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ARE CONVENTIONAL WATERPROOFING TECHNIQUES STILL VALID

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We studied the Indian market of construction industry and we felt that the awareness of it was very limited and almost non-existent till 1989.

When the Australian group visited India, the construction techniques were different and the waterproofing was only confined to some admixtures but the scenario is changing and the demand of construction chemicals is growing everyday and is expected to grow at 100% growth rate by 2007.

India is now poised for growth and construction industry is going to be one of the fastest growing industries and the real bone of our economy.

The performance of infrastructure is largely a reflection of the performance of the economy. Infrastructure industries measured by six key infrastructures like roads, highways, flyovers, bridges, waterways, water supply, sanitation, airports, ports, inland ports etc. Infact only in the case of Maharashtra being the most industrialised state they have taken lead and promoted many large industries supported by captive jetties for their exclusive use. Captive jetties at places like Dharamatar, Revdanda, Ratnagiri and Ulwa-Belapur are some of examples of the support provided by the Government to the industry.

Our country needs large number of bridges and flyovers and one can see the development in all the major metropolitan towns, as we are progressing so fast in this area and eventually the area of waterproofing would be as critical. There are no specifically published figures but based on the information available repairs and rehabilitations take away atleast 20-25% of the budget allocated to this area.

This is obviously appreciated and understood by all the major waterproofing companies in the world who have started entering into the Indian market but the problem with most of them is that their products are not suitable for our environment and other conditions. Most of these multinationals bring products based on techniques, which are ***developed in the west*** and their adoption in India becomes difficult.

A structural element of concrete may possess high strength, but may deteriorate sooner than expected, making it a material of poor quality.

The strength requirements (that is, the strength of concrete) is satisfied by choosing the proper amount of cement, limiting the amount of water, consolidating the mixture well, and curing the hardened concrete as long as possible. Durability, on the other hand, depends on several factors that are attributable both to the material and to the exposed environment.

For over one and quarter century after inventing OPC, durability of cement concrete was taken for granted in view of higher strengths over that of lime based concretes.

The following have been identified as the main issues to affect the durability of structures:

- Permeability
- Occurrence of micro-cracks in the concrete due to heat of hydration of cement and related stresses.
- Carbonation.
- Passivity film of reinforcement and chances for corrosion.

The above issues lead to understand the concrete in pragmatic terms associated with the rationalities as follows:

- In concrete, strength and durability are not necessarily linear to each other, more so when high-grade cement is used.
- Strength alone cannot ensure durability, which means durability is an independent factor to strength.

In recent years the deterioration of 20th century reinforced concrete buildings has become a very significant problem. In simplistic terms the problem is associated with the corrosion of reinforcement which can be classified into two types:

- General corrosion associated with carbonation
- Pitting corrosion associated with chloride ions

The visual signs of serious concrete deterioration are cracks, spalls and rust stains. It is important to determine the cause of deterioration and the likely consequences before deciding on the type and scale of remedial works.

The durability of a concrete structure is affected by original design faults, poor detailing, the use of unsuitable materials, shortfalls in workmanship and lack of routine maintenance. These inadequacies accelerate penetration of the concrete by atmospheric carbon dioxide and water borne chloride ions from the environment. Serious breakdown occurs when concrete is permeable or concrete cover to reinforcement is deficient. Permeable concrete is caused by high water/cement ratios, low cement contents, inadequate curing and poor compaction.

Moreover the concrete, structure and construction techniques are causing havoc to the already polluted environment.

The modern buildings although comfortable are high risk for External and Internal Pollution. ***Unfortunately indoor pollution is quite prevalent and equally damaging. Important sources of chemical indoor pollutants include outdoor air, the human body and human activities, emissions from building materials, furnishings and appliances and use of consumer products. Microbial contamination is mostly related to the presence of humidity***.

Waterproofing is the formation of an impervious barrier, which is designed to prevent water entering or escaping from various sections of building structures. Internal areas that are waterproofed include bathrooms, shower recesses, laundries and toilets. Whilst external areas waterproofed extends to roofs, planter boxes, podiums, balconies, retaining walls and swimming pools.

THE IMPORTANCE OF WATERPROOFING

If we refer back to the definition of waterproofing as an impervious barrier designed to prevent water entering or escaping from building structures, then the importance of waterproofing is reflected in the consequences of not waterproofing.

Water, which enters or escapes from building, can have immediate and long-term undesired effects. Apart from damage to the buildings contents, structural damage is unavoidable if the problem persists.

Water damage is second only to fire as a cause of building decay and deterioration. Furthermore, the Australian building systems appraisal council, ABSAC, a division of the CSIRO state that the majority of building materials have a considerable shorter life span when subjected to moisture or emersion over a prolonged period of time.

The casualties of water damage include:

· Rotting of timber structures and finishes such as floor joints, beams, floors, studs, skirting, architraves and frames.

· Corrosion of metals such as steel reinforcement in concrete, steel beams, lintels, metal door frames etc.

· Swelling of plasterboards and the subsequent debonding of ceramic tiles.

· Electrical hazards causing the possible short circuit of lighting and power points.

· The blistering of paint.

· Unsightly deterioration of the building facade.

· Health problems due to dampness, which may lead to respiratory problems.

· Rotting carpet.

The importance of waterproofing cannot be overstated. The damage caused to the building's structure, coupled with the high cost of rectification warrants careful design and application of waterproofing.

THE ROLE

The role of waterproofing is to protect a building's visual and structural integrity. It achieves this by forming an impervious membrane that prevents water entering or escaping from wet areas to dry areas.

In order to effectively fulfill this role a membrane must possess the following qualities:

- The membrane must be impermeable to prevent the passage of water.
- Flexibility - membranes need to accommodate any normal movement that may occur in building structures.
- The membrane must be durable, it must be able to retain it's integrity over a long period of time.

- The membrane must lend itself to design details in a building. It must be suitable for each specific application. The membrane is useless if it cannot be applied where needed because of structural details.

Infact it has been ***found in so many cases that the human tragedy and property loss and repetition of 1999 Turkey earthquake and the similar type of earthquake in Gujarat and Uttarkashi, where corrosion was found as the main cause for disaster could have been avoided if we the scientists had paid more attention to this dangerous chemical reaction.***

The maximum loss to life and property in the Asian Region, due to frequent occurrence of natural disasters, dictates the need for the evolution of safer habitat, which can respond and resist the loads, forces and effects due to the natural disasters.

The tropical cyclone which struck Gujarat state on the western coast of India on 9th June 1998 left thousands dead and damages worth more than Rs. 2,600 crores.

Use of stearates and oleates as admixture for waterproofing, we all know the mechanism of these waterproofing compounds and their durability. Normally conventional waterproofing systems used are

- Tarfelt
- Brick bat Coba
- Grunting
- Stone waterproofing
- Coatings
- Integral Waterproofing

The system is probably the oldest in practice and uses layers of tar interspersed with various forms of reinforcements to hold the layer together and prevent cracking to provide impermeable layer between the water and the surface to be protected.

Disadvantages

- **CRACKS DUE TO TEMPERATURE VARIATIONS**

The brick bat coba treatment through successful in the damp heat of coastal regions cracks up completely on contact with the variations of temperature faced in North India between day and night temperature.

- **IMPOSES UNNECESSARY LOAD**

This system has the disadvantage of imposing an unnecessary load on the system. Once cracks appear they are almost impossible to repair and water as in the case of the tar felting travels below the coba and exits wherever it finds a path. It is impossible to trace the inlet point let alone repair it.

- **ALMOST IMPOSSIBLE TO DISMANTLE FOR REPAIRS**

Some parts of the coba stick so well to the concrete that even if an attempt is made to dismantle the system the slab gets damaged.

We will now confine ourselves to the difficult aspects of waterproofing systems.

Conventional and protected membrane systems

Two basic roof systems are in common use:

- The conventional roof system, in which the membrane is outside the insulating layer and essentially exposed to the elements,
- The protected membrane roof system (PMR), in which the membrane is located to the inside of the insulating layer and protected from the elements.

As shown in Figure, a conventional roof system has five basic components:

- Roof deck and supporting structure,
- Vapour barrier,
- Thermal insulation,
- Roofing membrane and flashing,
- Top cover and ballast (often, though not always, included)

and a protected membrane roof system has four:

- Roof deck and supporting structure,
- Roofing membrane and flashings,
- Thermal insulation,
- Top cover and ballast.

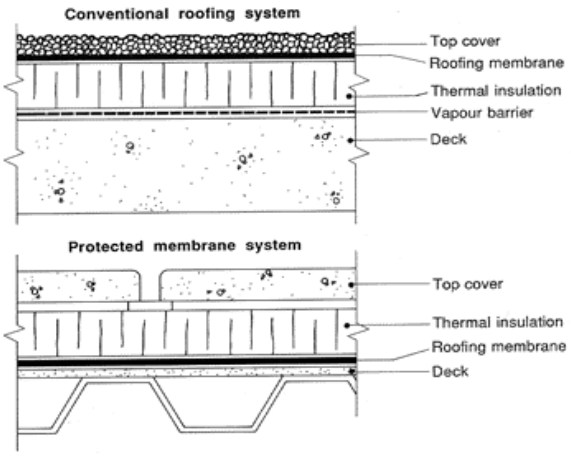

Figure. Conventional and protected membrane roofing systems

In addition to the basic components, systems will include adhesives and mechanical fasteners to secure the components together.

Advantages and disadvantages of each system

The protected membrane system was first recognised as an acceptable alternative to the conventional system follow-slope roofing in the mid-1960's. Interest in it was stimulated by continuing problems with roof membrane failure in the conventional system. Neither system dominates the market in Canada; both can give good service or have problems. Each system has features that recommend it and disadvantages that must be recognized.

The conventional system

Advantages

- Protects the insulation against wetting and mechanical damage. (This allows a broad selection of insulating materials and, in theory, maintains the materials thermal resistance. In practice, it is not always successful.)
- May not require ballast, depending on the design. (This will reduce the overall weight that must be supported by the structural system.)
- Allows easy inspection of the membrane.

Disadvantages

- Exposes the membrane to extreme temperatures (from -40°C or lower to 70°C or higher in the course of a year); high temperatures accelerate aging and large temperature changes cause potentially damaging physical stresses in the membrane.
- Can trap moisture between the vapour barrier and the roof membrane. (If a conventional roof becomes wet due to a roof leak or condensation from air leakage or diffusion, the moisture may not be able to escape and will continue to accumulate.)

Few examples are

- Water-based repellency and impregnation like Protekta G, Protekta R, Protekta Micro Emulsion, Protekta Stoney, Protekta Showerplug
- Crystallization & Porosity reduction products like Protekta Base, Protekta Guard, Protekta Stonecrete, Protekta Protex, Protekta Protonex.
- Elastomeric Coatings like Protekta Flexphalt, Protekta Flexjoint, Protekta Flexicoat
- Polycarboxylate based admixtures like Protekta RR series, Protekta TD Series, Protekta GL-5

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REPELLENCY & POROSITY REDUCTION PRODUCTS

- ***Protekta Guard*** : Protekta Guard incorporates calcium into the surface and is essential before Protekta Base is sprayed. For the effective use of Protekta Base, you must use Protekta Guard.

- ***Protekta Base***: It is a specially made product, which is sprayed on cured concrete. After spraying this product you should use 3-day watering process (spray water 3 times at 24 hours interval). The product penetrates and reacts with the concrete forming a sub-surface barrier, waterproofing pores, capillaries and larger cracks against the ingress of water and contaminants. It reacts with free Calcium and water to form a non-water soluble Calcium Silicate Hydrate gel complex in pore capillaries and cracks. This gel creates a sub-surface barrier

- ***Protekta Protex*** : Protekta Protex is based on the concept of protecting the concrete by ***crystallization.***

- ***Protekta Stonecrete:*** Is useful like super seal and incorporates additional C-S-H concrete making it more watertight.

- ***Protekta G*** : As a damp-proof course (just above the existing damp-roof course) in buildings where the existing damp proof course is not functioning.

- ***Protekta R*** : Pre-construction treatment over the concrete slab when the slab is cured for 21 days – this totally replaces the weathering course such as surkhi-concrete plastered with cement mortar.

- ***Protekta C*** **:** For protecting seafront structures (both old and new) against sodium chloride penetration-inhibits concrete cancer and reinforcing steel corrosion. Supplied with Heart, to be mixed well just before use.

- ***Protekta Micro Emulsion :*** Can be used for exteriors, brick walls, marbles, stones. Protekta Micro Emulsion is a solvent-free aqueous silicone ester emulsion. It is designed to be used for reducing water absorption capacity of building materials.

- ***Protekta Stoney***: (Surkhi, surface compacting, & repellency):

- ***Protekta Shower plug***: (Bathroom, repellency, Impregnation, antiskid): Shower plug is a unique, clear impregnant, which soaks into tile and grouts within 12 hours make them waterproof.

COATINGS

Disadvantages of coatings

1. Blister formation due to out gassing of the slab or the presence of moisture. This is generally found with the single coat liquid applied membrane systems where the membrane thickness is less than 2 mm.
2. Poor resistance to chemical attack.
3. Asphalt shifting occurs under wheel loading. This is generally a function of the asphalt stability and thickness of the membrane.
4. Debonding of membrane where vapour pressures exceed bond strength. This is a particular problem with sheet applied adhesive membranes where vapour gets trapped.

5. Due to the thickness of the system, concrete delaminations on the surface of the slab are not evident at an early date.
6. Mastic type wearing surfaces are not suited to exterior applications.
7. On exterior applications black surface increases temperature of slab, increasing slab thermal movement and cracking.
8. Additional load to the structure.
9. Need to consider impact on headroom.
10. Generally unstable on steep sloped applications.

Our products

- Protekta M
- Protekta M coat
- Protekta FWS
- Protekta Doug bond
- Protekta RWS
- Protekta Protex

THERMAL INSULATION

The main function of insulation is to control heat flow both into and out of the building. It also prevents condensation by keeping the vapour barrier and components inward of the vapour barrier above the dew point temperature.

Many different types of thermal insulation are used in roofing. They can be broadly divided into two categories: porous (which includes open cell plastics and fibrous insulation) and non-porous (which includes closed cell insulation. Many different materials are used to make insulation, including mineral fibres, wood fibres, polystyrenes, polyurethanes, and cellular glass.

Thermal resistance. The materials of which these insulations are made are not particularly good insulators in themselves. The thermal resistance occurs because the materials are made into fibres or foamed in such away as to form open spaces. Air, which has a low thermal conductivity, clings to the fibres or is trapped in the spaces. Thermal resistance can be increased in closed cell insulations by trapping denser gases. Table III provides thermal resistance values for typical roof insulation materials.

Thermal resistances of some roofing materials

Material	Thickness (mm)	Thermal Resistance ($°C \cdot m^2/W$)	Thermal Resistance ($°F \cdot h \cdot ft^2/BTU$)
Rigid glass fibre	50	1.42	8
Wood fibre board	50	0.91	5.2
Extruded polystyrene	50	1.78	10
Bead polystyrene	50	1.42	8
Cellular glass	50	0.92	5.2
Phenolic foam (open cell)	50	1.46	8.3
Phenolic foam (closed cell)	50	2.86	16.2
Concrete (stone aggregate)	100	0.07	0.4
Wood	25	0.18	1
BUR membrane	10	0.06	0.33
Surface air films			
interior		0.1	0.6
exterior		0.03	0.2
Air space	20+	0.18	1

There is a myth that Brickbat coba gives thermal insulation. This is a system used particularly for roofs in the coastal region and consists of putting brickbat on roofs to give a slope and then grouting the same with mortar admixed with various proprietary chemicals most in the nature of water proofing compounds. This is mostly finished with IPS topping with a tile pattern cut into the top to form crack inducer joints to prevent cracks from appearing. This has the advantage of providing an excellent slope so that the water drains away.

Cracks

We have now concentrated on one of the major problems in the construction industry and that is formation and type of cracks

Concrete, like other construction materials, contracts and expands with changes in moisture and temperature, and deflects depending on load and support conditions. Cracks can occur when provisions to accommodate these movements are not made in design and construction.

Most random cracks that appear at an early age, although unsightly, rarely affect the structural integrity or the service life of concrete. Closely spaced pattern cracks or D-cracks due to freezing and thawing, that typically appear at later ages, are an exception and may lead to ultimate deterioration.

MAIN**TENANCE OF BUILDING**

The basic requirements are:

- Effectiveness
- Impact
- Management
- Economics
- Practicability
- Maintenance & Service life

CONCRETE REPAIRS

Polymer modified mortars

- ***Protekta – 500*** : Protekta –500 is used mainly for modifying Hydraulic setting agents particularly cement mixtures. It is preferably used in cases where maximum demands are made on the mechanical properties of these products. Example: Touching up mortar and screed.
- ***Protekta –600*** : This is an aqueous polymer emulsion and when mixed with cement mortars, it makes the modified mortar as hard, tough and durable. It is superior adhesive and gives impact strength. This is an excellent waterproofing compound. Capability and the mortar made with it are resistant to many industrial chemicals, UV light and heat.
- ***Protekta –400*** : This is an Aqueous, anionic, dispersion of an acrylic-styrene copolymer based formulations specially prepared for making flexible mortar.

GROUTING

We are the only company who have used combination of chemical grouting and double component injection technique at the sight of damage.

- ***Protekta SB***: Protektacrete SB systems prevent future costly repairs of new concrete buildings and prevent further deterioration of old buildings.
- ***Protekta MS***: Sometimes the void or the damaged area need water type product which can be grouted and which interacts with the concrete or building material immediately. In such cases Protekta MS can be injected in pure form without any filler, in order of merit.

- ***Protekta SS***: Grouting of voids, Honey combs, tiles. This is a gelling agent added to fast setting cement slurry compiling water and cement
- ***Protekta STG***: It is used for small gaps in the tile joints
- ***Protekta Hard***: The primary function of the grout is to fill voids in the coarse aggregate, to bind them together upon hardening and to consolidate the entire mass. The quality of PAC concrete depends on the use of a grout mixture, which is cohesive, workable and develops sufficient strength in the hardened state.
- ***Protekta Hydro Grout*** : This single component can also be injected into the heart of the damage area, i.e., into the whole fabric and polymerise, producing an elastic neutral end product. This allows a full seal with minimum material and short working times.

- ***Protekta Stonecrete***: Is useful like super seal and incorporates additional C-S-H concrete making it more watertight. When the two principal components of portland cement - tricalcium silicate and dicalcium silicate - react with water, they form a complex calcium silicate hydrate compound called C-S-H. This compound is effectively the "glue" in portland cement. As C-S-H forms and grows in hydrating concrete, a network of pores forms among the hydrating cement particles - even with the C-S-H itself. Large pores and uncomplicated network channels allow water to easily enter and leave the concrete, often penetrating deep into the structure to cause corrosion.
- ***Protekta -500***: Compatibility with old surface, repair of honey combs. Can be used as coat with same fillers
- ***Protekta Protonex***: This is latest molecule where an appropriate polymer has been encapsulated by silicate molecules.
- ***Protekta Protonex SB*** : Gets encapsulated with clay which expands 15 times when comes in contact with water
- ***Protekta Protonex SS*** : The polymer Hydrogrout gets encapsulated with Silicates and gives the strength.
- ***Protekta Protonex (M)*** : Has symbotic properties of both Protekta Protonex SS & Protekta Protonex SB

We can conclude by saying that we have developed admixtures which do not interact with the cement constituents and product undesirable products and it can be used for RMC's, retaining slump loss.

Elastomeric coatings are ***flexible, breathable with high elongation and weatherability and crack bridging membranes rather than coating*** which have several problems.

Repellency Products, Anticarbonation Products, Soil Stabilization products, basements, double component injection and tanking systems. 4^{th} generation elastomeric coatings.

We have found solution for terrace gardens, overhead tanks and even repaired in Bangalore a overhead tanks at a height of 80ft without removing water from the tank.

We have tried to develop products for bathrooms to retain the beauty and freshness of exteriors and antiskid tiles.

We have developed bonding products which can bond even glass and metal. One of the major problems which the construction industry is facing is the vertical and horizontal expansion joints and our Protekta EJR is unique. We worked in infrastructures, bridges, jetties is worth mentioning.

We are now looking forward to receiving from you, your suggestions because we are in the process of extending our research activities and enter British government and Australian science. As you know outsourcing from India is the need of the day and this group has plans to do so.

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