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WATERPROOFING
PART - 4
WATERPROOFING OF INTERNAL WET AREAS

Dr. Fixit Institute
of Structural Protection & Rehabilitation

A Not-for-Profit Knowledge Centre

From the Editor's Desk

In continuation to our efforts to create awareness on waterproofing, this issue of ReBuild is devoted to waterproofing of internal wet areas of the buildings. Some common problems faced by a homeowner are dampness, seepages, leakages and the resulting damages. Very often, there are immense difficulties in finding the source of leakages and seepages which leads to unsuccessful remedial measures, mental agonies and finally, financial losses. The bathroom water leakage is mostly a common difficulty in housing societies that causes disputes, between flat owners, for sharing the cost of remedial treatment. Even where the finance is not a constraint for high-end income groups, the mental agony is too much. There is hardly any building/ bungalow/tower/villa that does not face problems occurring due to leakages, seepages and dampness. The problem compounds in flats having false ceiling as mostly seen in buildings with interior decoration where the approach for diagnosis and investigation become difficult. Apart from seepages and leakages there are many other problems in the internal wet areas such as rising dampness, peeling of paint, efflorescence, spalling of the concrete and delamination of cover concrete of roof ceiling. In view of such a wide range of problems, this issue of our ReBuild focuses on the design approach of such internal wet areas and preventive measures to be taken during construction and installing waterproofing systems.

The most common problems are leakages at pipe joints and fixtures, wrong installment methods, inadequate slope in bath and toilet floor areas, corroded steel pipes embedded in the floor, failures in the plumbing system and lack of or improper waterproofing system being carried out in those wet areas. One has to avoid GI pipes in wet areas and use only PVC pipes to avoid corrosion and further leakages. Liquid applied waterproofing membrane is more suitable than preformed membrane because seamless waterproofing can be carried out in small areas whereas in case of preformed membrane, there would be many joints. While selecting a liquid applied waterproofing material, a cementitious system is most suitable because of its compatibility with concrete and good vapour permeability properties. The polyurethane is more flexible as it has very good adhesion and tearing strength properties. But solvent-based polyurethane is very sensitive to moisture hence it can only be applied to the dry surface. But the most important factor is surface preparation, unless the surface is being well-prepared, in which case whatever the best quality of the material may be, it will fail. During the remedial works, all the pipes and fittings need to be installed first. All the gaps and joints need to be filled with polymer-modified concrete or polymer-modified cementitious grouts. The waterproofing system should be laid from downward to upward slope seamlessly as per manufacturers' specification. One vulnerable location in wet areas for leakage is the joints of floor and wall, which should be provided with angular fillet around the periphery of the wall. An additional layer of waterproofing membrane should be provided always at such junctions along with glass fibre mesh sandwiched between two layers. The ponding test has to be carried out after the completion of each stage — such as in the first stage, check for cracks, voids, honeycombs in the concrete slab, in the second stage, check the effectiveness of the plumbing system after the laying and installation of all pipes and fittings, in the third stage, check the effectiveness of the waterproofing system before doing the screed and in the last stage, a final check after the screeding but before laying the tiles. The ponding test is carried out not only to check the effectiveness of the waterproofing system, but also to see if any remedial measures need to be taken during the installation of the system.

Remedial treatment for leakages in bathrooms and toilets results in higher costs many times more than the actual waterproofing would have taken. This is because of removal and dismantling of expensive finished items during the remedial works. Even success of any remedial treatment depends upon identifying the root cause of the problem or source of leakages. Treatment for dripping leakages can be made by injection of polyurethane foam from the negative side. Treatment of mild and moderate dampness on the underside of bath and toilet roof ceilings can be made with a cementitious crystalline coating from the negative side. Treatment from the negative side is done only when rectification from the positive side is not possible. While treating from the positive side, it is essential to remove all the floor finish materials including screed, waterproofing membrane right up to the mother slab. Any cracks or voids are to be rectified by polymeric crack-filling material or suitable injection grouts based on actual side condition. A proper surface will ensure the durability of waterproofing system. Any small gaps around the pipes or any fixtures can be sealed with a suitable sealant in any of the internal wet areas. Wherever the gaps are more, they can be rectified with fine cementitious grouts. All internal dampness needs to be rectified with epoxy-based damp-proof coating.

We hope this issue will bring out the importance of planning and shed light on the preventive measures to be taken during the installation of bathroom, toilets and their waterproofing system. We shall focus more on waterproofing on roof terraces of buildings in next issue of our ReBuild.

Designing and Waterproofing of Internal Wet Areas

[Excerpts from "Good Industry Practices - Waterproofing for Internal Wet area", Building and Construction Authority, Singapore, 2003 and Dr. Fixit Healthy Construction Booklet "Construct Your Ideas", 2012, pp.34]

1.0 Introduction

Bathrooms, kitchens, water closets etc. are the designated wet areas of a building. They are the main sources of leakage and dampness which lead to unhygienic conditions. This affects the health and comfort of its occupants and seriously deteriorates the building, reducing its stability.

Decisions made during the design stages have serious implications on the construction and future maintainability of wet areas. Wet areas that suffer from water leakages, ponding, staining and other defects are usually result of poor designs and specifications.

Water may penetrate wall and floor finishes in wet areas. Depending on the frequency, the intensity and the length of time these surfaces are exposed to water; unintercepted, the water may damage the moisture-sensitive materials lying beneath, and reach adjoining rooms and their finishes. Consequently, careful attention should be paid to the design and installation of all materials, components and systems to prevent damage by water.

2.0 Design Consideration & Precautions

2.1 Water Closet

In case of water closets, the source of water leakages is in the joints of water closets, between the flushing cistern and the flushing pipe, between the flooring tiles and in the faulty pipes which are used for down take and made of material susceptible to corrosion. Similarly, water leakages may happen at various other junctions such as the flushing pipe with the WC (Water Closet) pan, the WC and the foot rest with flooring, the WC and traps with the branch pipe and at the floor trap. The other reasons may be depressed reinforced concrete slabs to accommodate the pan and trap, incorrect placement of the overflow pipe, a cut out in the structure for the branch pipe and the Indian type WC fixed loosely. All these source of leakages are shown in Fig. 1.

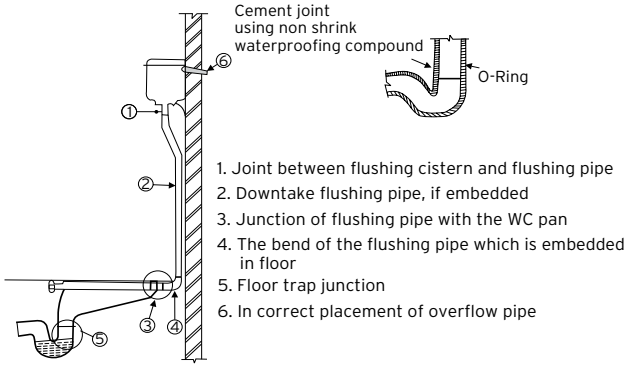


Fig. 1: Sources of leakages in WC & flushing cisterns

The recommendation for prevention of leakage is given as follows:

2.1.1 Flush Pipe

- It should be securely connected to the cistern outlet and made airtight by means of a coupling nut. The nuts made of moulded HDPE / PVC may be used only if the end pipe is also made of HDPE / PVC.
- It should not be made of iron, as it is likely to corrode.
- If, a GI pipe is used, the pipe should be completely protected by bitumen painting and taping where it is embedded in concrete.
- It should be properly fixed with rubber gasket or gold size quality putty at the entry hole of the WC pan.

2.1.2 Where Squatting Pan is Provided with Traps

- Firstly, temporary laying of pipe line and WC pan should be done by giving temporary pickings.
- The level should be checked and corrected taking into account the final finish level of the flooring.
- After the WC pan is fitted and jointed, cement concrete blocks should be put around this joint and then the depressed portion should be filled up.
- A suitable portion should be given to the depressed RCC floor which accommodates the pan and trap to lead the water to the rear portion of the WC pan.
- A corrosion resistant GI pipe of 25 mm dia should be provided to drain off any water accumulated in the depressed area as shown in Fig. 2.

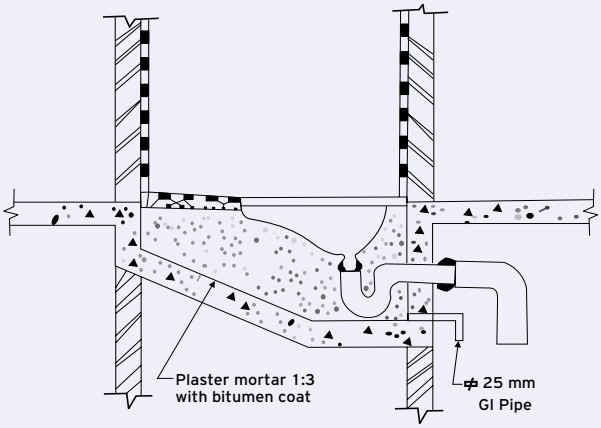


Fig. 2: Depressed slab and arrangement of joints in WC

- In addition to the draining of the depressed portion, the depressed area should be made waterproof.
- The finished floor should be sunken by 25 mm from the adjoining floor, and walls up to at least 300 mm should be made from an impervious material such as cement plaster, terrazzo in situ or tiles, glazed and ceramic tiles.
- Where a squatting pan is fixed with a rim either in line with tile flooring or below the flooring junction of flooring tiles, the rim is the main point of leakage. To avoid this, suitable nonshrink, bonding material should be used for fixing the last tile and the joint between the flooring and the rim of the WC.

2.1.3 Indian Type WC

- Where the bath and Indian type WC are accommodated in a single toilet connected to a septic tank, the slope of the floor in the bath area should be away from the WC to avoid drainage of soapy water.
- As far as possible, integral tread WC pan should be preferred to avoid seepage from the joints. Where separate footrest is used, the joints between tread and flooring should be made leakproof by using non-shrink waterproof mortar.
- The overflow pipe from cistern should be brought right up to floor level and provided with a right angle bend outlet over the floor.

2.1.4 European Type WC

- In the European type WC, the WC is fixed by screws using rubber washer to the floor. A rubber gasket should be used at the joint to avoid leakage. The junction between the pan pedestals with the flooring should be filled with cement mortar mixed with a non-shrink waterproofing compound.
- The joint between the pan and trap should be made leak-proof with cement mortar at 1:2 or at 1:3 with a non-shrink waterproofing compound. The detail of fixing WC is shown in Fig. 3.

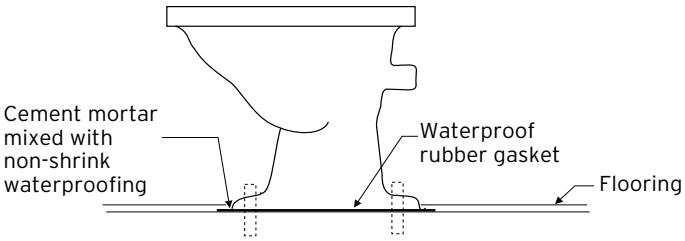


Fig. 3: European type WC

As far as possible, a joint-less floor should be laid. However, where flooring tiles have been used, these should be laid on a bed of waterproofing mortar, and care should be taken to fill the joints effectively.

The cut out hole made for the outlet pipe should effectively be sealed with waterproof cement mortar after the pipes are fixed.

2.2 Bathroom

The source of water leakages in a bathroom may be from the junctions of the water pipe and floor / wall, the floor and wall where the shower splashes water, the door frame and floor on account of eventual rotting of door frame, wash basin, concealed piping and fitting, improper slope, joints between flooring tiles, cut out in the structure for a branch pipe and floor trap junction. The recommendation for prevention of leakage is given as follows:

- The floor of the bath room should be constructed of material which does not readily absorb and the entire floor should be sunk by 25 mm from the adjoining floor.
- The surface of the wall and floor should be made of an impervious material.
- The floor should be sloped away from the door (entrance) towards the outlets, a minimum slope of 1 in 60 recommended.
- Bathroom floors and walls to a height of at least 1 m from the finished floor and in case of shower, 2 m from the finished floor should be made of impervious materials such as waterproof cement plaster, terrazzo in-situ tiles or glazed tiles.
- As far as possible jointless floor should be laid, however, where flooring tiles have been used these should lie on a bed of waterproof mortar and care should be taken to fill the joints effectively.

2.3 Kitchen

2.3.1 Sources of Leakage

- Type of sink and placement of draining board.
- Area surrounding the sink.
- Joints between the sink and draining pipe.
- Junction joint between kitchen platform and the wall.
- Improper ventilation leading to condensation.
- Floor traps.
- Floor level washing place.

2.3.2 Recommendation for Prevention of Leakage

- The draining board used with the sinks should be placed in such a way, that water which is being drained does not find the way towards the wall and it should overlap the side of the sink.
- The area surrounding the sink should be made waterproof by using impervious materials such as in-situ terrazzo flooring, mosaic tiles and glazed ceramic tiles.
- The joint between the sink and the draining pipe should be leakproof.
- The waste pipe from the sink must discharge effectively into the floor trap. Preferably a cleanout junction should be used to facilitate periodical rodding.
- Kitchen slabs made of stone or precast cement concrete slabs are normally fixed by being inserted into the wall. The insertion is done by making a chase, and the chase becomes a source of seepage. To avoid seepage, a skirting should be provided at the junction point.
- Proper ventilation should be provided in the kitchen to avoid condensation.
- A slope not less than 1 in 100 should be provided to the washing floor towards the drainage points with floor traps.

3.0 Design Considerations

3.1 Substrate – Floor

The structural slab should be of minimum of M25 grade of concrete admixed with a waterproofing compound. A slope of minimum 1:50 should be maintained. The waterproofing system in a typical wet area consists of the following and is shown in Fig. 4.

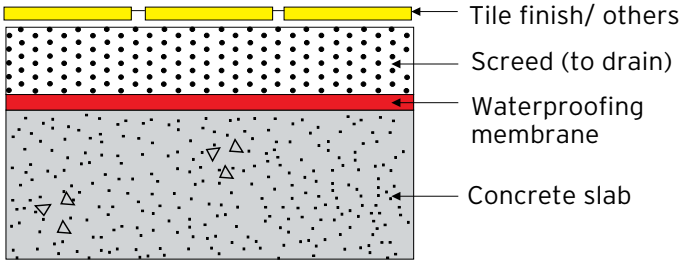


Fig. 4: Floor slab with waterproofing and membrane finishes

An adequate drop during concrete casting should be provided to ensure that the finished level of the wet area is sufficiently lower than the level of the adjacent concrete slab to prevent migration of water into the dry area (Fig. 5).

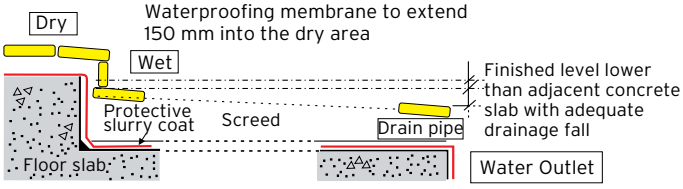


Fig. 5: Adequate drop in floor slab

If pipes are encased in screed, the drop required should take into account the minimum screed thickness of 20 mm required at the lowest level, i.e., at the floor water outlet.

For a wet area adjoining to a dry area, the membrane should extend minimum 150 mm from the wet area into the concrete slab in the adjoining dry area.

It is idea to provide concrete kerbs to prevent migration of moisture into dry areas (Fig. 6). It is also a good practice slab to prevent debonding of the kerb. Kerbs should be constructed at the base of walls to act as barriers against the lateral movement of water. A height of 100 mm for the kerbs should be sufficient for this purpose.

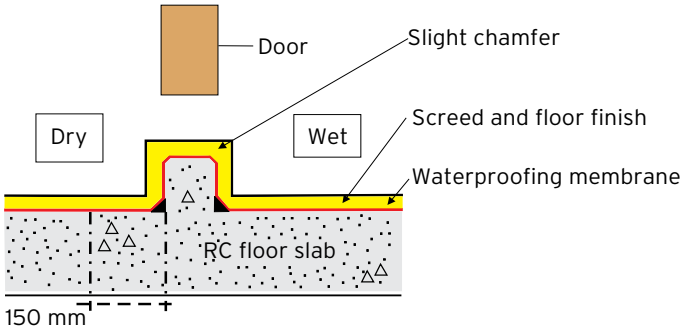


Fig. 6: Kerb between wet and dry area

3.2 Substrate – Wall

The joints at walls of wet areas, such as a brick wall to reinforced concrete columns, should be minimized. Where the joints are unavoidable, the designer should consider specifying reinforcement with polymer modified mortar (Fig. 7) at these areas. The designer should also consider rendering walls to a minimum height of 300 mm from floor level, for a smooth finish to receive the waterproofing membrane upturn.

Fig. 7: Reinforcement installed at brick – RC joint

Showers / bath areas and other parts of the wall that require membrane application should also be rendered to the height and width specified.

The designer may choose to add a waterproofing agent to improve its waterproofing performance.

For wet areas with a high amount of water splash, the waterproofing membrane should turn up to a minimum height of 300 mm. This will create a minimum tanking protection against the migration of water to spaces adjacent or below the wet area.

At the upturn areas, the membrane should extend minimum 100 mm horizontally from the wall floor joint to create sufficient lapping with the subsequent membrane application. The details of waterproofing upturn at a wall are shown in Fig. 8.

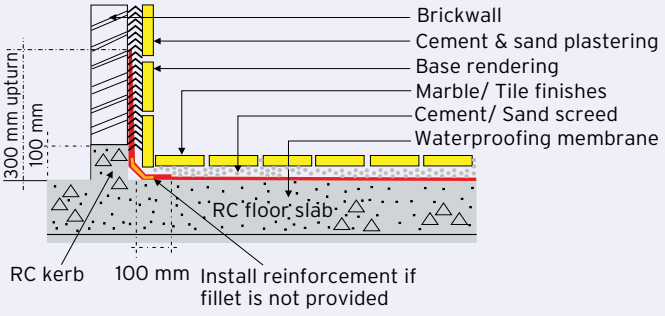


Fig. 8: Details on Waterproofing upturn at walls

At bath and shower areas, ensure that the waterproofing membrane is applied to at least 1800mm height and 1500 mm width of the enclosure (Fig. 9 & Fig. 10). The wall or substrate immediately adjacent or behind a basin, sink or similar fixture

must be applied with membrane to a height not less than 300 mm above the fixture if it is within 75 mm of the wall. At long bath areas, the cross section detail is shown in Fig. 11.

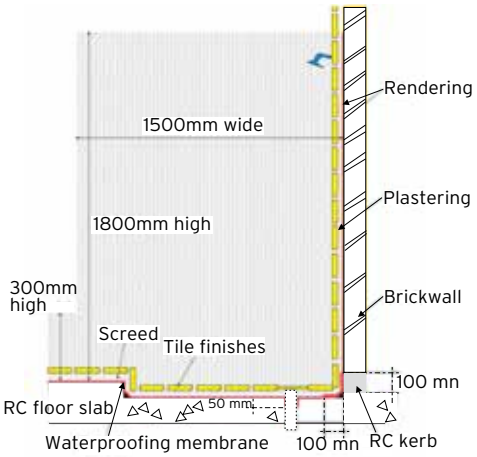


Fig. 9: Waterproofing details of shower area

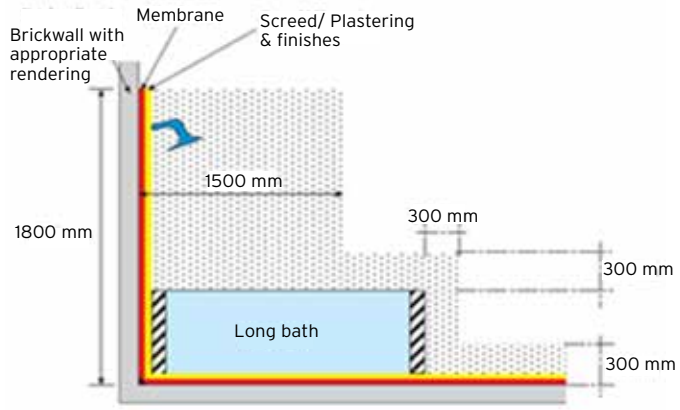


Fig. 10: Waterproofing details at long bath area

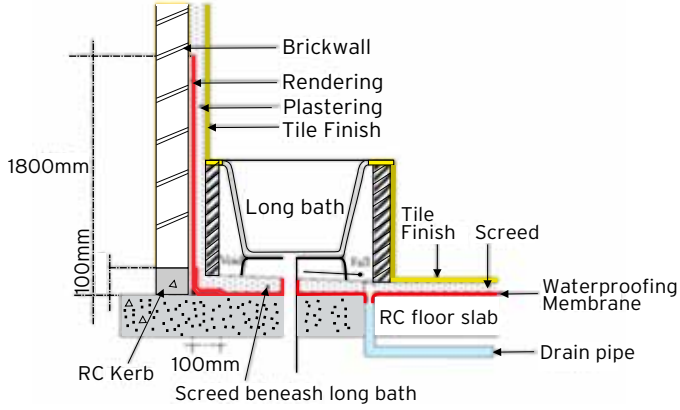


Fig. 11: Detailed cross section at long bath area

At sunken bath areas, the membrane should similarly be applied to a minimum height of 1800 mm (Fig. 12).

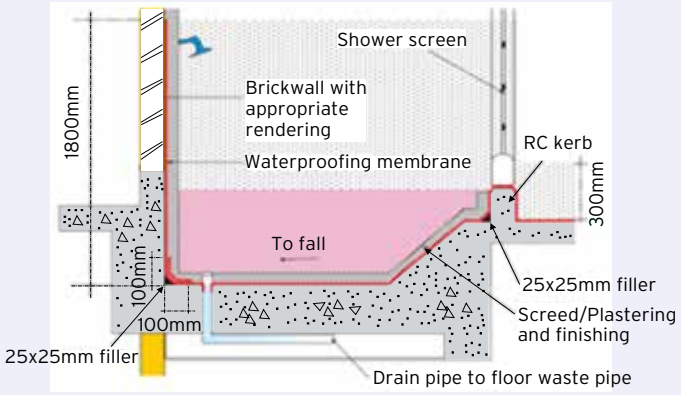


Fig. 12: Waterproofing details at sunken bath

3.3 Pipes and Penetrations

3.3.1 Arrangement of Pipes and Penetrations

Number of penetrations through the slab / wall should be minimised, since it will affect the continuity of the waterproofing membrane and increases the probability of a leakage.

Group common discharge stacks and provides a raised platform at this area, or alternatively provides a shaft / service space to house them.

Avoid chasing of walls and floors.

Connect drain pipes directly to waste pipes.

Avoid concealing drain pipes in the screed of dry areas e.g., bedroom and hall.

Pipes / pipe sleeves should be cast with the floor slab rather than leaving an opening in the slab for the pipes (Fig. 13).

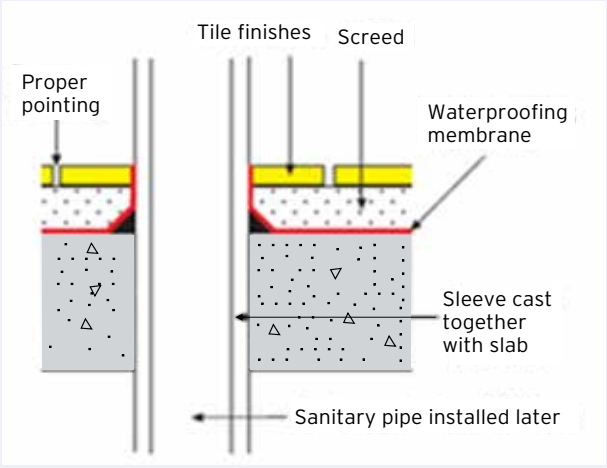


Fig. 13: Pipe sleeve cast with floor slab

3.3.2 Waterproofing Membrane around Pipes and Penetrations

Membranes should be dressed up at pipe penetrations to the finished floor level (Fig. 14) and dressed down to at least 50 mm into the floor outlet (Fig. 15).

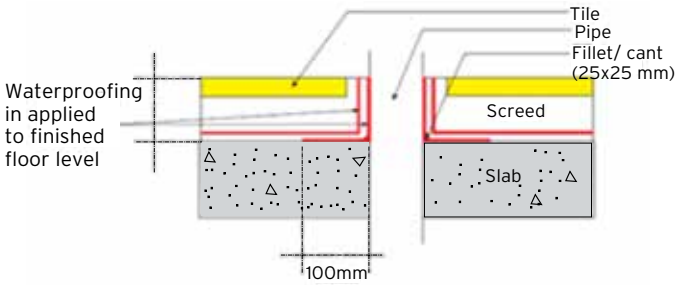


Fig. 14: Waterproofing details at floor penetration

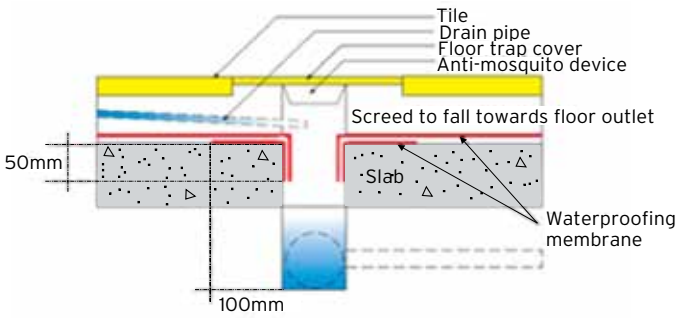


Fig. 15: Waterproofing details at floor outlet

The membrane should be applied 100 mm horizontally around the pipe. This coating should overlap with the subsequent membrane applied to the entire wet area. The cross section of pipes should be fully embedded in the screed (Fig. 16).

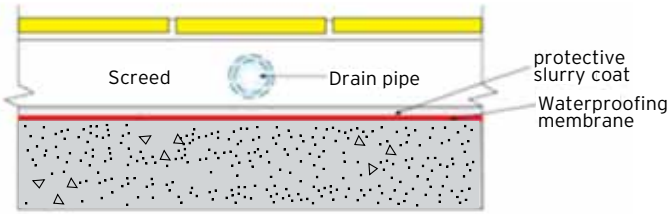


Fig. 16: Pipes embedded in screed

3.4 Ventilation and Air Circulation

Air circulation of wet areas should not only remove odour, but extract dampness and subsequently minimise defects such as the growth of mould on floors, ceilings and walls. Proper air circulation can be achieved by natural means, mechanical means or a combination of both. Exhaust fans and ventilation ducts should be located within 3m of the fan inlet or intake grill. The minimum required outdoor air supply is 10 air exchanges per hour (ACH). For areas that are entirely mechanically ventilated, minimum air exchange rate should be 15 ACH. Intake grills should be provided at low levels near WCs and urinals. This would enable foul-air to be extracted quickly.

The exhaust air should be discharged at least 2m away from the pavement level and at least 5m away from any window.

3.5 Plumbing

3.5.1 Layout

Plumbing and sanitary fittings require some forethought while planning for a leak free bathroom. But often on sites, the works are done in isolation, i.e. no co-ordination between the waterproofing contractors. This results in dampness and leakage, much after the owner has moved in. Since plumbing pipes are nowadays concealed, leakage in the joints shows up as dampness in walls. Hence, the plumbing layout is very important in wet area designs, as efficient plumbing layout ensures the reduction of many discontinuities which affect the homogeneity of the waterproofing membrane and thus minimises the possibilities of membrane failure in the structure.

3.5.2 Important considerations include

- Detailed drawings of the layout of service pipes that are to be cast with the floor slab should be provided. These detailed layouts should include details such as gradients of horizontal pipes, joints and connections.
- The number of wet wall and pipe penetrations through the wall and floor should be minimised so as to maintain high integrity of the structure. Single wet wall design with a common discharge stack can reduce the number of penetrations.
- Raised floors provided around the pipe could minimize contact between water and pipes and reduce the chances of water leakages through pipe penetrations or corrosion of the pipe (cast iron).

3.5.3 Accessibility

The accessibility for repair and replacement of service pipes is one of the major concerns that should be addressed during the design stage. Openable covers can be provided to facilitate access for maintenance. Walk-in pipe ducts can also be included for easy access. In addition, designers should take into consideration the positions of service pipes with regards to the accessibility of the entire floor or wall area for cleaning and maintenance. The pipes should not inhibit the ease of cleaning of floor and wall surfaces. Surface-mounted pipes are typical examples that could increase the difficulty of cleaning.

4.0 Waterproofing System

4.1 General Features

The waterproofing system for wet areas should be as follows:

- Be able to bridge over cold joints.
- Be compatible and easy to apply, especially at pipe penetration areas.
- Be elastic to bridge over different materials.
- Have good adhesion and cohesion strengths.

- Be able to receive screeding and plastering.
- To a certain extent, be resistant to some mechanical damage prior to screed finish.
- Be fully bonded to the substrates to isolate any leaks in the future.

4.2 Limitations of conventional practices of wet area waterproofing

- The PVC pipe inserts do not adhere well with the brickbat coba / cement / concrete used for filling the area and joints around the pipes.
- The polymer waterproof coating and brickbat coba have limited ability to withstand cracks.
- Insufficient attention to detail in the corners and joint areas of the bathroom.

4.3 Selection of Materials

Liquid applied systems are normally preferred over performed systems and integral systems for internal wet areas because of the following advantages:

- Continuity of the membrane between horizontal and vertical planes, around projections and penetrations, and it is self – flashing.
- Membrane adheres to every part of the substrate, which helps in isolating leaks and preventing lateral movement of water.
- Membrane is able to withstand minor cracks.

Apart from standard mechanical properties of flexible cementitious or other water based waterproofing membrane the resistance to water penetration as per DIN 1048, Part 5 should satisfy for no water penetration at 0.2 kgf/cm^2 for 6 hours. A comparison of different characteristics of liquid applied water proofing systems used in internal wet areas is given in Table 1 and images of such waterproofing application are given in Fig. 17-18.

Table 1: Suitable waterproofing system and their characteristic

Typical Characteristic	Rubber Based System	Acrylic Based Systems	Polyurethane System	Cementitious System
Main characteristics	Highly flexible with excellent resilience to cyclic extension and contraction.	Good UV resistance, flexible and good tearing strength (due to fibreglass reinforcement.)	Good flexibility, excellent adhesion to concrete and good tearing strength.	Easy application, excellent compatibility with concrete and good vapour permeability.
Dry film thickness	Generally between 0.8 to 1.5 mm recommended	Minimum 1.2 mm due to fibreglass reinforcement.	Between 1 to 1.5 mm	Between 2 to 3 mm
Application Method	Brush, roller or airless spray.	Application is normally by rollers, to work material into fibreglass reinforcement.	By brush, squeegee or broom. Vertical grade by brush or trowel.	Brush or spray followed by trowelling.
Method of curing & drying time	Air – drying. About 1 hour in exposed condition. 3-4 hours in enclosed areas. 72 hours before flood test.	Air drying. Within 1 hour, but requires minimum 4 to 5 coats due to reinforcement. Total system therefore requires longer drying time. 48 hours before flood test.	Normally moisture cured. Contains solvent therefore requires ventilation. Recommended 24 hours curing time. Most system recommended 72 hours before flood test. For coal tar based system 7 – 10 days is required.	Normally 1-2 hours. Requires curing similar to concrete. Flood test within 24 hours to assist in curing.
Adhesion to concrete substrate and bedding concrete	Generally good adhesion. May be improved by appropriate priming.	Good adhesion to concrete. Vertical application to exclude fibreglass reinforcement for better bonding.	Solvent based is sensitive to moisture. Adhesion may be affected if applied onto damp substrate.	Excellent bonding to concrete for both slabs and vertical walls. Not affected by surface dampness.

Fig. 17: Bituminous elastomeric coating in sunken floor of a bath room

Fig. 18: Polyurethane coating applied in a bathroom

5.0 Application Methodology

5.1 Surface Preparation

- All surfaces must be pressure washed or cleaned with compressed air and then allowed to dry. It should also be free of loose materials, oils, form release agents and other contaminants (Fig. 19).
- The gaps around the pipe inserts and the floor traps etc should not be wider than 50 mm.
- Make angle fillets all around the periphery of the wall with polymer modified mortar prepared with SBR Latex (Fig. 20) and lay a glass fibre mesh (Fig. 21) over the angle fillet all around the periphery while the coating is still wet.

Fig. 19: Surface preparation

Fig. 20: Providing angular fillet around the periphery of wall

Fig. 21: Laying of glass fibre mesh

5.2 Application

- The sanitary pipes entering through the walls and floor are to be sealed with leak-proof sealing tape for pipe wrapping and the gaps should to be grouted with a non shrink cementitious grout (Fig. 22). The 'Nahani' trap, etc., are to be fitted securely in the same manner and the gaps around it to be grouted.
- The 1st coat of Cementitious two components should be applied on the floor (Fig. 23) and extend up to 150 mm on walls and above the finished floor level (FFL) (Fig. 24). Extend the coating in the shower flash zone to 1500 mm wide x 1800 mm high.

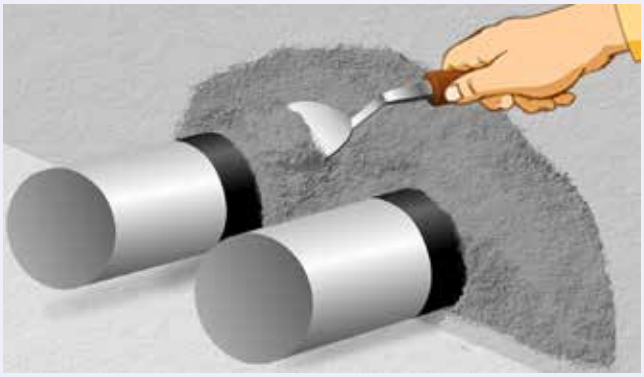


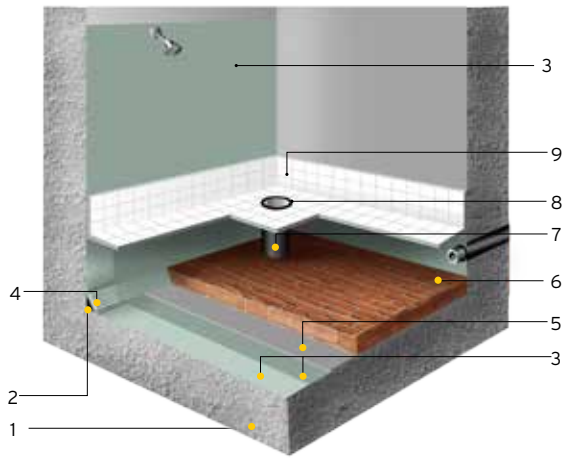
Fig. 22: Fixing the pipes with sealing tape and further doing the grouting

Fig. 23: Cementitious coating on floor

Fig. 24: Application of 1st coat cementitious coating on wall

- While this first coat of Cementitious two components is still wet cover all angle fillets with a 150 mm wide strip of open woven glass fibre mesh of 2 mm X 2 mm immediately over the coating and allow it to soak completely. Cover it with one additional coat of Cementitious two components over the angle fillets and allow it to dry completely.
- Apply a 2nd coat of Cementitious two components after the first coat dries completely. Sprinkle sand over the shower splash zone while the coating is still wet. Also cover the angle fillets during the second coat application.
- 24 to 72 hrs after, the sunken portion must be laid with a concrete screed of 50 mm thickness. Sanitary pipes and traps can be laid over this screed the next day.
- Brickbat coba using an Integral liquid waterproofing compound for plaster and concrete can be laid 24 hrs later to fix these pipes in position.

A typical water proofing detailing in an internal wet area is given in Fig. 25.



1. Concrete slab
2. Angle fillet
3. Two component polymer modified cementitious coatings
4. Glass fibre mesh
5. Concrete screed
6. Brickbat coba
7. Bathseal Tape
8. Cementitious Grout
9. Tiling adhesive & tile grout

Fig. 25: Typical water proofing detailing in internal wet area

6.0 Ponding Test

Before doing the waterproofing the watertightness of bare concrete slab needs to be ensured by the ponding test (Fig. 26). The dampness, leakages need to be detected and according remedial measures need to be taken. The honey combs may be treated by injecting micro fine cementitious or polyurethane grouts material. Any unsound concrete may be removed and repaired with polymer modified mortar. Further ponding should be carried out to ensure water tightness of the structure and proceed further for waterproofing of the substrate. To ensure that the waterproofing membrane is watertight, a water ponding test should be conducted before laying the protective screed. This is not only to ensure the water tightness, but also to check if any remedial measures should be taken for the waterproofing system. Before doing the ponding test it must be ensured that sufficient curing and drying of the waterproofing material has taken place as given in Table. 1. Then all the pipe outlets should be sealed and a temporary bund has to be made at the door sill so that the bath & WC floor is ponded with water for 25 mm depth for a period of minimum 48 hours (Fig. 27). Thereafter an observation has to be made underneath the floor of the applied waterproofing system for any dampness, leakages etc. If required, remedial measures should be taken as per the site condition. If no dampness or leakage is observed then a final protective screed over the waterproofing system should commence. The ponding test should be carried out at a sunken floor slab and all pipe joints should be checked for watertightness before commissioning of the system.

Fig. 26: Water ponding in bare concrete slab of bath room

Fig. 27: Water ponding test after waterproofing in bath room

7.0 Waterproofing Screed

Screed should be laid to slope towards the floor outlet. Performance of screed is important, especially for wet areas and depends on the mix proportions and method of mixing. If the control over such factors is poor, the screed will have shrinkage cracks which may become potential paths of water seepage. This will result in faster deterioration of the waterproofing membrane beneath it and as a result, the life span of the total waterproofing system in wet areas will be shortened. Screeding after waterproofing in bath rooms is shown in Fig. 28.

Fig. 28: Screeding after waterproofing

Design of screeds requires careful consideration of the fitting layout in wet areas to provide required falls and accommodate services for plumbing.

These include:

- Gradient of falls specified should be adequate to allow for efficient drainage of runoff. The directions of slopes should be clearly indicated in the drawings. The minimum gradient of the fall at shower areas or wash areas should be maintained at a minimum of 1:60 towards the floor trap.
- The thickness of screed may be determined by the size of the services that are installed within screed, as the overall depth of the screed is to be increased by the depth of the particular service accommodated.

It is not recommended to lay tiles directly bonded to the waterproofing membrane, as a protective measure against damaging the membrane after the curing of the membrane. Similarly, for waterproofing applications to wall upturns or shower areas, apply a layer of 20 mm thick plaster admixed with waterproof components to protect the membrane before laying the tiles. After installation and commissioning the waterproofing system a final ponding test should be carried on floor and shower water spray test for minimum 15 minutes on the surfaces of the wall to observe the dampness and seepages if any, on underneath of floor slab or other sides of the bath room walls.

8.0 Fixing the Tiles with Tile Adhesives and Tile Grouting

The normal practice followed for fixing glazed tiles in bathrooms, lavatories, kitchens, and other places is the use of stiff neat cement paste and joints with white cement. The cement paste applied at the back of tiles does not often flow towards the edges of the tiles and as such water enters at the edges. In a large number of cases it has been seen that paintings and plaster gets affected behind these glazed tiles, supposedly applied to prevent moisture movement from wet areas.

Cement paste is not the right material for fixing the glazed tiles. The polymer based, hydraulically setting, ready to use, waterproof tile adhesive should be used. They offer many advantages over the conventional method of tile fixing such as better bond and adhesion strengths, faster work and good waterproofing quality to the wall. No curing of the tile surface becomes necessary. If the wall and plastered surface is done to good plumb, a screeding of only 1-2 mm thickness of tile adhesive will be sufficient to fix the tiles. In such a case, the adoption of this material will also become economical.

After finalising the plumbing work in the bathroom floor & wall, tiling work should be done by using the tile adhesives (Fig. 29) & filling the joints with tile grouts (Fig. 30). The tiles should not be put on skinned (dried) adhesive paste. The tile adhesives should have uniform bedding and allowed to be cured for 24hrs without any foot traffic. After filling the tile joints with tile grouts the remaining grout from the surface should be wiped by a dampened cheese cloth or tile cleaner without being pulled from the joint. After finishing all works, the sanitary ware such as wash basin, bath tub, soap stand etc. can be fitted and the gaps around it should be filled with Acrylic Sealant (Fig. 31) to complete the bathroom waterproofing. A view of finished bath room is shown in Fig. 32.

Fig. 29: Fixing the tiles with tile adhesive

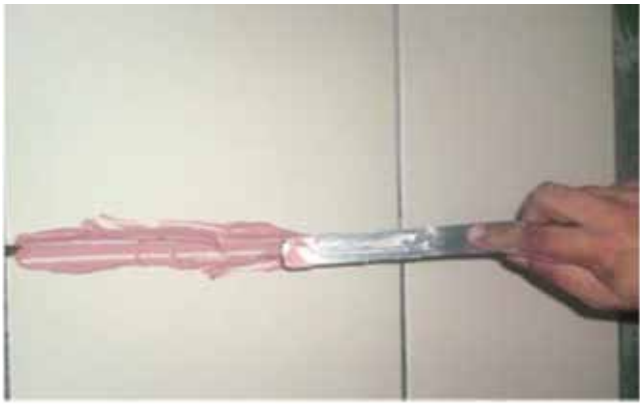


Fig. 30: Filling the joints with tile grouts

Fig. 31: Filling the gap with acrylic sealant

Fig. 32: View of finished internal wet area

9.0 Conclusion

The seepage and leakages in bath rooms and toilets are most common. The problem arises when proper attention is not provided during the planning stage. The pipe joints are most vulnerable for leakages. If waterproofing is designed and laid properly, then the durability of the system improves. But, we are still using old traditional practices of waterproofing, without any modern system in those areas. In terms of prices, the entire bath room waterproofing system is only a fraction of the total cost of a flat. However, we still follow the old traditional practices and face the seepage and leakages, thus creating a dispute between the occupants of upper and lower floor regarding sharing the cost for remedial measures or fixing the leakages.

Remedial Measures in Internal Wet Areas for a Leak-Free Situation

[Excerpts from "Rehabilitation and Repair of Structures", Vol.2, CE& CR, pp.7-8 and Dr. Fixit Healthy Construction Booklet "Construct Your Ideas", 2012, pp. 40-41]

1.0 Introduction

Internal wet areas of a building are those that are prone to be wet internally within structures. These include kitchens, toilets, bathrooms, wash areas, balconies, etc. Water penetration caused due to a lack of water-tightness in the concrete structure manifests in the form of unsightly patches on the walls (Fig. 1) and ceilings (Fig. 2). It can also be seen as the gradual peeling off of the expensive finishes and paints (Fig. 3). Capillary rise of water in the brickwork can bring up dissolved salts leading to 'efflorescence' (Fig.4). In due course, the moisture will lead to corrosion of the steel reinforcement, and the cracking and spalling of concrete. On the whole, the damages due to water penetration are seen in the form of rotting, staining and blistering (Fig. 5), moulding, odouring, swelling, shrinkage, warping, peeling off of paint or wallpaper, water dripping, fungus growth, defective concrete, plaster or tiles, rust staining, decomposition of adhesives, loosening of renderings and weakening of materials. Water could also accumulate ('ponding') if the surfaces are uneven and difficult to drain, like in the kitchen, bath, toilet, etc.

Fig. 1: Internal dampness in a wall causing agony to the inhabitants

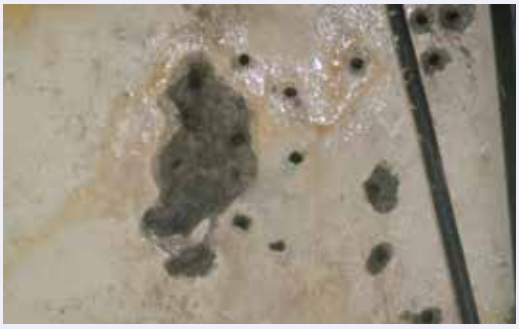


Fig. 2: Water dripping and accumulation on the surface of a roof slab

Fig. 3: Dampness around a wash basin causing the paint of the wall to peel

Fig. 4: Capillary rise of water causing efflorescence

Fig. 5: Stains and blistering of paint in kitchen

Out of the numerous effects of water leakages, some of the more serious ones are:

- Damage to the building's internal appearance
- Danger to human health.
- Loss of property – furniture, equipment, paintings, etc.
- Deterioration of materials, corrosion of reinforcement and decay of timber causing reduced life of structure.
- Ill effects on the building's electrical and technical systems, and overall safety.

2.0 Inspection and Diagnosis of Water Leakage

Though it is obvious that water migrates downwards owing to gravity, it gets difficult sometimes to identify the source or cause of water seepage. An extensive investigation may be necessary with the use of special detectors or some apparatus to track down the source of leakage. Colour dyes, collection samples for analysis, tests on the potential sources or the specific spots, etc, are the usual means adopted to identify the source. Various tests such as a moisture meter (Fig. 6), liquid leakage detector or thermal imaging, are often used for diagnosis of water leakages. The digital and thermal images of same location near the wash basin are taken for identifying the source of lekage (Fig. 7 & 8). However, most of the time, it is very difficult to locate the exact source of the water leakage. The various possible causes of water leakage need to be analysed and checked before performing the remedial measures.

Fig. 6: Measuring the moisture content using a moisture meter

Fig. 7: Digital image for comparison with thermal image for detection of water leakage

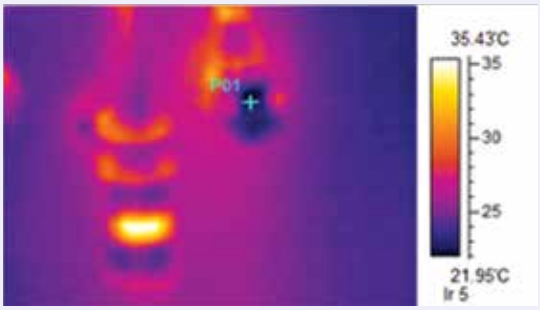


Fig. 8: Source of water leakage (+) being identified by thermal imaging

3.0 General Causes of Water Leakage

Bathrooms and toilets can leak due to the following reasons:

- Negligence during plumbing and sanitation
- Usage of conventional tiling methods that do not actually work as waterproofing
- Sealing of through joints with white cement
- Usage of through joints between ceramic sanitary units such as wash basins / bathtubs
- Compromise in the quality of construction
- Usage of concrete which has aged or has honeycombs and voids

Let us now look at some causes in detail.

3.1 Negligent During Plumbing and Sanitation

Plumbing lines must be checked by a plumber for leakage through joints / elbows / bends in the pipes. It may require breaking open the pipes to expose the exact point of leakage. Fix up the joints, elbows or nipples with effective caulking material. In case of hot water lines, it is also necessary to check their ability to withstand high temperature of the geysers.

If the pipeline is being put back into the walls and re-concealed, it is preferable to use a polymer modified mortar made with SBR Latex for waterproofing to seal it back. This will ensure water-tightness.

Nahani traps must be inspected for leakages. All the gaps around the pipes in the traps must be filled in with fine cementitious grouts.

3.2 Leakage through Conventionally Tiled Surfaces

Traditionally, tiling does not use waterproofing materials. It is done with grey or white cement, which will shrink and crack. The fixing material for tiling consists of a neat cement paste made with water, which is applied partially on the back of a tile. This practice does not give a 100% waterproof tiling solution. It is therefore important to compulsorily use a tile adhesive.

3.3 Through Joints Sealed with White Cement

Tile joints are still being grouted with white cement mixed with colour in order to match tiles. White cement shrinks making it possible for water to permeate to the gaps behind the tiles and the walls of the bathrooms. Rake out all the existing tile joints with a paste to ensure a water-tight grouting system.

3.4 Joints between Ceramic Sanitary Units

Joints between ceramic sanitary units like washbasins, bathtubs, etc. are traditionally grouted with white cement, which could crack and allow seepage of water. Besides, white cement also starts looking shabby since dust / bacteria can be easily spotted on white surfaces. Such joints can be raked out and re-filled with an acrylic-based sealant.

3.5 Downtake Pipes on the Exterior Wall

Downtake pipes often leak at the joints, allowing water to seep into the interior of the bathroom / toilet resulting in internal dampness. These points can be re-done with a polymerised cement-sand mortar to ensure no leakage. This joint will now be waterproof due to the use of the polymer.

3.6 Toilets Dripping with Water from the Roof Slab

If dripping from the roof slab is persistent, drill holes to fix injection packers and grout PU Foam Injection with a user-friendly pump. This injection will expand on contact with the water-bearing cracks and permanently seal the leakage. Over a period of time, the entire roof slab will become dry.

4.0 Remedial Waterproofing

The following steps are necessary for effective remedial waterproofing :

- Complete removal of unsound material like dust, oil, etc. from surfaces
- Undercutting to form smooth edges
- Providing good cavity form with rounded inside corners and uniform surface
- Repairing cracks, if present
- Treating of joints, if present
- Stopping or rerouting of water
- Application of the coating in accordance with the manufacturer's instructions.
- In case of walls, where plaster is badly damaged, re-plastering is required mainly to the extent of the damaged portion. The mortar used for re-plastering should contain an integral waterproofing admixture. On the finished plaster, a waterproofing coating should be applied.
- The shoulders of the joints must be thoroughly cleaned and then the seal must be rebuilt. Poor adhesion to the sub-surface of the facing sealant is the commonest cause of failure.

4.1 Bathrooms, Kitchens or Balcony Floors

4.1.1 Sources of Leakage

In bathrooms or kitchens, the source of the leakage must be identified before any repairs are considered. If it is the loosening of components in the drainage system such as bottle traps under the sink, basin or bathtub, some simple fixing can curb the leak. However, if defective water supply pipes are identified as the culprit, licensed plumbers should be engaged to replace the defective parts or overhaul the entire system. A common cause is defective sealant around the bathtubs, basins, sinks or defective waterproofing system at the floor. This problem can be easily dealt with the replacement of sealant. However, if the

floor is wet habitually, the waterproofing system of the floor is put to test. Should the cause be identified as water spilled on to the floor, it is always advisable to reconstruct the entire waterproofing layer instead of patch repair. But the bare concrete surface should be sound enough and without any cracks. Otherwise, the waterproofing may fail. In such cases, the cracks should be repaired with a polymer modified mortar. If the surface is having more voids and honeycombs inside, then it should be injected with cementitious grouts (Fig. 9) at certain intervals depending on the condition of the site.

Fig. 9: Fixing of nozzles for grouting injection in a bathroom

In balconies where ponding may be frequent due to heavy rain or blockage of drain outlets because of rubbish, the waterproofing system has to be sound so as to not create nuisance to the floor below.

4.1.2 Remedial Measures

Before reconstructing the waterproofing layer of a floor, all the sanitary fitments and finishes should be removed to allow the formation of a continuous waterproofing construction. Waterproof cement-sand screeding or other similar materials are commonly used. The screeding should be applied to have sufficient upturns at the base of the walls, and have an adequate fall to the floor drain to prevent water ponding. Sanitary fitments are to be installed on top of the waterproofing layer without penetrating it. The floor surface under the bathtub or shower tray should be formed with a fall to avoid trapping water at their bases if water leakage ever occurs.

After applying the floor finishes, the joints between tiles should be grouted properly with waterproof cement mortar. Junctions of wall finishes and bathtub or shower trays should be sealed with a suitable silicon sealant. Wall tiles should be fully bedded with tile adhesive and joints should be fully grouted with waterproofing cement. Gaps between marble tiles should be fixed with flexible waterproofing joint sealant to prevent long-term minor movements that give rise to cracks for water penetration. Should the source of leakage be identified from drains embedded in walls and floors, repair methods should be carried out as per standard procedure. An embedded drain should be changed to an exposed one to avoid any future difficulty in maintenance.

4.1.3 Treatment for Dampness underside of Bath & Toilet

Treatment for damp patches from underside of roof slab of bath and toilet areas can be done by cementitious crystalline coating applied on negative sides. Whenever these crystalline materials come in contact with water they traverse in reverse direction of flow of water and form the crystal which breaks the capillary and seals the crack. But this is not suitable when there will be dripping leakages.

4.1.4 Treatment for Dripping Leakages

Treatment for dripping leakages from underside of roof slab of bath and toilet areas should be done only when the treatment from positive side is not possible. A polyurethane foam material can be injected from negative side by drilling holes and installing the packers. The PU foam material expands when it comes in contact with the water and completely arrests the water leakage.

4.2 Treatment for Internal Damp walls

All the mild and moderate dampness such as damp spot, damp patches, black spot, green spot etc. in inside flat of bath room, toilet and other areas need to be applied with two coats of Epoxy based damp proof coating. For severe dampness such as peeling of paints, efflorescence, blistering, and white patches etc. the same need to be scrapped and cleaned thoroughly. A putty of Epoxy mixed with white cement to be applied over scrapped surfaces for leveling over which two coats of Epoxy based damp proof coating need to be applied.

5.0 Conclusion

The main causes of water leakage are the natural deterioration of materials by wear and tear over a period of time as well as poor workmanship and surface preparation. In bathrooms, the main reasons for water leakages are the degradation of pointing between tiles and wall / floor joints and deterioration of concrete infill / grouts around the pipes. Faulty pipes / sanitary fittings / fixtures may also lead to leakage. Since it requires dismantling the entire floor, finished materials and redo the pipe fitting, remedial waterproofing of internal wet areas turns out to be a costly affair. However, if proper planning and designing is done using latest waterproofing material, then such problems may not even arise. Compromising on waterproofing may save us some money initially, but could lead to ten times the amount being spent over remedial measures!

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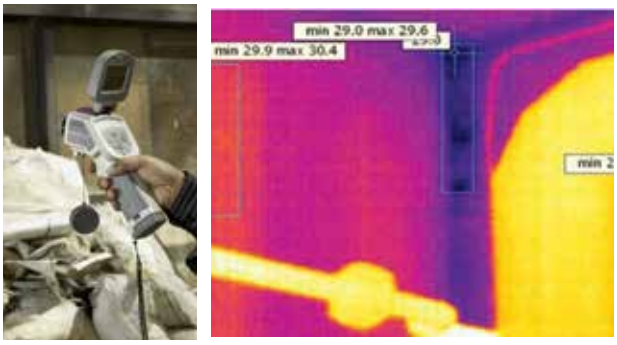

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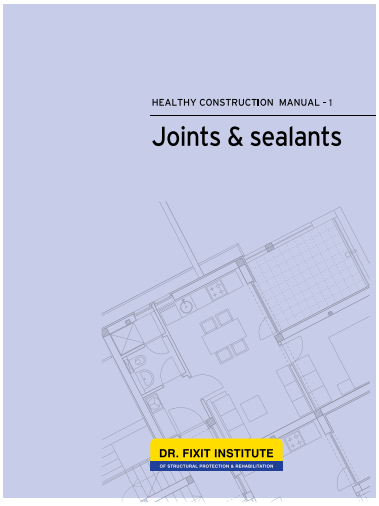

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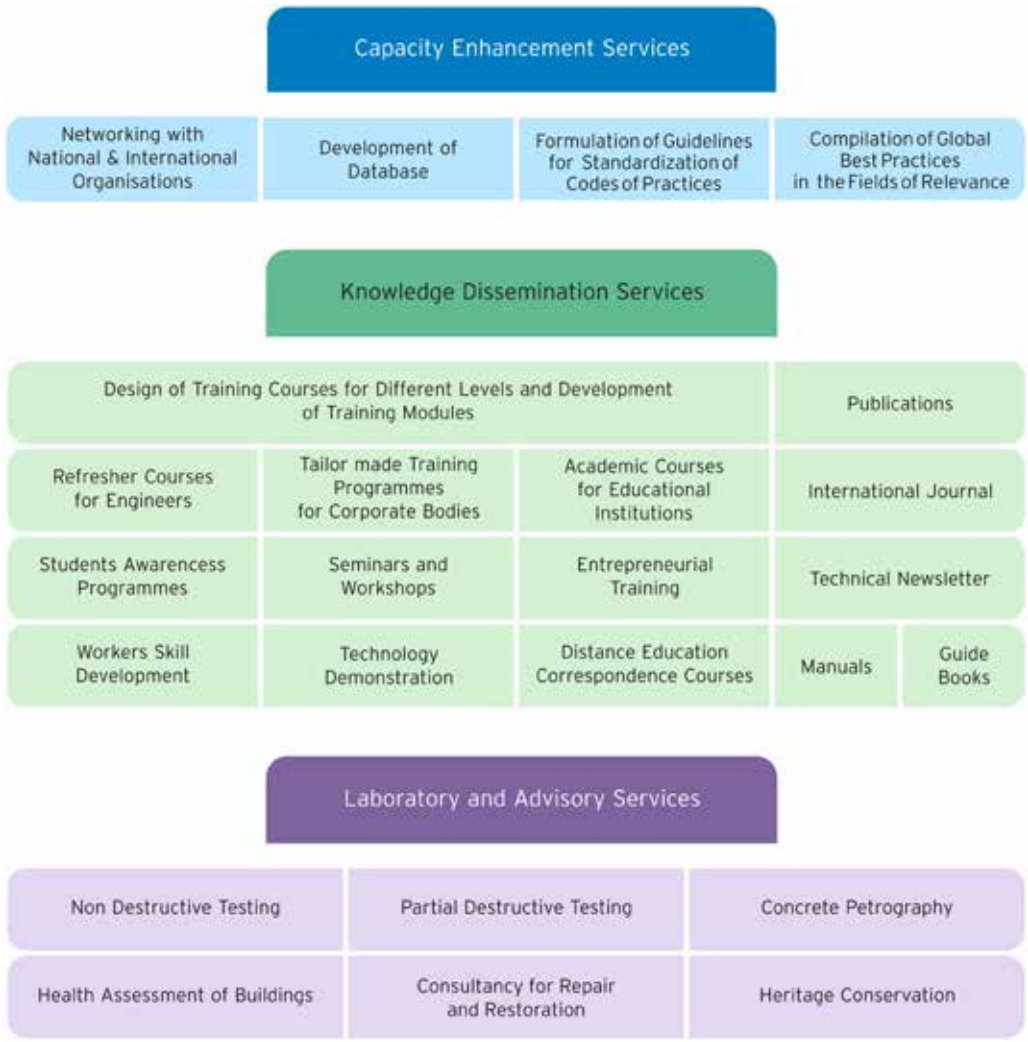

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