage:

a) waterproofing profile on precast component e.g. step profile;
b) waterproofing strip and non-shrink grout between upper and lower components at kerb; and
c) cementitious waterproofing membrane laid on the floor in the unit.

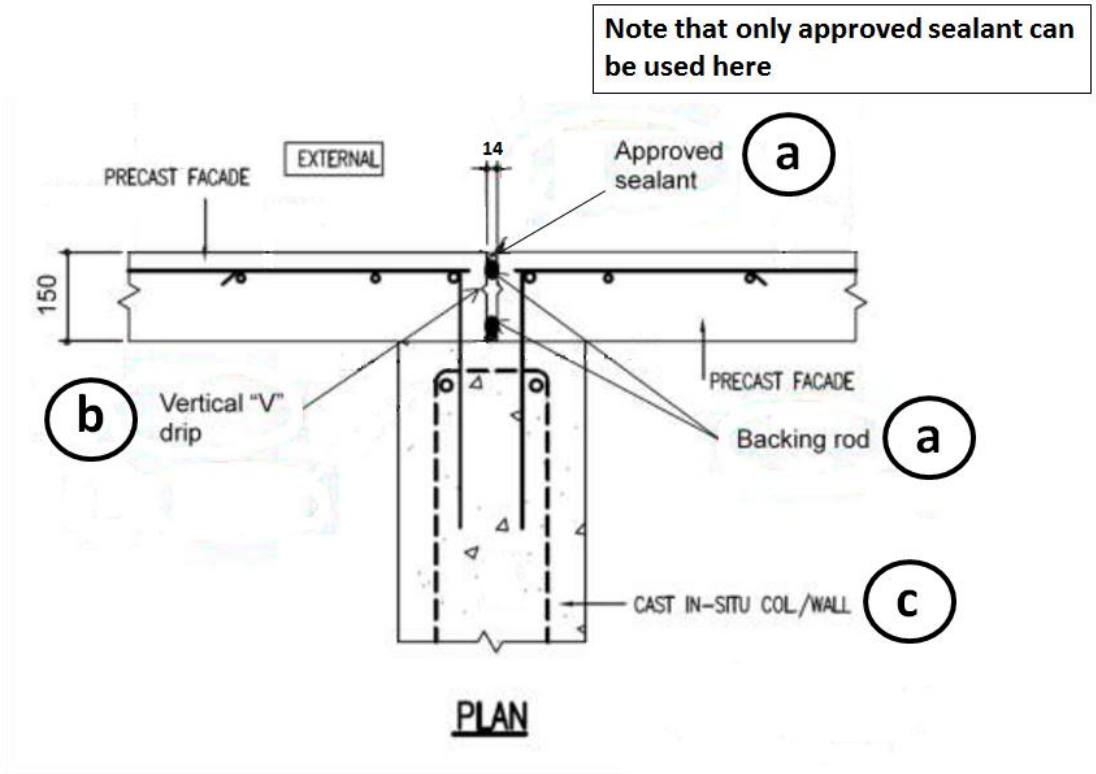


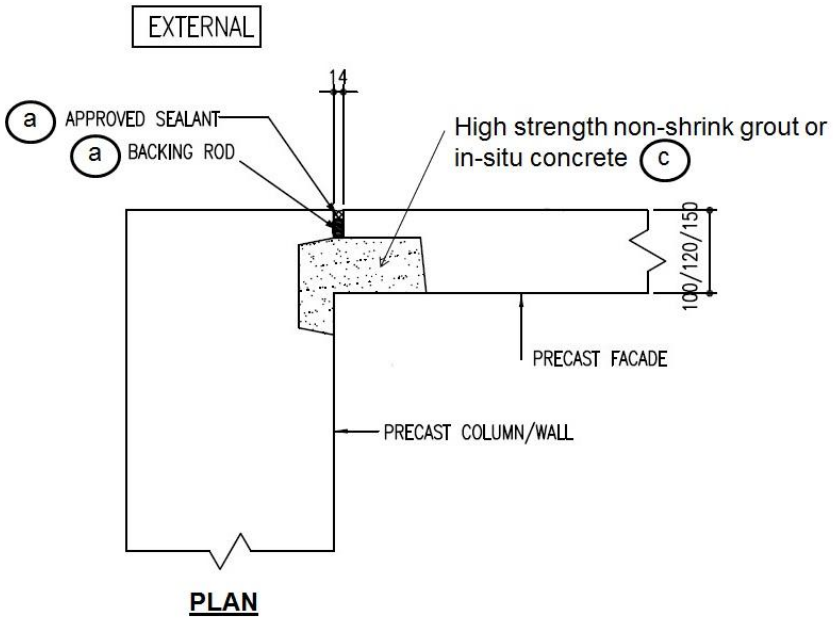
Note: The horizontal joint gap must be free from any object to allow water to drain off.

F3. Typical vertical joint waterproofing system

A typical precast vertical joint waterproofing system consists of three lines of defence against water seepage:

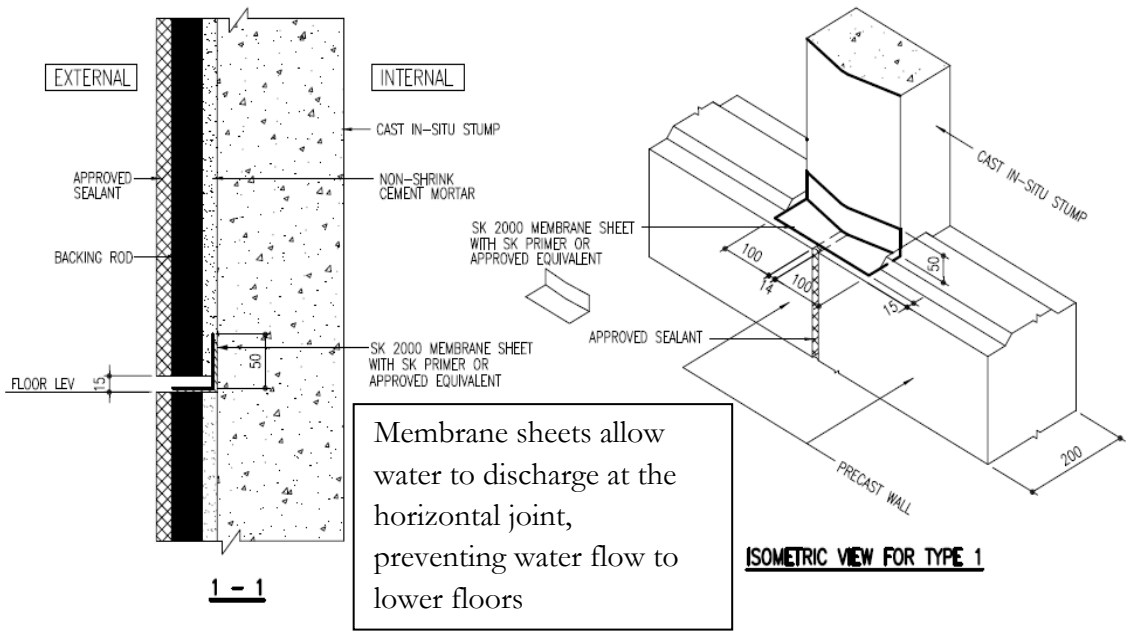
a) Sealant & backing rod;
b) Vertical "V" drip and
c) In-situ concrete





F4. Function of waterproofing membrane sheet

At the intersection between horizontal and vertical joints, waterproofing membrane sheet plays an important role to prevent the buildup of water head, discharging the water out through the horizontal joint. The guide drawing illustrates the use of membrane in many scenarios, and membrane must be folded properly in order to achieve its desired effect.



Membrane sheets allow water to discharge at the horizontal joint, preventing water flow to lower floors