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# Non Destructive Waterproofing Remedial Treatment

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**ABSTRACT**

Excess dampness caused by water ingress is the most widespread and damaging cause of deterioration affecting building components. The effects of high levels of moisture on buildings can be devastating and usually demand total replacement of affected areas. However, the total replacement of waterproofing systems can be a destructive and tedious process. This paper presents a non-destructive method of waterproofing remedial treatment of Multiple Protection Injectable System (MPI) to treat water ingress defects such as interfloor seepages, basement water intrusion and external facades water infiltration. This MPI system has been applied successfully and refined for the past five years over a total of 250 water intrusion cases in Singapore. Three successful local case studies of each interfloor seepage, basement seepage and external façade water infiltration, resolved by MPI system would be demonstrated in this paper.

**KEYWORDS**

Non Destructive, Waterproofing remedial treatment, Mutiple Protection Injectable System.

## INTRODUCTION

All buildings start to deteriorate from the moment they are completed. This inevitable process can be regulated and hence, the life span or ultimate failure of the building or elements can either be avoided or accelerated according to the way in which it is maintained (Chew et.al., 2004b).

A failure can be considered a shortcoming in the function and performance of a building, and manifest itself within the structure, fabric, services or other facilities of affected building. Excess dampness caused by water ingress or leakage is the most widespread and damaging cause of deterioration affecting buildings (Watt, 1999). Wet areas in buildings are defined as areas where they are subjected to constant damp conditions with alternating dry and wet cycles (Chew et. al., 2004a). The effects of high levels of moisture can be devastating when it accelerate conditions for both chemical and biological degradation.

## EXISTING PRACTICES FOR WATERPROOFING REMEDIAL TREATMENT

In Singapore, where majority of the building stocks are of full or part masonary construction, key areas experiencing persistent water intrusion defects are interfloor seepages from bathrooms, basements and external wall seepages, with interfloor seepages being the most widespread.Though the percentage of areas occupied by the wet areas (bathrooms and toilets) are usually not more than 10 % of the building gross floor area, the annual maintenance cost for wet areas can range from 35% to 50% of the total maintenance cost of a building (Building Construction Authority, 2000). Typical interfloor seepages are as in Table 1.

Table1: Interfloor seepage defects

Common repairs and remedial to the above mentioned water intrusion defects are typically carried out by general contractors or waterproofing contractors. Two main methodologies frequently adopted by the local contractors are either total replacement wet area and/or polyurethane (PU) grouting at seepage areas.

Total replacement of wet area comprises of hacking out the existing wet area waterproofing and tiling system. Due to the size of wet areas, total replacement and reinstallation of waterproofing, tiling system and sanitary fixings is often considered the preferred method but the destructive nature and high cost often lead owners to low cost quick-fix alternative such as PU grouting. (Figs. 1 and 2).

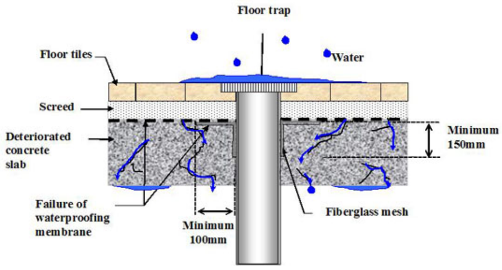


Figure 1: Typical deteriorated wet area

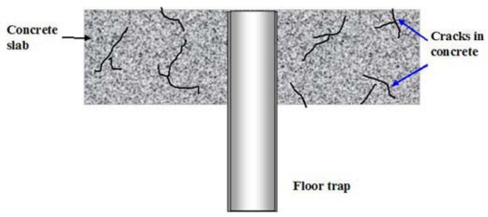


Figure 2: Removal of entire waterproofing and tiling system for wet area

The technique of PU grouting to stop water leakage has existed in the industry as early as 1960s (Woods, 1982; McBrayer and Wysocki, 1998). Typically in a situation of leaking bathroom where waterproofing membrane has failed and cracks are inherent in concrete, the main application of PU serves to inject chemical from the underside of the leakage points or cracks at a high pressure ranging from 800 - 1500 PSI (Fig. 3). As high viscocity PU comes into contact of water, the chemical will swell to form foam-like susbtance to "plug" the leakage points. Under such high pressure, PU grouting risks the propagation of existing cracks. In addition, in many cases, the cured PU can only plug water leakage at localised area, thus redirecting any persistent water intrusion to other weak areas without addressing the water source.

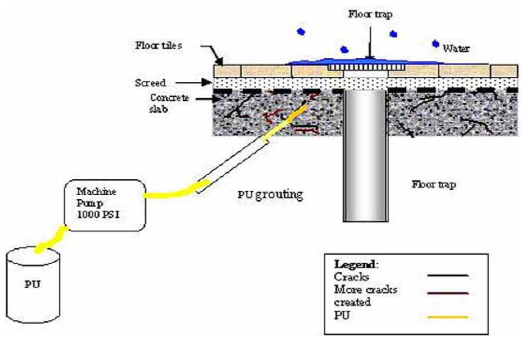


Figure 3: Application of PU to leakage area

As owners become better informed of water intrusion defects, they demand more efficiencies in remedial methods to resolve water intrusion defects in a hassle-free and less destructive manner. Total replacement of wet areas no longer appeal to owners being the need for total removal of existing finishes and fixings. Gradual recognition in the maintenance industry of the inefficiencies of PU grouting not able to provide a durable solution to water intrusion defects has also set in. These compel the owners to demand more innovation and attention in treating water intrusion cases.

This paper presents a non-destructive method of waterproofing remedial treatment of Multiple Protection Injectable System (MPI) to treat water intrusion defects such as interfloor seepages, basement and external façade water intrusion and its case studies.

## MULTIPLE PROTECTION INJECTABLE SYSTEM (MPI)

### The system

MPI is non-destructive as the actual waterproofing remedial treatment is carried out without large scale hacking, total removal of existing tiling system or sanitary fixings. MPI is a comprehensive multi-pronged approach, specially developed to suit our tropical climate, to target at eliminating the inefficiencies of the remedial practices of total replacement of wet areas and PU grouting. MPI system actively combines waterproofing chemicals and techniques synergistically to repair water intrusion areas at its source to achieve a watertight environment. For the past five years, MPI was mastered and refined, and have successfully rectified more than 250 complex water intrusion cases (Fig. 4). Arepresentation of the methodology of MPI is shown in figure 5.

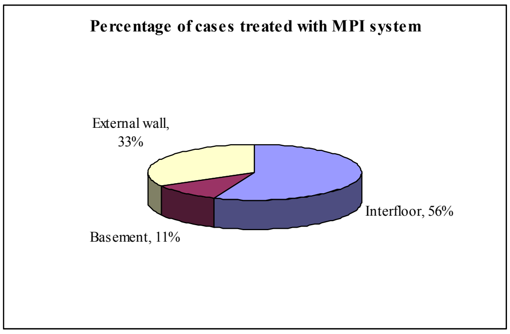


Figure 4: Percentage of cases treated with MPI system

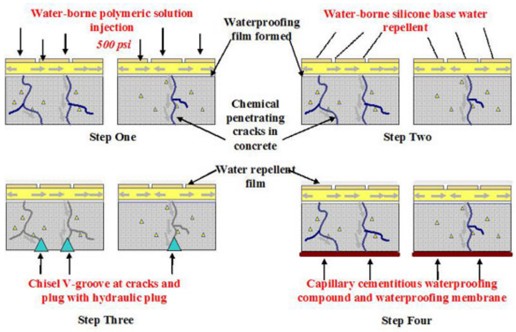


Figure 5: Multiple Protection Injectable System for Interfloor Seepage

Step 1: At the existing bathroom, a low viscosity polymeric solution is injected in between tiles joints. The chemical flows via low pressure of 150-500 PSI and by gravity downwards through the tile screed and the concrete. Upon curing, the chemical gels and seals up all the cracks in the screed and concrete, forming a watertight environment. A waterproofing film is also formed at the existing waterproofing membrane, thus "repairing" the existing membrane (Fig 5).

Step 2: A water repellent is sprayed onto the existing floor tiles to form protective waterproof layer over the entire floor area.

Step 3: From below, grooves are chiseled at visible cracks and plug with hydraulic cementitious compound to seal off the cracks where water and polymeric solution had leaked.

Step 4: To complete MPI system, capillary cementitious compound and flexible waterproofing membrane is applied to the underside to treat and waterproof the soffit.

**Flexibility of this system**

MPI was carried out to other areas where complex water intrusion cases also occur, such as basements and external walls. During a building's lifespan, basements and external walls are often exposed high risk of water intrusion. Water intrusion cases in basements demand more novel methods to treat as existing wall basements are subjected to constant water table and total replacement of external tanking is not practical and PU grouting can not effectively rectify such complex water intrusion.

Whereas for external facades, difficulties of access is the main bane to provide cost effective repairs to water penetration. However, with constant research and development and onsite experimentations on the feasibility of MPI on these two areas, MPI has proven to be successful not only in resolving interfloor seepages, but has the flexibility and capacity to resolve water intrusion for basements and external wall of all cases. Below are three typical case studies for complex interfloor seepage, basement and external wall water intrusion solved by MPI.

## CASE STUDIES

### Interfloor seepage

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|  |  |
| Plate 1: Interfloor seepage | Plate 2: Efflorescence formation on floor |

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|  |  |  |  |
| Plate 3: Injection of chemical to fill up porous screed and waterproof | Plate 4: Chisel groove to the underside of bathroom | Plate 5: Stand by to apply hydraulic plug to underside of bathroom | Plate 6: Application of cementitious waterproofing compoound to underside |

Plates 1 and 2 depict typical signs of interfloor seepage. Works are carrried out at existing affected areas with selective drilling locations, coupled with low pressure and gravity, the chemicals were able to penetrate into the cracks and voids without any hacking. Plates 3 to 6 illustrate actual onsite case study of the application of MPI to resolve interfloor seepage. Plates 3 and 5 show application of hydraulic plug to areas where the injected chemical on the top leak out from the underside of the concrete slab. This indicates that the injected chemical has filled up all cracks and void of concrete slab. To complete the system, cementitious waterproofing compound is applied to seal off any large visible cracks and set to cure.

**External wall water intrusion**

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| Plate 7: Water intrusion at 1st level external wall | Plate 8: Water intrusion at 2nd level external wall |

|  |  |  |  |
| --- | --- | --- | --- |
| Plate 9: Chisel groove to receive hydraulic plug | Plate 10: Injection of chemical into wall from internal | Plate 11: Injected chemical flow out from the internal | Plate 12: Application of water repellent |

Plate 7 and 8 shows water intrusion through external wall. Plate 9 shows application of hydraulic plug to grooves to seal off large cracks. Plate 10 and 11 depict the injected chemical to penetrate the voids in the external wall and upon curing, forms a gel-like susbtance to achieve watertightness of wall. Plate 12 shows the last step of MPI to provide a second line of defense to the completed system.

**Basement water intrusion**

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| Plate 13: Overview of water intrusion | Plate 14: Overview of water intrusion |

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| Plate 15: Scrape off defective paint | Plate 16: Injection of chemical into basement wall | Plate 17: Application of capillary chemical to wall | Plate 18: Completion of remedial waterproofing |

Consequences of complex water intrusion are shown in Plates 13 and 14. Plate 16 shows how the injected chemical penetrated the substrate and travel distance before flowing out at the weak point, thus sealing off all voids as it migrates. Application of capillary cementious compound to the entire substrate is illustrated in Plate 17. Plate 18 shows completion of waterproofing works. Comparatively, Plates 13 and 18 demonstrate the before and after of a complex basement water intrusion case.

## CONCLUSION

This paper illustrates the methodology of a developed non-destructive waterproofing remedial treatment of MPI, tried and tested on over 250 complex water intrusion cases in Singapore. Three typical case studies were presented to show how the MPI system was adopted at interfloor, basement and external wall seepages. With synergistic combination of material chemicals and technology, the MPI system has achieved flexible application while not comprising on its effectiveness and efficiencies to arrest water intrusion. Its application has eliminated the inefficiencies of the destructive nature of total replacment of wet areas and recurring issues contributed by PU grouting and has also proven itself as a more viable alternative to today's water intrusion defects.

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