1. INTRODUCTION

A survey conducted by BCA on private residential buildings that were less than 5 years old indicated that most incidents of water leakage occurred at the floors and internal walls of toilets and kitchens. In Singapore where high rise residential estates are common, the problem of leakage at ceilings and floors is further compounded when the leak comes from the unit above.

In enhancing the watertightness performance of the internal wet areas of buildings, it is important to look at how the structure and the waterproofing membrane are detailed. This publication is a good practice guide that includes among others, sections on design, selection of material and installation. It is intended to complement the current Singapore Code of Practice, CP 82: 1999 titled “Waterproofing of Reinforced Concrete Buildings”.

2. DESIGN

2.1 GENERAL

The Designer should refer to applicable local and international codes, standards and specifications when designing wet areas to be watertight.

The drawings and specifications should be prepared in sufficient detail by the Designer to provide proper guidance to the Waterproofing Specialist and other trades involved in the execution of work in wet areas. It is also important to ensure the compatibility and bonding performance of the membrane to substrate.

The structural, architectural and M&E drawings affecting the wet areas should be reviewed together for reliability of the waterproofing system and to ensure consistency in dimensions (e.g., final thickness of the floors, M&E configurations, etc). There should also be a good level of awareness and understanding of the structural system being used (e.g., precast hollow core slab system, cast in-situ RC system, etc).

2.2 PREFABRICATED BATHROOM UNITS (PBUs)

In recent years, both HDB and private developers have increasingly used PBUs. The feedback from homeowners has been encouraging. Some of the advantages of the prefabricated system over the conventional toilet/bathroom are:

- The various trades involved in the wet area (tiler, plumber, electrician and waterproofing applicator) are made the responsibility of one party, reducing chances of errors due to lack of coordination.
- Better control of the materials and prefabrication process in the factory, resulting in higher quality finishes and lower wastage of materials.
- Piping and electrical cables are run in the space between unit bath’s shell and the building structure, eliminating the need to chase the walls/slabs or embed the services.
- The entire toilet unit can be produced in the factory without affecting site operations, thereby shortening the construction cycle and construction period.

Figure 2.1: Interior of a prefabricated bathroom
These benefits translate into substantial cost savings, a consistently high quality product and simpler quality control process. To reap the full benefits of PBUs, its use should be considered at the early design stage. PBUs can be either precast concrete or prefabricated lightweight cells with finished walls and floor pre-assembled in the factory or assembled on site. More details on PBUs in Singapore can be found in BCA’s publication titled “Reference Guide on Standard Prefabricated Building Components”. 

Figure 2.2: Different components of a prefabricated bathroom

Figure 2.3: Pre-assembled PBUs

Figure 2.4: Prefabricated finished walls separately lifted and assembled on site
2.3 SUBSTRATE

2.3.1 Floor

In general, the use of high quality dense concrete and addition of admixtures in concrete help to enhance the watertightness performance of the substrate. The waterproofing system in a typical wet area consists of the following:

- Concrete slab
- Waterproofing membrane
- Screed
- Tile finish / others

An adequate drop during concrete casting is required to ensure that the finished level of the wet area is sufficiently lower than the level of adjacent concrete slab to prevent migration of water into the dry area. If pipes are encased in screed, the drop required should take into account the minimum screed thickness of 20mm required at the lowest level, i.e., at the floor water outlet. For wet area adjoining to dry area, the membrane should extend 150mm from the wet area into the concrete slab in adjoining dry area (see Fig 2.6).

Alternatively, concrete kerbs (see Fig 2.7) may be used to prevent migration of moisture into dry areas. It is a good practice to cast the kerb monolithically with the concrete slab to prevent debonding of the kerb.
2.3.2 Wall

Joints at walls of wet areas, for example, brickwall to reinforced concrete columns should be minimized. Where joints are unavoidable, the designer should consider specifying reinforcement at these areas (refer to Fig 2.8).

In accordance to CP 82, kerbs should be constructed at the base of walls to act as barriers to lateral movement of water (refer to Fig 2.9). A height of 100mm for the kerbs should be sufficient for this purpose.

For wet areas with a high amount of water splash, the waterproofing membrane should turn up to a minimum height of 300mm. This will create a minimum tanking protection against migration of water to spaces adjacent or below the wet area. Note that at the upturn areas, the membrane should extend minimum 100mm horizontally from the wall-floor joint to create sufficient lapping with the subsequent membrane application (see Fig 2.9). Depending on the designer’s specifications, reinforcement such as fiberglass mat may be used at the wall-floor joint.

At bath and shower areas, ensure that the waterproofing membrane is applied to at least 1800mm height and 1500mm width of the wall (see Fig 2.10 and 2.11), or the entire width of the enclosure (see Fig 2.12). The wall or substrate immediately adjacent or behind a basin, sink or similar fixture must be applied with membrane to a height of not less than 300mm above the fixture if it is within 75mm of the wall (see Fig 2.11).
Figure 2.10: Typical waterproofing details at shower area
Figure 2.11a: Typical waterproofing details at long bath area

Figure 2.11b: Detailed cross-section at long bath area
At sunken bath area, the membrane should similarly be applied to a minimum height of 1800mm (see Fig 2.12).

![Diagram of typical waterproofing details at sunken bath]

**Figure 2.12: Typical waterproofing details at sunken bath**

### 2.4 PIPES AND PENETRATIONS

#### 2.4.1 Arrangement of pipes and penetrations

Designer should:

- minimise number of penetrations through the slab/ wall which affects the continuity of the waterproofing membrane and increases the probability of leakage.

- group common discharge stacks and provide a raised platform at this area or alternatively provide a shaft/ service space to house them.

- avoid chasings of walls and floors.

- connect drain pipes directly to waste pipes as shown in Fig 2.13.

- avoid concealing drain pipes in the screed of dry areas eg, bedroom and hall.

Pipes/ pipe sleeves should be cast with the floor slab rather than leaving an opening in the slab for the pipes. For instance, it is not good practice to leave an opening so that the pipe position can be adjusted to accommodate the tile layout. This is to avoid possible leakage due to improper grouting around the pipes.
Figure 2.13: Pipes and Penetrations

- Poor arrangement of pipes
- Avoid leaving opening for pipe
- Recommended arrangement of pipe connections below the slab
- Recommended arrangement of pipes at floor outlet (Plan view)
- Pipe sleeve cast with floor slab
2.4.2 Waterproofing Membrane around Pipes and Penetrations

Membrane should be dressed up at pipe penetrations to the finished floor level (see Fig. 2.14) and dressed down to at least 50mm into the floor outlet (see Fig. 2.15). The membrane should be applied 100mm horizontally around the pipe. This coating should overlap with the subsequent membrane applied to the entire wet area.

Figure 2.14: Typical waterproofing details at floor penetration

Figure 2.15: Typical waterproofing details at floor outlet
The cross section of pipes fully embedded in the screed is as shown in Fig 2.16.

![Diagram of pipes embedded in screed]

**Figure 2.16: Pipes embedded in screed**

### 2.5 SCREED

Screed should be laid to slope towards the floor outlet. The direction of the fall must be planned with pedestrian traffic flow in mind so that pedestrian traffic will move across rather than up and down the slope. The direction of slope should be indicated clearly in the drawing (see Fig 2.17). Tiles may then be laid onto the screed with an adhesive compatible to the waterproofing screed.

Note that it is not recommended to lay tiles directly bonded to the waterproofing membrane. As a protective measure against damaging the membrane during tiling, a layer of screed should be laid over the membrane after the curing of the membrane. Similarly, for waterproofing applications to wall upturns or shower areas, apply a layer of 20mm thick plaster to protect membrane before laying the tiles.

![Diagram of saucer slope for internal wet areas]

**Figure 2.17: Saucer slope for internal wet areas**