POLYURETHANE INJECTION AS WATERPROOFING SOLUTION

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INTRODUCTION

Water leakage is a serious problem in every building as it causes the building to become more brittle. Stress develops internally when the water seeps through it, into the interior of the building, thereby reducing the concrete material strength and causes cracking and spalling of concrete. In the worst scenario, the reinforcement bar of concrete will rust as a high presence of moisture and the building structure will eventually collapse. Water leakage can cause certain hygiene problems, such as allergy, irritation of the skin and respiratory system. This is because the fungus growth with moisture present and its spores are a source of allergens and irritants.

Defects associated with moisture are normal due to defective waterproofing of the house. A well-designed building should avoid water leakage by installing a proper waterproofing system. Figure 1 shows the building elements required for waterproofing [1]. Failure in waterproofing is generally related to the construction design and choice of materials, cracks created, poor workmanship during installation, and water trap in the joints.

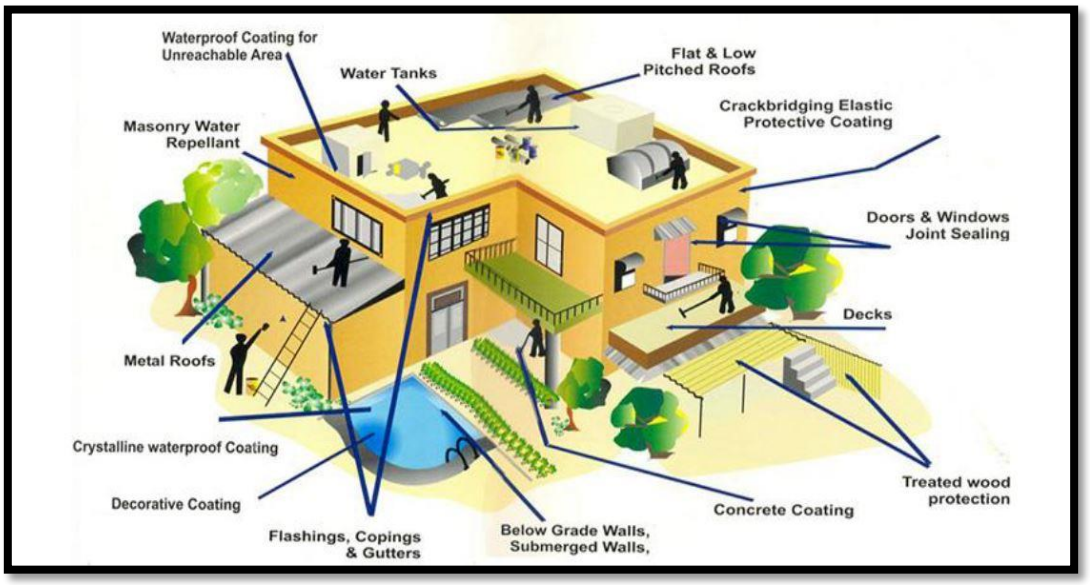

Figure 1: Building Elements Required For Waterproofing [1]

Polyurethane (PU) resin is a long-chain polymer formed by polymerisation of isocyanate (-NCO) and polyol (-OH) groups, and it can be either elastic gel or become rigid when reacts with water [2]. Figure 2 illustrates the formation of PU in the chemical formula. PU is good insulation material due to its wide range of chemical and physical properties. It has high expansion characteristic and short reacting period, thus it is an appropriate material for repair water leakage, repair concrete cracks, raising depressed concrete slab or road pavement, resolve settlement problems, etc. PU grouting or injection is a waterproofing solution that uses polyurethane injection expansion to prevent water from running through or splitting in concrete.

$$\begin{aligned} \text{R–NCO} \quad &+ \quad \text{HO–R}' \quad = \text{R–NH–CO–O–R}' \\ (\text{isocyanate}) \quad &+ \quad (\text{polyol}) \quad = (\text{polyurethane}) \end{aligned}$$

Figure 2: Chemical Formula For The Formation Of PU [2]

BENEFITS OF USING PU INJECTION

The benefits of using PU injection are listed below [3]:

a) **High abrasion resistance:** It is a solid adhesive that protects the concrete from building movement. The high volume of cross-link (Figure 3) available in its material matrix makes it rigid, strong, and able to withstand abrasion [2].

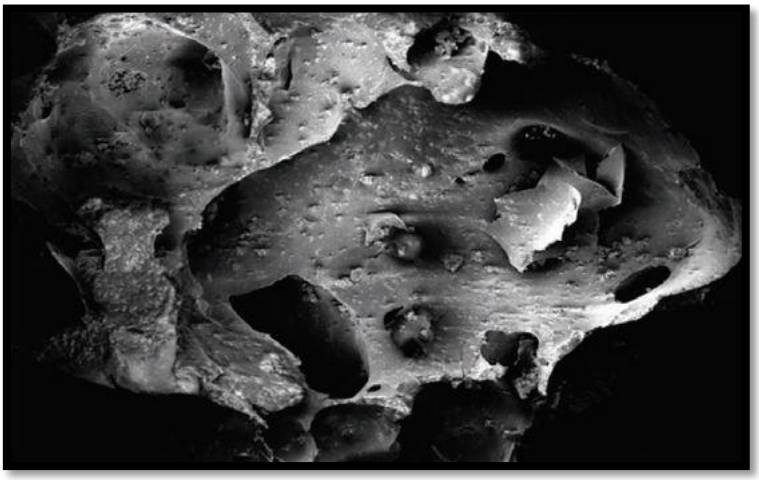

Figure 3: PU Cross-link Observed Under Electron Microscope

b) **Wide molecular structural variability:** PU is a flexible resin that can also be used for paint, maintenance, emergency, and insulation purposes. It also exhibits rigid and expandable when reacting with water and can be used to repair building cracks, raising the depressed structure, solve settlement, and repair water leakage.

c) **Rapid repairing and curing time:** It's fast-drying and can close tiny cracks and voids on the concrete.

d) **Comparatively low cost:** PU injection comes with relatively low repairing cost and this approach needs lesser maintenance.

PU INJECTION

The methods and procedures for PU injection are listed as following [3] [4]:

1) Clean the area and decide the location and spacing for PU injection holes (20 – 40 cm).
2) Drilling the holes for PU resin injection. The holes should be 45 degrees or less, the depth of drilling should be 2/3 of the thickness of the structure.
3) Insert packers (nozzle for PU injection).
4) Inject clean water into packers by using a high-pressure pump at 6MPa to clean the dust in the cracks.
5) Sealed the visible cracks with cement-based waterproof material to avoid PU grout leak out from the cracks available.
6) Inject PU by using high-pressure injection grouting machine. Injection stats at bottom packer and one hole at a time.
7) Remove the packers when there is no more leakage.
8) Patch up the holes with cement-based waterproof materials.

Figure 4 shown the PU injection to repair the water tank crack [4]. which constructed 3 water tank models to investigate the effectiveness of PU injection waterproofing repair. The case study has proven that the water tank repaired by PU injection can significantly reduce water pressure losses compared to the other 2 models (without waterproofing and with flexible water-stops layer as waterproofing system) (Figure 5).

Figure 4: PU Injection To Repair Water Tank Crack [4]

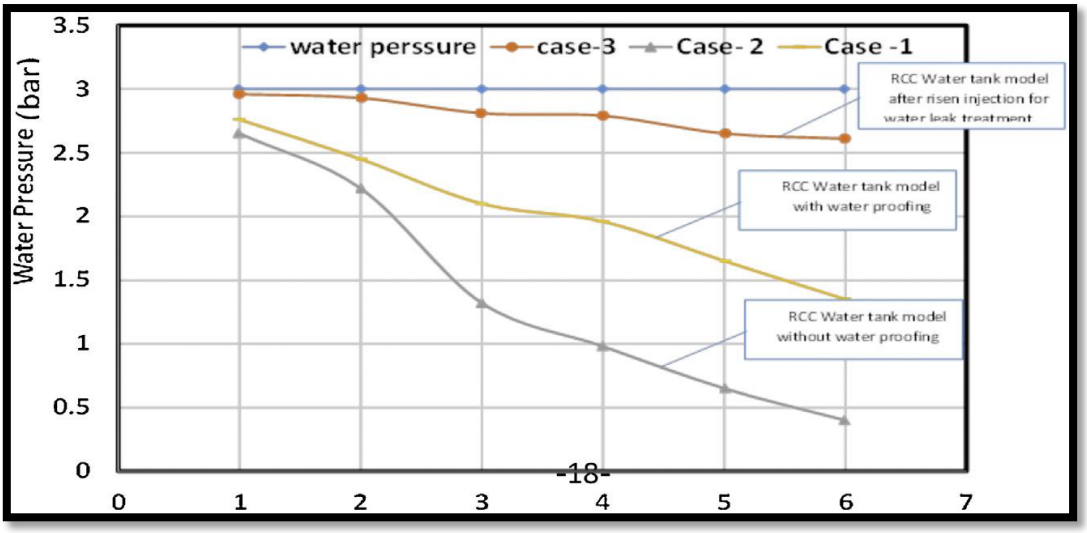

Figure 5: Water Pressure For Each Water Tank Model [4]

CONCLUSION

Polyurethane resin injection is a good approach to waterproofing repair due to its advantages such as low cost, quick-drying, solid, and high abrasive properties. However, the root cause of waterproofing system failure should be identified to select the best repair methods that fit the financial, material, and safety aspects.

References:

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