

## Building Waterproofing an Important Aspect

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Concrete is one of the major and most economical building products for its long life span and versatility. But concrete, more precisely, cement-concrete is porous in nature. The long life or durability of concrete is greatly dependent on water permeability and ingress of chemicals. In most of the cases, water acts as carriers for harmful chemicals like salts of chlorides, sulphates, alkalis, acids, etc. and these may corrode concrete and/or reinforced steel. Water may also come out from the concrete/plaster and evaporates from the surface leaving salts and alkalis, which react with paint, and/or making patches. Therefore, waterproofing of concrete is an integral part for construction of a building.

Sometimes it is claimed by some that concrete admixtures are not necessary and are certainly no substitute for sound concrete mix design. But others argue that the addition of admixtures often offset errors at the practical stages of making concrete, so increasing the

chance of producing concrete up to the specification. These statements have some justification for that group of admixtures known as integral waterproofers. However, waterproofing of concrete or cementitious substrates does not mean cent percent protection from water, rather some portion of water in liquid or vapour form is beneficial to continue hydration reaction of cement.

Theoretically, 22-25% (by weight of cement) water is needed to complete the hydration reaction of cement. But in normal conditions, concrete is prepared with extra amount (as much as 45-60% by weight of cement) of water to get desired workability. Any extra mixing water over the minimum requirement of hydration reaction is evaporated from the concrete mass leading to an increase of voids or creating more capillary pores. This is a common factor in all concretes allowing the passage of water and/or water vapour is the presence of inter-connected capillary pores without such voids and their inter

connections water or vapour transfer can not take place.

Let us consider for a moment how voidage in concrete can be altered.

1. The gel pores that are formed due to hydration reaction of cement. These pores are very minute and have diameter of approx. 2 nano-meters and independent of water-cement ratio.
2. Capillary pores (0.05 to 1 micron diameter) that result from excess water being present and therefore depend upon water-cement ratio.
3. Entrapped voidage reflecting the concrete mixing, laying and finishing method.

Since the diameter of gel pores (approx. 2 nano-meters) are so small that water cannot go through it.

Categories 2 and 3 are relevant to problems of concrete waterproofing.

In category 2, capillary pores (approx. diameter 0.05-1.0 micron) are larger in diameter as compared to gel pores and water can travel

through it. Controlling the w/c ratio using water-reducing admixture can reduce these capillary pores. During the hydration of cement some of the capillary pathways become progressively blocked by reaction products of calcium silicate hydrates gel. This gel has a very low hydraulic permeability, if water-cement ratio is low enough (less than 0.4), the volume of gel will be sufficient to completely block the inter connecting capillary within the cement paste. But in case of water-cement ratio is more than 0.40 the capillary pores generated in OPC, there will not be sufficient gel to block the capillary pores so resulting in inter connections. Curing of concrete is also an important factor to continue cement hydration reaction resulting reduction of capillary pores.

In category 3, entrapped voids are created due to following reasons:

1. Poor mix design.
2. Faulty aggregates gradation.
3. Inadequate compaction.
4. Excessive bleeding and segregation.
5. Very high or very low workability than the requirement.
6. Poor workmanship.

Sometimes cracks are developed in the plaster or concrete and water may travel through those cracks. There are so many factors for development of cracks through which water can travel and damage the embedded reinforced steel and/or paints.

Therefore, waterproofing or damp proofing is an essential and integral part of building construction and by doing so one can get following benefits:

- 1 Life span of the building will be increased remarkably.
- 2 Frequent repair or maintenance of building shall be eliminated completely or reduced to a greater extent.
- 3 Life of paint in interior or exterior shall be extended remarkably.
- 4 Aesthetic look of the building shall remain for much longer duration.
- 5 Minimises health hazards.

If we consider the cost of effective waterproofing, it is only 0.5 to 2% of the total cost of building, which is really negligible!

Waterproofing or damp proofing of concrete or masonry is carried out in two stages. One is during construction and another is post construction.

Most effective and economical waterproofing or damp proofing treatment is carried out during construction of a building whereas post construction treatment is very expensive, more time consuming and to some extent less effective.

### Materials

There are so many waterproofing materials available in the market one may confuse to choose the right material for the right propose. However, for simplicity, we can categorise these materials as per their time of usage. Firstly, some materials are used for waterproofing treatment as a preventive measures and secondly some materials are used when seepage, leakage or dampness are found. Since the space is limited, we will discuss those products, which are used at the time of construction for waterproofing purpose to protect the building.

### Integral Cement Waterproofers

These products are incorporated in concrete or plaster during mixing with water for lowering water permeability. In normal condition, it may provide 25 to 90% water tightness of the structures.

There are several types of integral cement waterproofers available in the market. But most common varieties are:

**Water reducing admixtures-** It reduces the w/c ratio without altering the workability of a particular concrete mix resulting less permeable, denser concrete/masonry structures.

**Very fine particulate materials-** Very fine particulate materials are of real benefit if the concrete mix is

low in cement and in deficient in fines. However, in concrete rich mixes the effect could be the reserve since the addition of fine particles could increase the water requirement leading to a less dense and lower strength concrete. These fine particles block the capillary pores during hardening of cement mass.

**Hydrophobic/ water repellent agents-** Materials in this group reduce the passage of water through dry concrete, which would normally occur as a result of capillary action and not as a result of an external pressure of water. In principle it is thought that all these materials impart a water repellent property to the concrete surface as well as lining and, in some cases, blocking the pores.

Air-entraining agents (AEA) - Air-entraining agents act in a similar manner to water reducing agents by imparting improved workability to the mix and thus allowing less water to be used. The micro air bubbles entrained into the cement mass shall block the capillary pores. But care shall be taken to minimise the use of over dose. Over dosing of AEA shall lead considerable amount of strength loss of concrete.

### Selections and Applications

In view of the large number of possible applications and the variety of waterproofing admixtures available, the choice of a particular waterproofer to perform a given task requires careful consideration.

Many concrete structures are built for water storage or maintain dry conditions within the structure when it is subject to water conditions on the outside. Since concrete is not always completely impermeable to water in spite of the use of integral waterproof compounds and concrete may develops cracks after placement, it is sometimes necessary to use a barrier material to cover the concrete surface to resist water penetration under hydrostatic

pressure and/or capillary rise. There are various types of barrier materials available in the market but most common and popular products are cited below:

### Coal-Tar / Bitumen Based Coating

This is one of the oldest and cheapest methods for waterproofing of concrete structures. Unmodified hot melt coal tar or pitch is used as waterproofing coating. But hessian cloth impregnated with hot melt tar (popularly known as Tar felt) was massively used to protect concrete from water. This type of waterproofing is not lasted for longer time. There are many drawbacks of unmodified coal tar waterproofing system. One of most important drawback is the coating gradually become brittle and erodes if it is exposed to environmental conditions. Some times coal tar is blended with one or more polymers to modify its performance.

### Stone Waterproofing

Natural stone (known as KOTA STONE in Delhi) slab is used for waterproofing of basement of a building. Though, this type of stone is cheap and good water-resistant, there are many joints between stone slabs from where water may percolate to the main concrete. Another major disadvantage is very difficult to rectify the post construction defects.

### Membranes

Now a days factory made polymer modified bituminous membrane (APP) sandwiched with synthetic fibre cloth, polymer modified PVC membrane, neoprene rubber membrane, etc. are available in the market for barrier waterproofing. These felts are elastomeric and very good water resistant and long lasting. These felts are available in roll form with different thickness (1.5mm to 5 mm) and may be fully bonded to the substrate or laid loose according to the manufacturer's instructions. The

main drawback is very poor vapour breathability. Therefore, one should ensure that the structure should be free from moisture as much as possible inside the structure before laying the membrane.

### Chemical Impregnations

There are some polymers with very low viscosity used to waterproof of the concrete structures. Most common chemicals are silicone compounds, which are water repellent in nature. Some silicone compounds are water soluble, highly alkaline and very cheap. Basically, these are sodium or potassium silicate salts solutions. This type of material may generate white patches on the substrate surfaces without hampering the water repellent property. Another version is solvent based silicone compound which is purely organic in nature will not give such type of white patches.

Sometimes, outer surfaces of buildings are kept unpainted or decorated with stones, bricks or brick tiles etc. Most of these materials are porous, therefore, rainwater will be absorbed and that water may travel to the interior surfaces and create dampness and destroy the paint film. Water is retained for longer time within the porous substrate. This facilitates algae/fungi/mildew growth on the surface of exposed wall and aesthetic beauty will be lost within a year. Growth of algae can be prohibited if the surface is kept dry by providing a water repellent coat of silicone, which will not change the surface texture in an economical means.

### Non-Shrink Grouts And Grouting Admixtures

In this category, ready - mixed cement grout is used to consolidate honeycombed concrete. This type of materials are mixed with water and injected through a nozzle into

the defective concrete. Before hardening this admixed cement slurry will expand and fill the voids. But most of the cases non-shrink grouting admixtures are available which are to be mixed with cement at the time of mixing with water. This slurry is also injected as above for the same purpose.

### Cementitious Polymer Coating

These products are available in three varieties. First and most common variety is a single component polymer emulsion, which is to be mixed with cement at site to a brushable consistency. Second variety is a two-component system, one pack is in liquid form and other pack is in cement based powder form. When these two components are mixed together a slurry mix is obtained. Third variety is single component cement based products blended with various types of chemicals and fillers. This type of material shall be mixed with water to a brushable consistency. All these slurry are mainly applied by brush on the substrate surface at the positive side of the water pressure. These products are very good water resistant and flexible in nature which will not crack due to thermal movement of the structure.

Polymeric cement based waterproofing system has special advantages over all other system considering their versatile properties, low maintenance cost, ease of applications, moisture vapour breathability, UV rays resistance, economy and many more.

### Polyurethane (PU) Coating

In recent time, various types of polyurethane coating systems are available in the market for waterproofing purposes. One is solvent free or solvent based two packs, chemically cured system and another is tar modified single pack, moisture cures system. The major advantages of PU systems are better adhesion, elasticity, seamless application and resistance to various harmful

chemicals. Recently, polyurethane dispersions (PUD) in water are developed for waterproofing which is eco-friendly, but their costs are comparatively high. Occasionally, cast-in-situ polyurethane foam (PUF) is used for roof waterproofing as well as thermal insulation. This system is used for special purposes. Most of the polyurethane coatings are not UV (ultra-violet) rays resistant.

## Execution of Waterproofing

Frequently complaints are raised about the failure of waterproofing and blamed the quality of waterproofing materials. If we look into this matter wisely, in major cases, it is seen that waterproofing materials pass all the quality requirements. Most of the failures are due to faulty specification, human error, and poor workmanship.

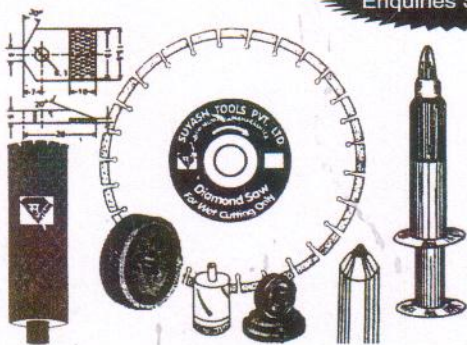
Therefore, it is very important that full care should be taken at the initial stage, i.e., at the time of making specification of waterproofing. During selection of waterproofing system, the specifier should use his experience and judgment considering severity of water conditions, type of construction and the conditions under which the materials will be applied. Manufacturer should also be consulted concerning selection of materials, method of application, surface conditions, number of coats/ dosage, crack repair, protective covering etc. and that will assure satisfactory performance of waterproofing.

During making the specification following points shall be kept in mind: Type of material, durability or service life, effectiveness of intended purposes, ease of application, ease of repair in future, compatibility with other building materials, cost and effect to the environment.

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The waterproofing system should also be designed in due consideration of the present condition of building as well as the worst conditions that may arise in future. The system should not ignore the basics of structural and civil engineering and material science.

## Quality Assurance

Normally, waterproofing treatment is carried out with job guarantee given by the applicators. But very few are turned back when problems come. Therefore, one should ensure that the work should be carried out by a well-experienced, trustworthy applicator who is well versed with products and systems. Now many construction chemicals manufacturers are keeping technical team who can review the system, select right materials and suggest good, company authorised applicator. Normally, company authorized applicators are easily traceable in future if, any problem comes. The common tendency is to spend a little amount of money on waterproofing leads dilution of specification by the applicators or contractors to grab the work. This type of approach spoils the genuine waterproofing system.

A good waterproofing system is a collective and wise effort of the applicator/contractor, homeowner, architect / specifier and the inspecting authority.

Waterproofing system should be checked during execution or immediately after installation by several methods to ascertain the quality of work. This will minimise future rectification or damage of the building. Normally, surface preparation and surface conditions, weather conditions such as humidity, temperature etc are checked prior to application waterproofing treatment. Flood testing with water is carried out during or immediately after completion treatment for horizontal surfaces or liquid storage tanks. Visual inspection is carried out where flooding is not possible. In this case, thorough inspection is necessary. All laps, joints, terminations, must be carefully checked for any evidence of "fish mouth," inadequate adhesion, etc. that may detrimental to the water tightness of the system.

## Conclusion

Waterproofing system is a minor part of a building from economic point of view but a great importance as durability of building is concerned. Since this system is dependent on so many factors it requires sound knowledge of engineering, material science, skilled and experience workforce and good co-ordination between house owner, material suppliers, specifier, applicator and inspector to fulfill the aim of waterproofing.

## References

- ◆ The Chemistry Of Cement And Concrete- F. M. Lea.
- ◆ ACI Manual Concrete Practice- Part - 1 & 5, 1989.
- ◆ D. W Flower- "Polymers in Concrete" - Handbook of Structural Concrete, 1983.
- ◆ A Manual Of Resin For Surface Coating - Edited by PKT Oldring and G. Hayward.
- ◆ Technical Literatures And Specifications Of Waterproofing- CICO technologies Limited.
- ◆ Durability of Building Materials and Components - Edited by J.M. Baker, P.J. Nixon, A. J. Majumdar and H. Davies.
- ◆ Corrosion Damaged Concrete- Peter Puller-Strecker.
- ◆ Chemical Admixtures for Concrete - M. R. Rixom, N. P. Mailvaganam.