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## Why One Needs Waterproofing

My article entitled “Are Conventional Waterproofing Techniques Still Valid?” speaks about different conventional and non-conventional waterproofing techniques used in India.

The concept of waterproofing in India was almost non-existent till the 1980s, when Fosroc entered the Indian market. At that time the market was restricted to the usage of some admixtures for dams, bridges and hydro electricity projects. Most of these chemicals were imported except in a few isolated cases where they were locally manufactured. Industrial growth suffered because of the lack of awareness amongst specialists regarding the importance of waterproofing. The level of consciousness on the benefits of waterproofing was not very widespread. This situation and the very high cost of imported chemicals left the construction chemicals market to be served by the unorganized sector that sold the branded products through hardware shops. Even today, in India, the waterproofing segment continues to be dominated by this sector but it is expected that eventually there will be a shakeout and that the organized players, though very few, will remain in the fray to service a construction chemicals market worth several crores.

As we all know the performance of infrastructure is largely a reflection of the performance of the economy. Rapid industrialization requires infrastructure and this has led to construction of a wide network of roads, bridges, flyovers, ports, etc. Even with the economy at its worst, this country of over one billion people did very well and while construction of buildings may have slowed down, it did not stop. The irony though is that while we can boast of the large number of distinguished scientists in our country, our bridges are showing signs of distress in just ten years. Still nobody tries to examine why our buildings, even new ones, are showing signs of distress while concrete infrastructure is already in serious distress. We must find out the reasons and learn from them. Instead, we continue to use brick bat coba and coatings like bitumen, polyurethane, epoxy etc.

It is not a matter of coincidence that the path adopted by the more than 120 companies and waterproofing chemical suppliers in India is almost the same. They follow the same methodology, under different brand names, while claiming to safeguard the durability and sustainability of the building.

It is surprising that in spite of technological advances in materials, water continues to create unnecessary problems when left unchecked. Most people are under the impression that rain affects our buildings only cosmetically, which is akin to our mental thinking that if it rains we need an umbrella. It's time we realized that this is a far more serious matter and should not be taken so casually – an unfortunate outcome of our educational system, where engineers are not taught chemistry and chemists are not taught engineering. Clearly the fact that most buildings leak and even new and costly flyovers, bridges, roads, jetties and ports show very early signs of distress, indicates that the treatment given to them today is not necessarily the most suitable one.

There are different techniques to waterproof buildings and we will discuss most of them but before going into that we must do some introspection and try to find the cause and effect of construction shortfalls; to analyze the reasons why our bridges are in bad shape, our roads show the first signs of distress within two months to a year, our buildings are leaking, our jetties and ports need attention; why we prefer to not acknowledge that we need to change. **Success and failure are part of life and the interpretation depends on one's thinking.**

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In 1988–89, Dr. Kagi of Tech-Dry Building Protection Systems, Melbourne visited India. He was then the Director of the Building Protection Systems Department of the Victoria Institute of Technology. Dr. Kagi was surprised to see the caliber of the untrained “skilled” masons and workers; shocked by the poor quality of our bricks and to find that even water from nearby contaminated ponds was used in construction. He was further dismayed to learn that for the sake of cost cutting, even technocrats do not assert themselves for fear they will lose clients. We at Tech-Dry (India) have never assented to these methods.

There are certain construction chemicals that are indiscriminately used by everyone without scientific analysis or logical understanding. Let us deal with them.

**Admixtures:** The role of waterproofing is to control the concrete, by not allowing water to leak and permeate through it. A waterproofing admixture is that admixture which reduces the capacity of concrete to absorb water. There are several types of admixtures for different purposes, like retarder, accelerators, waterproofing, and so on. We will only talk of waterproofing admixtures.

Most often nobody knows the function of the individual branded admixtures and sometimes these admixtures can react with cement to give side products.

While one must admit that to maintain the water: cement ratio is very important for the durability of the building, this can only be achieved by using plasticizers and super plasticizers. However, several people misunderstand the role of plasticizer and superplasticizer, and consider them as waterproofing materials.

As regards waterproofing admixtures, most of the companies are selling oleates and stearates which are derivatives of fatty acids. Unfortunately these are not very effective, nor useful. The mechanism of such products is that they form an enteric coating around capillaries and pores if one is able to add a sufficient amount to cover all the capillaries and pores. However, these enteric coated pores and capillaries are exposed to the alkaline environment of concrete and therefore their durability is very short.

**Brick bat coba:** Without reservation, the second love of the Indian construction industry is the use of brick bat coba for roofs. There is a myth that brick bat coba offers waterproofing and some insulation against heat. Brick bat coba in particular is said to be used for waterproofing of flat roofs. Nobody can rightly call it a waterproofing material because **it is porous and allows the entry of water into it very easily, serving as a reservoir.** Neither is it, by any stretch of the imagination, a thermal insulation product. In fact the **heat absorbed by brick bat coba it is the same as that absorbed by concrete.** Tech-Dry (India) has written several articles on the demerits of brick bat coba but even today it is in use and people believe in its efficacy.

Some other **disadvantages of brick bat coba are that it (1) imposes unnecessary load on the system, (2) brings in cracks due to temperature variations and movements due to thermal stresses, (3) causes noise and the inconvenience of disposal of debris and possible damage to the mother slab, upon removal.**

**Bitumen, asphalt:** The next culprits in destroying the concrete are bitumen and asphalt. We have pointed out the **disadvantages** of these and other thick toppings several times in our articles, but it would be well to repeat them below:

- **Blister formation** due to out gassing of the slab or the presence of moisture.
- **Poor resistance to chemical attack.**
- **Asphalt shifting** occurs under wheel loading. This is generally a function of the asphalt stability and thickness of the membrane.
- **Debonding of Membrane** where vapour pressures exceed bond strength. This is a particular problem with sheet applied adhesive membranes where vapour gets trapped.
- Due to the thickness of the system, **concrete delaminations** on the surface of the slab are not evident at an early date.
- Mastic type wearing surfaces are **not suited to exterior application.**
- On exterior applications **black surface increases temperature of slab, increasing slab thermal movement and cracking.**
- **Additional load** to the structure.
- Need to consider **impact on headroom.**
- Generally **unstable on steep sloped application.**

### **Is our Infrastructure Safe? The Case for Waterproofing**

There are plans for huge investment in infrastructure both by government and private institutions. An important agreement has been signed between IIFCL and the World Bank for about \$2.5 bn. The Ministry of Road Transport & Highways have projects in hand involving about Rs.30,000 crores.

Construction of several new bridges and flyovers is in the offing. A large amount of money is also being spent on many other programmes like airports and low cost housing. Still, one needs to think seriously about their protection, given the poor track record of existing infrastructure and buildings, old and new.

Here again we are faced with the question of why our concrete structures have all started showing distress and leakage, and why there is such little understanding of the direct effect of leakages on the durability of structures and concrete bridges. This has become a serious problem, costing billions of dollars to various national economies, besides influencing the productivity, international competitiveness, and quality of life in these countries.

There seems to be little realization that part of it, if not all, is because of poor planning or poor quality of materials used for waterproofing. Normally, loss of durability occurs gradually, and some modes of deterioration can remain undetected for a time. However, deferment of maintenance and lack of timely action and repair or rehabilitation can result in serious loss of safety and serviceability. Corrosion causes unnecessary damage and can be avoided if precaution is taken. The author personally believes that it is very important to safeguard our modern infrastructure, our flyovers and bridges, roads and harbours, and that if this is not realized and proper care is not taken right now, there will be disastrous consequences.

### **Earthquakes**

During earthquakes one of the factors that plays a key role in the collapse or otherwise of buildings is reinforcement. As one can well see from the following pictures of the buildings that collapsed during earthquake, most of the reinforcement was fully exposed to corrosion.



*Aftermath of an earthquake: even RCC frame buildings can break apart!*



*Virtually nothing can be recovered from most RCC frame buildings that collapse. Clearing of debris from numerous multistorey RCC frame buildings is an even bigger challenge.*

### **Reasons for the Deterioration of Concrete Structures:**

**Environmental Impact:** The ingress of damaging materials to structures may occur in the gaseous state or in the liquid state. This makes the design of a durable protection system the more difficult. Gaseous damaging materials include  $\text{CO}_2$ ,  $\text{SO}_2$ ,  $\text{SO}_3$  and nitrogen oxides. On entering the building material as a gas they may dissolve in water present in pores and capillaries

forming a dilute acid solution. Water contacting a structure may contain these dissolved gases and may contain salt from marine conditions or from salts used in de-icing operations. Where water contains acidic gases, evaporation of the water from the surface concentrates the acid to a very high level just before dryness. The frequency of ingress, temperature, and general climatic conditions influence the severity of the attack.

Mineral building materials absorb water through their pores and capillaries. The most important water absorption mechanisms are:

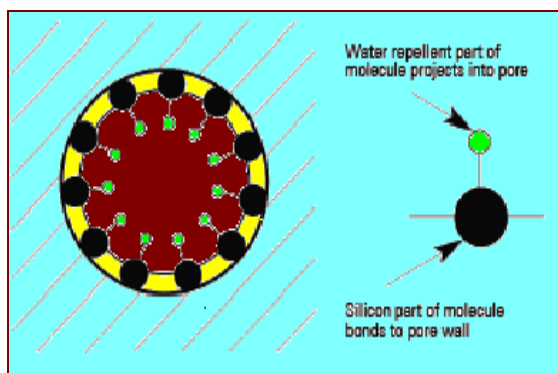
- Capillary water absorption
- Water absorption through seepage and flooding
- Hygroscopic water absorption
- Water absorption through capillary condensation
- Water absorption through condensation

In the first two mechanisms water enters the building material in liquid form whereas in the remainder it enters in gaseous form. Liquid water entry can be reduced by hydrophobisation. Hydrophobisation of capillaries changes the angle of contact of water. Where a capillary is untreated, capillary rise is obtained and where a capillary is hydrophobic, capillary rise does not occur. On the structures of substrates this hydrophobic effect is exhibited as a water beading or droplet effect.

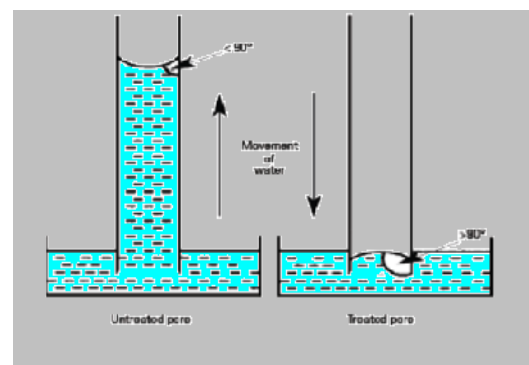
**Mechanism that guides these Impregnants**

The water repellent material lines the pores of the masonry (Figure 1). On curing, the water repellent causes a modification of the interfacial tension between the wall of the pore and the water (Figure 2).

In an untreated pore the ‘contact angle’ is less than 90° and the interfacial tension causes the water to rise. Following application of the water repellent the interfacial tension changes. The contact angle becomes greater than 90° and the resulting tension now causes a slight downward ‘pressure’ so preventing the future rise of water.



**Water repellent lining pore**



**Figure 2 Water Repellency**

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