

ReBuild

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WATERPROOFING

PART-2

REMEDIAL WATERPROOFING OF BASEMENT

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A Not-for-Profit Knowledge Centre

It is estimated that up to 95% of all basements will succumb to water intrusion at some point in their lifetime. With damage ranging from minor dampness to total flooding, the cost can become astronomical, especially if valuable contents are also affected. The best form of defence is to get the specification for waterproofing right the first time. This is applicable whether it is a new build or a refurbishment. A well-specified system that takes into account every element of a structure and the results from a full site evaluation will provide an integrated waterproofing solution that will overcome the threat of water ingress. New build projects feature waterproofing systems that are generally designed with the structure. However, refurbishment projects can be more complex as they may involve dealing with both an existing structure and a new structure, which leads to more complicated solutions. In the case of new structures, the choice of materials and systems are wide open, while in the case of remedial waterproofing of basements, it is limited and again subjected to prevailing site conditions, thus narrowing down the options of selection of materials and systems. Our last issue of ReBuild was on basement waterproofing of new structures where we had discussed the suitability of different materials and systems being used for waterproofing in basements including different tanking systems and protection measures. But keeping in view the large number of problems in existing basements, this issue of our ReBuild is devoted to remedial waterproofing of basements with many case studies.

Basement defects such as water seepages/leakages are tedious and expensive to rectify. The significant factors leading to the occurrence of water seepage in basements can be benchmarked, namely: degree of water-tightness; safety measures for structural concrete; performance of waterproofing systems; integrity of the basement structure; provision for movement and quality of compaction in concreting, for minimizing water seepage/leakage.

Positive side basement waterproofing is most ideal but depending on the site location, if it is difficult to do any remedial waterproofing on the positive side, then negative side waterproofing is the only solution. The various positive side application materials used are elastomeric bitumen emulsion based polymer coating, coal tar epoxy coating, elastomeric polyurethane coating and bentonite. In the case of positive side application, removal and refilling of backfilled material with proper compaction is a major concern and some times practically impossible. Rather, negative side application with a crystalline coating of

cementitious material is more a common solution. But while injecting at the negative side but making a barrier at positive side with cementitious, bentonite or polyurethane is a more effective method. Among the injected materials the PU foam injection is the most popular material for waterproofing since it seals the bigger leakages.

In an existing basement where the leakage is quite often, an interior footing drain may be more suitable. In this system a pipe channel with perforations is being installed below the floor level and adjacent to the basement wall for collecting and draining water, but unlike the traditional footing drain it sits on top of the footing and prevents debris from entering the pipe, thus eliminating any clogs. Wherever the hydrostatic pressure is too high, PVC base board channels with square inlets with different laying arrangements are being installed at the floor, thus directing the water into the system and draining to a sump pump system. Cavity drain systems act as a water management system, moving any moisture or water behind the dimples and down to an internal drain which is installed at the wall/floor junction. The drain can then either feed out to an open elevation or to an existing drain or a sump and pump. The existing drainage can be modified by an automatic drainage system installed with an alarming device.

Apart from waterproofing, the basement floor and raft get damaged due to ingress of moisture, seepage of water and some times chlorides and sulphates and corroding the reinforcement steel and causing spalling and delamination of reinforced cement concrete. The various other factors such as internal plumbing leaks, surface condensation, interstitial condensation, damage in the waterproofing system, failure of joints, blocking of cavities/drains, and failure of pumping systems need to be checked. The repair of concrete structures should be in accordance to the general repair practices of concrete with polymeric repair materials before the installation of waterproofing system.

Our readers are advised to read this issue in conjunction with our last issue of ReBuild which was on waterproofing of basements of new structures that will help in a general understanding of designing waterproofing systems for new structures as well as remedial measures of basements of existing structures.

Remedial Waterproofing of Basement

[Source:http://www.property-care.org/files/cop_structural_waterproofing.pdf and <http://www.foundation-repair-guide.com>]

1.0 Introduction

Remedial waterproofing of basement is very critical since one has to check many factors before going for remedial waterproofing. The aim of monitoring in basement is to locate the leaks at the earliest possible opportunity so that remedial works may be taken immediately without damaging the structure further. The designer of the waterproofing system should also consider the implications of any future failure if the system and how any defects can be repaired in the future. Basements can flood from almost any point including the walls, floor, pipes, windows, and hatchway entrances. The solution to a flooded basement depends entirely on what's causing the flood in the first place. In basement the primary cause of defects and damages are due to ingress of water vapour or ground water along with chemicals such as chloride, sulphates or other aggressive chemicals causing corrosion of reinforcement. This may happen due to failure of waterproofing system. A regular inspection and proactive maintenance policy will limit the damage to the basement. Visual inspection along with selected non-destructive testing such as infrared thermal imaging, moisture meter should be carried out to find out the nature of damage and defects. If required a concrete core from wall, floor of basement may be taken to find out the in-situ strength of the concrete. The same core sample may be used for chemical analysis tests for chlorides, sulphate and pH or alternatively a drilling machine may be used to extract powdered concrete samples for all chemical analysis tests. Knowing the exact cause of deterioration a systematic approach for remedial basement waterproofing should be taken.

2.0 Surface Preparation

The basement should be inspected thoroughly to find out the exact source of leakage and the extent of leakage. All the leaking points should be marked to decide the treatment area. Surface should be cleaned to remove all the loose materials. Based on the findings of condition assessment remedial measures should be carried out accordingly. All damaged concrete areas should be repaired with polymer modified mortar as per standard specifications.

The substrate which is to receive the remedial waterproofing system must be well keyed to achieve a good bond and sound to prevent de-bonding. Any old renders, coatings or general contamination must be removed by suitable means such as grit blasting, high pressure water jetting, scabbling, or other suitable means. Care needs to be taken if wire brushing is used as it can leave the surface soft and dusty. Bush hammering tends to compact the

surface and can result in the system pulling away, taking the surface with it. Soft mortar joints should be raked out, and any unsound and defective areas cut out and made good. Open joints should not be repointed but the mortar should be pushed into the open joints when applying subsequent renders. Excessive suction should be controlled prior to applying renders by saturating with water, or applying a suitable bonding agent as a primer or slurry. Unless the substrate is reasonably flat and true, a render leveling coat should be applied prior to application of the waterproofing system.

On basement floor, unsound or loose coatings such as screeds, laitance, salt residues, mould growth or adhesives must be removed. If mould is present, the floor should be treated with fungicidal wash, (care should be taken to avoid contamination of watercourses when using fungicides). Uneven substrates should be dubbed out with a suitable mortar, to achieve a flat finish. This must be allowed to harden before laying the membrane. Check and remedy, using appropriate methods, any unacceptable leaks in the concrete or masonry substrate before the system is installed. For basement flooded with water, the dewatering should be done to remove the water from the base slab for carrying out the inspection. Wire brushing should be done on the surface to remove all the loose particles before applying any coating material. If required, the grinder shall be used to open up the surface pores which will allow better penetration of the product.

3.0 Application Methodology

Before doing any remedial waterproofing treatment either at positive side or at negative side all the cracks need to be repaired and all corrosion related cracks should be made as per standard procedures. Any cracks lower than 5 mm to be filled with ready to use polymer modified crack filling material. Cracks larger than 5 mm to be filled with polymer modified mortar. In remedial situations most jobs require the application of waterproofing systems to be internal. For this type of work, cementitious coatings, multi-coat renders, epoxy coatings or cavity drain membranes with integrated drainage channels are most common. If the dampness is present all over with minimum dripping leakage, the same can be treated with a crystalline product. All the dripping leakage points should be grouted with PU foam injection system. After completion of remedial treatment wherever required, tiling work has to be carried out over the finished mortar screed with non shrink waterproof polymeric tile adhesive and filing the joints with non shrink tile grout.

Though positive side waterproofing is difficult but it is more effective than negative side waterproofing. The various positive and negative side remedial

waterproofing systems are discussed as follows:

3.1 Positive side Application Treatment

3.1.1 Elastomeric Bitumen Emulsion based Polymer Coating

Bitumen emulsion based elastomeric polymer coating is suitable for basements in normal soil condition for positive side application. It is ideal waterproof coating, which forms an elastomeric membrane capable of withstanding small movements of concrete. It has excellent adhesion and is flexible and non-toxic. Two coats of elastomeric polymer coating should be applied on the clean surface at coverage of 2 m² per kg in two coats. The second coat should be applied after 6-8 hours of drying of the first coat and sprinkle sand on the second coat. In the event of the coating being discontinued, resumption of the coating should be done by providing an overlap of 50 mm on the old layer. A screed of 15 mm plaster should be given on top of the coating to avoid any puncturing of the membrane while back filling.

3.1.2 Coal Tar Epoxy Coating

Wherever the treatment has to be given in contaminated soils, a two component coal tar based epoxy system for coating for protection of concrete structures against aggressive environment. A full cured coal tar epoxy coating effectively waterproofs and gives protection against corrosion. It has high bond strength and abrasion resistant properties. It has to be applied in two coats @ 3-4 m² per kg with a brush. The backfilling should be carried out after 3- 4 days of laying of coal tar epoxy.

3.1.3 Elastomeric Polyurethane Coating

In remedial water proofing "elastomeric" is more popular. The term elastomeric simply means that the material- whatever material is being discussed- is flexible throughout its lifetime. For the basement waterproofing application, a synthetic material called "urethane" or "polyurethane" (a colourless, odourless, crystalline compound) has been formulated into a liquid which can be applied with a roller to form a monolithic basement waterproofing membrane on positive side. The polyurethane basement waterproofing membrane is equally impermeable and has a much longer useful lifetime than the asphalt-based material. Some urethane waterproofing products are manufactured as "bitumen-modified" so that the bituminous component is still out there. The application process for the elastomeric basement waterproofing system is similar to the asphalt-based system. One or two coats are usually sufficient. Reinforcing material is not normally required. A good sub drain system with perforated pipe placed entirely below the top of the footing is essential and protection board must be installed against the new membrane prior to the placement of any backfill. The polyurethane elastomeric basement waterproofing system is most successful in

numerous basement waterproofing jobs over the years without any failure of the waterproofing membrane. The cost is competitive with the asphalt-based system but the durability is much improved. Since it is applied on positive side the excavation and filling of backfilled soil is more difficult in a deep basement whereas it can be managed in a shallow basement. But positive side application is most effective for any remedial works in all kinds of soil.

3.1.4 Bentonite and Blind-side Waterproofing

Bentonite is very effective as a basement waterproofing material because it swells up when brought in contact with moisture. Bentonite-based systems are supplied in rolls. The bentonite comes impregnated into a geotextile mesh. One can also find it adhered to polyethylene sheets. Bentonite rolls or sheets, like the other basement waterproofing materials are designed for a "positive-side" application. However, there are also other approaches to basement waterproofing. A modified version of the negative-side system has the material injected from the negative side but applied to the positive side can be more effective in remedial waterproofing. Then there are the so-called "blind-side" waterproofing methods.

Blind-side basement waterproofing is where you put the waterproofing up first and then place a new basement wall up against it. In blind-side basement waterproofing; everything is done in the reverse order of normal new basement waterproofing system. The filter fabric side goes in direct contact with the soil of the vertical cut. The drain sheets come next, providing free drainage to relieve any hydrostatic pressure. The dry bentonite clay goes away from the vertical cut where it will be in direct contact with the freshly poured concrete. At the bottom, a perforated pipe is run through and wrapped it in more filter fabric. After installing the reinforcing steel, the formworks are set to create the inside face of the new basement wall and then we poured the new concrete. Blind-side basement waterproofing is often required for new construction and retrofit jobs where property lines and adjacent structures prevent excavation and access which would allow positive side waterproofing to be installed after completion of the basement walls. In addition to poured walls, bentonite sheets are used behind "shotcrete" walls and "soldier-beam" walls with wood "lagging". "Tiebacks" and other penetrations of the bentonite membrane present challenges to the installer. Bentonite mastic is needed to work around penetrations and irregular surfaces. On contact with moisture, the bentonite expands into small irregularities and aids in the sealing process. Bentonite rolls or sheets are also used on conventional positive-side basement waterproofing jobs. The natural clay material would not be expected to degrade and the swelling characteristics give bentonite an added component of performance.

While bentonite can be an outstanding basement waterproofing product, one must consider the material and installation cost. Bentonite is significantly more expensive than the polyurethane membrane systems which seem to be well accepted for most positive-side applications.

3.2 Negative-side Application Treatment

“Negative-side” waterproofing system is that system where the material is applied to the inside surface of the wall. Negative side waterproofing consists of either a waterproof coating or hydraulic cement that is designed to coat the inside of a basement wall, sealing any cracks in the wall as well as stopping moisture that is constantly seeping into basement from the earth through porous cement basement walls and floors.

3.2.1 Crystalline Coating

The “crystalline” basement waterproofing systems is more popular for negative side application. It consists of a liquid solution of cementitious base which is applied to an existing concrete surface. Also called a “capillary” basement waterproofing system, the solution penetrates into existing concrete and seals the capillaries within the concrete mass. Proprietary chemicals within the solution react with lime in the concrete to form needle like crystals which fill the capillaries and reduce the permeability of the concrete. Moisture must be present in the concrete in order to form the chemical reaction. Water entering through the crack reactivates the chemicals and causes new crystals to form and grow, which self-seal the new cracks and maintain a watertight seal for which it is a permanent crack repair solution. This self-sealing property is one of most unique and useful features and can often reduce long-term maintenance and repair costs if only active crystalline forms. The crystalline basement waterproofing system gives the contractor an option when the owner does not have the budget to do a positive-side job or approach to the positive side is not possible because of space constraint. This system is more of a maintenance program than a repair. The general idea is to apply the material to the concrete and then wait for the moisture to seep in from the outside. The chemicals dissolve and follow the water, sealing up the cracks and capillaries in those zones of moisture. The next month or the next year, it may be necessary to apply more solution as the chemicals seep into the zones of moisture and are used up. The effectiveness depends upon the amount of moisture penetrating into the basement and the ability of the crystalline system to form crystals in passive state. Rather than one time remedial solution it can be a regular maintenance system. Since it is a negative-side basement waterproofing system on existing structures it has huge advantage. The removal and replacement of the perimeter soil and other improvements is not required. However, a negative-side system which offers the level of protection one get from a positive-side application can not be compared. The Fig. 1 shows that basement wall applied with a crystalline coating.



Fig. 1: Crystalline waterproofing on negative side

3.2.2 Cementitious Systems

Another type of material which is used frequently on basement repair jobs is the “cement-based” or “cementitious” coating applied on negative side. However, it should not be used on basement waterproofing jobs where hydrostatic pressure may be a factor. Certain cement-based coatings used in basement waterproofing applications have failed due to a significantly higher permeability to moisture. These coatings are relatively inexpensive and easy to apply. Whilst damp, but free of standing water, cementitious coating should be applied in two coats to the clean and saturated surface to achieve 1 mm thickness of the coating. Sand should be sprinkled on the top surface of applied coating while still tacky over the second coat. This system can be used only in smaller amount of dampness or seepages but can not be effective in heavier leakages. In this system the substrate must be strong enough to accept this stress. Non-structural floors and half brick walls are not suited to the application of this system due to their inability to withstand bending stress. Cementitious systems may not be suitable where they are likely to be subject to heavy vibration or substantial seasonal movement i.e. below roads, railway lines etc. Care should be taken for proper curing for cementitious coatings or rendering.

3.2.3 Injected Basement Waterproofing

Another type of basement waterproofing system which can be installed from the negative side but applied to the positive side is injected basement waterproofing with pressure pump equipment as shown in Fig.2. “Injected bentonite is being used to create waterproof barriers beneath floors or behind walls. “Injectable polyurethane” is pumped into holes drilled in floors or walls to form a waterproof barrier. Before using bentonite beneath a floor, one should ensure that changes in moisture levels in the surrounding soil would not result in heaving or settlement of the floor or foundation due to expansion or contraction of the bentonite material.

The injected polyurethane (PU) material is



Fig. 2: Injection equipment setup

“hydrophilic” or attracted to water. The drilled holes are used as injection points and also to gauge and monitor the penetration of the material. Crack sealing can also be accomplished by injecting “hydrophobic” polyurethane into the cracks. The urethane and bentonite injection systems provide an alternative to the capillary system for basement waterproofing of existing underground structures. Though significantly more expensive than the capillary system, bentonite or urethane injection offers a positive side application. When used on concrete floors- whether above or below grade- bentonite or urethane injection is a less-expensive option than membrane applications which require the removal and replacement of the concrete, exterior soil and other perimeter improvements. PU foam injection carried out in a deep basement for arresting the water leakages is shown in Fig.3.



Fig. 3: Foam injection carried out in a deep basement wall

However, one should not favour a waterproofing system on below-grade walls which does not include a drain system to eliminate hydrostatic pressure. One should never assume that an existing French drain system is working properly. Therefore for most basement waterproofing repair jobs, first recommendation would be a positive-side treatment with a liquid-applied elastomeric membrane together with a carefully installed perimeter French drain. With the relief of hydrostatic pressure, one should go ahead with injecting a below-slab hydrophilic polyurethane barrier to complete

the job. Fig. 4 shows grouting carried out in a basement wall. Where ever rising dampness in the basement is the concern the grouting should be made with a Silicone based material as shown in Fig.5.



Fig. 4: Grouting of basement wall



Fig. 5: Injection to basement wall at floor level for preventing rising dampness

3.3 More Basement Waterproofing Systems

Protection boards help prevent damage to the waterproof membrane during backfill and can be in the form of sound board, asphalt board, plastic drain sheets, or foam sheets the latter having the added function of providing insulation to the basement waterproofing job. Other accessories to basement waterproofing jobs would include flashings and fasteners, waterbars for control and construction joints, and a wide variety of adhesives, sealers and mastics. Basement waterproofing systems should include an integrated package of products for surface preparation, membrane installation, protection board, and drainage system.

3.3.1 Interior Footing Drain

The best and most reliable approach is the interior floor drain basement waterproofing system. While other approaches can work some of the time, this is the one that works all the time. It is a piping system engineered (Fig.6) specifically for wet basements designed to avoid the problems of other approaches. It is an interior floor

drain, but unlike the traditional footing drain it sits on top of the footing and prevents debris from entering the pipe thus eliminating clogs. It is installed next to basement wall, on top of the footing, and collects water seepage from the walls, floor-wall joint, wall crack and pipe penetration .



Fig. 6: A view of interior footing drain pipe channel with perforations for collecting and draining water

This system works with the sump pump so any water that's collected is removed. As with any waterproofing system of this type, this method leaves a gap between the floor and wall (Fig.7) that allows water from the wall to flow down into the drain. When this system installation begins, the perimeter of the floor is removed. This process is used on the floor only. The footing and foundation are not damaged by this process. If there is any block foundation walls, weep holes are drilled into each core of each block so that the water contained within the hollow cores of the wall is continually drained away. Clean gravel is laid down on the bottom of the trench that has been removed around the perimeter. Specially manufactured rectangular drainage pipe is laid on top, and then gravel is laid on top. Once this is completed, concrete is laid back down on top of the system, it's smoothed over and the area is cleaned.



Fig. 7: Installation of footing drain pipe at wall and floor junction

If there is any floor crack through which ground water is penetrating then lateral drainage piping is laid under the

floor and connected to the interior floor drain system. The wall drain is a molding with spacers that create a neat-looking drain against the wall. Because it sticks up above the floor about 25 mm so that dirt and small objects from the floor can't get inside and clog it.

Since such drainage system is not sitting in the soil and the fact that it is sitting on top of gravel, it is extremely unlikely that heavy soil particles will wash through the gravel and upwards into the system and make it clog. This system will still be clean and free draining system for all leaking basements.

3.3.2 Baseboard Drainage System

One of the most effective and least invasive methods of waterproofing a basement is with a baseboard drainage system. With this system, weep holes are drilled into the floor/wall joint or, in the case of a block wall, into the walls themselves. This relieves the hydrostatic water pressure. Once this is done, a hollow vinyl baseboard or PVC base board having square inlets (Fig. 8) is fixed to the floor. The water creating hydrostatic pressure on the foundation walls is directed into the system and drained to a sump pump system.



Fig. 8: PVC base board channels with square inlets for drainage in basement with different laying arrangements

The sump pump is installed with a feed pipe to the sump. The sump pump then discharges the water out of the house through a drain pipe that's buried and runs across the yard. The pipe extends past the backfilled soil and is directed to a location where the water can run downwards and away from the house. Once the water is away from the foundation walls, the hydrostatic pressure created by it is relieved.

3.3.3 Improving the Drainage System

The French Drain system is designed with a grated opening on top that collects water and sends it to sump (Fig.9) to a perimeter drain. It is designed with a half-round pipe section, with a grated top fitting. When installed, it's flush with the rest of the concrete floor for

a clean, professional job. It is meant to be used as part of an existing perimeter drain system. It spans the staircase area, collecting water that spills down and directs it to the drain and sump pump system. Drains with alarm devices shall be so arranged that there will be no danger of overflowing at the alarm apparatus (Fig.10) and automatic pumping from drainage should continue without flooding the basement. This system can span the entrance of the stairway or it can be extended inside. This is the most reliable and effective basement waterproofing system available.



Fig. 9: Sump chamber for housing two medium duty Pumps



Fig. 10: Control Panel provides advanced power back-up and telemetry systems for automatic pumping

4.0 Factors Need to be Considered During Backfill

As a basement repair contractor, one has to encounter many problems in remedial waterproofing. On a positive-side basement waterproofing replacement project, the task of removing and replacing the perimeter soil and all the improvements can greatly overshadow the scope of the actual installation of the waterproofing materials. Significant settlement of the backfill soils would damage the waterproofing system. There may be gaps between the bottom of the footings and the soil. The extensive below-grade concrete demolition would be required to access the below-grade wall surface for waterproofing.

4.1 Safety

Trench safety must be paramount during construction. Never permit workers to go into un-shored trenches. Expect wet weather which will weaken the trench walls. Keep trenches covered. To reduce exposure, backfill trenches as soon as possible. Fence off the job and post keep-out signs.

4.2 Excavation and Compaction for Remedial Waterproofing of Basement

Before any excavation takes place on a basement waterproofing repair job, the contractor should verify underground utility locations with hand-dug potholes. An important decision on any positive-side basement waterproofing repair job involves the method of excavation to expose the failed below-grade walls. The choice of compaction equipment on a basement waterproofing backfill job depends upon jobsite access. For very large jobs where access is excellent, track rolling with a track loader or dozer may work. However, large track equipment is seldom practical when working closely around existing buildings. Good compaction requires that the soil be layered in "lifts" with the "optimum" moisture content. For compaction of large volumes of earth around existing building, a "sheep foot" roller should be considered.

4.3 Alternatives to Compaction

The gravel and the earth backfill should be brought up in lifts. The geotextile fabric is installed between the gravel and the earth backfill. Gravel costs more than common fill but, unlike soil and fill, gravel does not have to be compacted. This is because the large individual rock pieces fall quickly into a "closest packed" configuration upon placement. The added cost of the gravel will probably be more than offset by the cost savings on compaction.

5.0 Conclusion

The basement waterproofing repair should be undertaken by an experienced repair contractor and not a new construction waterproofing specialist. The liquids and gases in the soil can easily penetrate normal concrete which is permeable because of the tiny capillaries generated during hydration. A variety of waterproofing materials available and one should make a distinction between positive and negative-side applications. It is important to keep in mind the important tasks of a basement waterproofing repair job, the majority of which require knowledge and skills which are not directly related to the application of basement waterproofing materials. A successful repair contractor will possess knowledge and ability in broad variety of trades, and basement waterproofing is among the most important.

Damage Assessment in the Basement during Remedial Works

[Excerpts from "Code of Practice for Remedial Waterproofing of Structures below Ground"; 2008 of PCA (Property Care Association)]

1.0 Introduction

Due to the failure in the waterproofing system, the damage takes place in the raft and walls of any RCC basement due to the seepage of water and dampness, subsequently causing the reinforcement to corrode. Before doing any remedial treatment in the basement, condition assessment should be made by visual inspection and non-destructive testing to provide proper solutions. The visual inspection helps to identify the affected area quickly and helps to select the type of NDT equipment that needs to be used during the investigation. It is very important to collect all the relevant drawings of the basement walls, rafts, joint detailing, drainage system etc. to understand the design aspects of the basement. The surveyor should determine the type, condition & finishes of existing walls, floors and ceilings and note any flat soffits. The images of the basement and its damages are shown from Fig.1 -3.



Fig. 1: Damages in basement walls and floor

- Watermarks due to capillary rise at floor of basement wall
- Brown marks indicating the reinforcement corrosion in basement floor
- White patches on basement floor



Fig. 2: Spalling of concrete due to corrosion in basement wall at floor level



Fig. 3: Dampness and seepages in basement

2.0 Use of Moisture Meters

Moisture meters in a basement should be used with great caution. Due to environmental conditions, a small degree of dampness will usually be present in basements and show on a moisture meter. The meter should be used for comparative readings, and then only by an experienced person. Where hygroscopic salts are suspected to be present, the wall should first be checked. If salts are present, do not use a moisture meter but investigate the cause of the salt's presence. Under no circumstances should a wall be tested for moisture in depth. Results will be meaningless as there will usually be significant dampness immediately behind a tanking system.

3.0 Tests for Contamination

Where it is thought that problems are caused by contaminating salts, either mixed into the materials or which have accumulated over a period of time, an independent laboratory should provide the necessary testing facilities. Simple salt analysis kits for on-site testing of the common salts such as chlorides and nitrates are available, and can be very beneficial. However, they will not provide information on sulphates, acids, oils, etc. This information will need fairly specialized equipment, and is usually only found in an established laboratory. Concrete core samples extracted or concrete drilled samples can be used in a chemical analysis laboratory to find out the level of contaminants. This will help to find out the cause of the damage and consequently take proper remedial measures.

4.0 Condition Assessment

4.1 Assessing the Cause

Dampness on the surface of a waterproofing system will invariably be as a result of one of the following:

- Internal plumbing leaks
- Surface condensation
- Interstitial condensation
- Permeability of the waterproofing system
- A break in the waterproofing system, such as cracking

- A failure or blocking of cavities, drains or pumps in a cavity drainage system. Cracking and de-bonding of a waterproofing system can have many causes, of which the following are the most common:
- Insufficient key on the substrate
- Dirt, dust, paint or other contamination on the substrate surface
- Substrate too weak to accept the renders
- Incorrect render mixes
- Insufficient curing
- Excessive or insufficient suction
- Chemical/salt attack (sulphate, nitrate, etc)

Consideration must be given as to whether the existing structure will require any upgrading prior to the installation of a waterproofing system. The services of a structural engineer may be required at this stage. The following points should be checked during the investigation:

4.1.1 Internal Plumbing Leak

When internal plumbing defects occur, they can manifest themselves in many ways depending on the location and severity of the leak. It is important that the surveyor investigating dampness in the building is aware of the location of water and central heating pipes before investigations begin. When plumbing leaks are detected these should be repaired and the extent of the water damage must be properly quantified. Any making good to the wall and floor finishes should be undertaken by the waterproofing contractor to ensure that this does not compromise the waterproofing system.

4.1.2 Surface Condensation

If the surface is damp, but immediately behind the surface it is dry, then the dampness is almost certainly surface condensation. The use of a diagnostic hygrometer and surface thermometer can be used to check if condensation is occurring at the time of the inspection. If not, a 'condensation telltale' can be left on the surface. It can be electronically interrogated at a later stage to see if condensation has occurred. If there is still doubt, a check for salts will help. The presence of chlorides and/or nitrates would probably indicate that there is lateral penetration of ground water. (Beware however of contamination from other sources, such as salt from water softeners, salts that are introduced in building materials or nitrates from damaged drains etc).

4.1.3 Interstitial Condensation

Much more difficult to verify, interstitial condensation can be checked with a diagnostic hygrometer and deep probe thermometer. Interstitial condensation is most frequently associated with the application of a vapour check to the surface of the tanking system. If this is the case, then the vapour check needs to be removed and the system allowed to dry out before further assessment can be done. If the surface does not dry out, check the system for the presence

of hygroscopic salts which could have passed through the waterproofing system by diffusion.

4.1.4 Permeability of the System

If the waterproofing system has renders and plasters applied over it, it will be necessary to remove these layers prior to assessing where water is permeating through the system. If condensation is ruled out and the damp patches seem to follow an ill-defined pattern, then it is likely that there is some water penetration through the system itself.

4.1.5 A break in the waterproofing system

If the waterproofing system has had renders and plasters applied over it, it will be necessary to remove these layers prior to assessing where there is a break in the system. If the dampness emanates from a distinct point, or points, then a pinprick hole is likely. If it seems to be over a large area, but follows a line, then cracking is likely.

4.1.6 Failure of Drains and Pumps

Blockage of cavities and drains, or a failure of pumps can result in uncontrolled water building up within a cavity drainage system. Water or dampness will come through as a result. It is essential that some form of access for water jetting and/or maintenance is planned and built into the system.

4.1.7 Cracking and De-bonding of Renders

Where renders crack and de-bond, it will be necessary to remove a section of the render to examine the substrate/render interface and, if necessary, to send the render for analysis for contaminating salts. Usually, when a de-bonding render is removed, the cause of de-bond is obvious from a visual inspection, e.g. dust or paint on the substrate, or incorrectly gauged render mixes.

4.1.8 Condensation

Surface condensation can usually be cured by adequate air control such as increasing ventilation, dehumidifiers or a central air conditioning system. Increasing the internal temperature without improving ventilation can make matters worse. Interstitial condensation can be cured in the same way provided any vapour checks present have been removed. If it is found that hygroscopic salts have diffused through the tanking and are causing a problem, one must consider replacing the damaged system. Minor condensation problems can often be cured by adjusting the heating patterns. Leaving the heating on permanently at a lower temperature will sometimes be sufficient.

4.2 Assessment Reporting

The report should include a reference to the following:-

- Confirmation of clients instruction

- Limitations/restrictions of the survey
- Client's required use of the basement and therefore the design grade required
- A description of the existing basement construction
- If known, the soil/ground type and permeability
- Defects/moisture sources that require rectification in conjunction with waterproofing works
- Proposed generic waterproofing method(s) e.g. Cementitious multi coat render, Cementitious slurry, Cementitious dry mortar etc.
- Suitability of the existing structure to accept the proposed system and any up grading works required e.g. a new floor slab etc. NB For type A internally applied systems, the floor slab should be designed by a structural engineer
- How existing staircases will be isolated from the walls and floor, or incorporated into the waterproofing system
- Reference to condensation control/ ventilation/ dehumidification.
- Reference to long term guarantee if applicable
- Detailed Specification for chosen method

In all situations where waterproofing treatments are recommended the specialist should include the following advice:

- The extent of the waterproofing must be clearly described/ indicated. If a full waterproofing system is not being specified then the reasons for this should be stated and the risks arising from a partial system explained. It should be made clear that the limitations of a partial system are at the client's own risk. Where a partial system is being offered it is advisable to offer a full system as an alternative so it is the client who makes the choice.
- Preparation works including removal of existing finishes, joinery items, services etc.
- Advice on fixing to/through the system
- Drawings showing areas to be waterproofed and other relevant details

Where a Cavity Drained System is used, the following information should be provided:

- Position and type of internal drainage including facility for cleaning/inspecting
- Position, size, number and type of pumps - the designed extraction capability of the pumps should be stated
- Pump outlet arrangements
- Pump wiring arrangements
- Membrane type & stud size for walls/floors/ceilings as applicable
- Joint sealing detail if applicable
- Finishes
- Pump/drainage servicing requirements and/or agreement

5.0 Conclusion

The basement should be inspected thoroughly to find out the exact source of leakage and the extent of leakage. All the leaking points should be marked to decide the treatment area. Surface should be cleaned to remove all the loose materials. Based on the findings of condition assessment, remedial measures should be carried out accordingly.

Case Studies of Remedial Waterproofing and Repair of Basements

1.0 Remedial Measures for the Uplift of Basement Rafts

The two case studies discuss the failure of basements due to uplift during monsoon, highlights the common errors in estimation of uplift pressures and indicates the remedial measures that were taken in two different sites in Mumbai.

At the first site in Bandra, a basement raft, 600 mm thick, covering an area of 18 m x 30 m was placed at a depth of 3.5 m below the ground. The overburden was filled with silty clay (murrum) overlying the volcanic tuff. The ground water was within a depth of 1 m. Continuous dewatering was adopted during the construction of both raft and basement wall but was stopped when floor slab construction began. Within a few days it was noticed that the basement was lifting up like a ship in water. The lift was uneven and varied from 0 to 560 mm, but there was no cracking of raft or walls. Drainage boreholes of 200 mm diameter were executed around the building and simultaneous dewatering was commenced. The building slowly started sinking down and rested on the founding strata, albeit unevenly. Perfect seating was not possible due to the presence of boulders and cobbles which had fallen from the sides and rolled underneath the raft when the basement was uplifted. Grouting was carried out with cement and sand mortar (1:1) through the 20 nos. 'Nx' size holes were specially drilled through the raft which went 5 m below the founding tuff strata. High yield strength deformed steel bars of 32 mm diameter were inserted in the grout holes before finally sealing them. The grouting pressure was limited to 100 kPa.

At the second site in Andheri (East), the building was planned with a basement and had 2 wings of 7 storeys each with 530 m² area per floor. The basement raft and columns had been cast and the superstructure was under construction. During heavy rains the adjoining natural drain started overflowing. One of the wings closer to drain got lifted up by damaging the box type tiled water proofing with an uplift varying from 0 to 200 mm. The tilt was seen in many columns and the basement raft that had cracked in the transverse direction. The footings on the crack line were damaged and tie beams connecting footings were sheared with diagonal cracks near the supports. Also, there were parallel vertical cracks in 3 bays in basement retaining walls. The raft was founded on fractured basalt rock which seemed to have provided easy access to water, creating excessive uplift pressure. Remedial measures

involved the complete reconstruction of the damaged wing and grouting of the fractured foundation rock and installing two types of passive anchors. 60 passive anchors were of 50 T capacities (3 Tor rods of 32mm dia in 125 mm dia. holes of 6.5 m depth) and 48 passive anchors were of 33 T capacities (2 Tor rods of 32 mm dia in 4.5 m deep holes of 125 mm dia) were installed to resist the estimated uplift. Thereafter a neat cement grout of 0.5 w:c ratio with non-shrink additive at a dose of 330 g per 50 kg cement was pumped in the grout holes with maximum pressure limited to 150 kPa. The foundation grouting along the transverse line of cracking in the raft showed a remarkably high consumption of grout.

[Source: Indian Geotechnical Conference - 2010, GEO trendz December 16-18, 2010, IGS Mumbai Chapter & IIT Bombay, pp.795-796]

2.0 Early Protection Keeps Water out of Basements for Life

A great example of one such refurbishment project that has made smart use of waterproofing is the Lancasters overlooking Hyde Park in London. The 120 m-long terrace was in a state of considerable disrepair following its poorly executed conversion to a hotel in the 1970s. As part of a USD 80 million development project to convert the building into 77 prime residential apartments, the Grade II-listed facades are being retained, while an all new concrete interior has been built within the structure. To provide additional saleable space, three subterranean levels have been created to provide car parking, fitness suites, swimming pools and a business centre, all for exclusive use by the residents. An integrated waterproofing system was selected in the same project.

The system is a pre-bagged render that is a blend of kiln-dried specially graded aggregates and cements. Packaged in four grades, it includes a liquid waterproofing admixture that is mixed into the render and prevents water ingress. Once applied to the walls and floors, the multi-layered render system bonds monolithically to the prepared substrate. The admixture within the render reacts to water by turning into a jelly-like substance, blocking all gaps and capillaries and providing an impregnable and invisible seal.

The basement was divided into four areas: habitable, car parking, plant and leisure facilities, as well as a network of interconnecting corridors. The different areas required different standards of waterproofing in line with BS 8102. This classification of standards sees waterproofing ranged across four grades, from Grade One, suitable for environments where there can be a tolerance of slight seepage and dampness to Grade four, a 100% dry environment that is suitable for the storage of sensitive materials or electronics. At the Lancasters, all below-ground habitable areas, leisure facilities, kitchens and plant rooms were waterproofed to grade three. A high functioning ventilation system was installed to guarantee

excellent air circulation, limiting the risk of mildew, mould and other forms of internal dampness, thus ensuring that these areas were suitable for prolonged usage by inhabitants and staff of the development. The car-parking areas were waterproofed to Grade 2, meaning that there will be no water penetration into these spaces. The communication rooms of the building, containing sophisticated electronic equipment, were all waterproofed to Grade Four, providing protection against any possible water or vapour ingress.

(Source: Concrete, Concrete Society, UK, Vol. 44, No.4, 2010, pp-17-18)

3.0 Waterproofing a Newly Created Basement in an Existing Property

This case study discusses how a new basement has been dug beneath an existing four-storey Victorian property in London and has been waterproofed with a cavity drain membrane and a vapour membrane.

Following a highly complex support and dig out process, which was carried out in sections, the new basement was formed using a contiguous pile construction with a concrete ring beam, providing a watertight concrete box - normally acceptable as a standalone system. In this instance there had not been the opportunity to carry out trial holes to check the soil conditions below the property and to ascertain water table levels, therefore a watertight concrete system could not be considered as a standalone system under the Standard; Management was asked to provide a specification for waterproofing and initially, a cavity drain membrane system was recommended to the walls and floor with Aqua Channel conduit around the perimeter discharging to sumps to the front and rear of the property.

However, the floor specification was amended to maintain minimum headroom to facilitate the client's requirements for the installation of under floor heating. Two coats of liquid-applied vapour membrane were laid to the floor slab instead, continuing up and over a perimeter step detail, which housed the drainage conduit and a 150 mm upstand to the internal walls.

The whole system was maintainable, as any leaks would present themselves through the kicker joints of the brick detail, where the aqua channel would direct water to the two sump chambers. The odour resistant non-return valves were incorporated on the outlets into the sump chambers, to avoid odours caused by any build-up of moss or other detritus. The vapour membrane was a single component acrylic modified coating that once cured, provides an effective, physical, waterproof barrier that bonds fully to the floor slab and therefore can not be punctured. Its speed and ease of application offered further benefits to the installation. The first coat can be applied 24 hours after installation of a new floor slab

and the second coat just 40-60 minutes later. Although not a requirement in this particular application, the vapour membrane also formed an effective barrier against radon, methane and carbon dioxide and therefore all joints on the membrane system were double taped and sealed for gas retention as a further safeguard.

(Source: Concrete, Concrete Society, UK, July, 2009, pp-37-38)

4.0 Historic Restoration of National Archives and Records of an Administration Building

The Adam's Express Company Building was originally constructed in the 1911 to 1912 period, being part of the overall Union Station railway facilities in Kansas City, MO. The building is approximately 19.5 m wide by 46 m long, and also has a large-height basement or "concourse" that is connected to the original Railway Express Administration (REA) building to the east, via a 6.1 m wide tunnel that connects the Union Station head house with all of the original buildings in the area. At the southwest corner of the basement is the original tunnel access to the Union Station Power House, which is now under development to become the future home of the Kansas City Ballet. The building was principally vacant for a number of years, except for some storage and office use by Union Station on the first floor and basement and, as such, was not temperature controlled or maintained to any degree, leaving the aging structure to the ravages of corrosion and degradation. The structural condition study of the building was carried out in August 2007, so as to review the available record drawings, conduct visual, photographic, and sounding surveys of the exterior façade and interior framed slabs of the building, perform forensics testing of the existing concrete for strength, prepare preliminary repair plans and details, and summarize recommendations with an estimate of probable construction repair costs. The condition study was completed in September 2007, and construction was set for early 2008. The basement remedial was part of the same repair project.

Before the work could progress with any efficiency in the large basement or concourse space, the contractors had to remove many years of accumulated storage and debris; the basement slab was always wet from the many active leaks, and a number of holes in the foundation walls had to be mitigated. Following the general clean-up of the basement space, the contractor power-washed the walls and basement slab to remove many years of mud, coal dust, and various unsuitable materials in preparation for the specified repairs.

Some nonmoving, non-leaking structural cracks above the groundwater table were epoxy injected to re-adhere the concrete. The existing pipe penetrations and exterior loading dock freight and coal chute holes were fully in-filled with reinforced and doweled full-depth, form-and-pour concrete. The pipe penetrations were routed out

and in-filled with vertical repair mortars. At the same time the concrete repairs were being made, the repair contractor injected the specified polyurethane chemical grout into the many active leaks to stop the constant infiltration which, of course, was of greater volume during wet weather conditions. Following completion of the concrete slab and wall repairs, epoxy crack, and urethane grout injections in the basement, the engineer required that the entire basement wall surfaces apply a crystalline waterproofing system to the first floor grade level, which amounted to a total of some 840 m² of wall surface. The leaks were checked.

(Source: Concrete Repair Bulletin, Vol. 23, No.1, pp.20-22)

5.0 Application of Crystalline Technology for Basement Waterproofing

Likhite Commercial Project in Dombivli, Thane, India at an area of 2000 m² faces several problems of leakage at the site like leakage in the retaining walls, active leakage from the three sumps and accumulation of water up to the top of the sumps, in spite of previous external box-type waterproofing from the outside. This basement waterproofing project was then finally rectified with the crystalline waterproofing method from the negative side. In the case of sumps, the side walls of the sumps had to be plastered. At the base of the sumps, screeding with cement and sand up to 25 mm was done. The sumps were then filled and on the top of the sumps, crystalline waterproofing product in the form of powder was sprinkled. The various chemicals used were crystalline waterproofing, proprietary joint filling material and proprietary plugging compound.

(Source: NBM & CW, Vol.13, Issue 1, July 2000 pp.216)

6.0 Moisture Ingress through Basement Walls Rectified with Crystalline Materials

The walls of a basement-level archive room at a leading Victorian University in Australia were experiencing severe concrete degradation and moisture ingress due to unforeseen placement and compaction issues during initial construction. The same rectification was carried out by National Concrete Solutions, Australia with crystalline repair products for reinstatement of the walls and to provide a protective barrier around steel reinforcement.

Preparation for the basement wall involved the removal of existing paint and other contaminants from areas that were damaged from water ingress. Additionally, all deteriorated concrete areas were pressure-washed to provide an open capillary, clean absorbent surface, and bony and honeycombed sections were chipped out to a square-edged substrate and surface laitance was removed. Upon successful completion of surface preparation, the substrate was saturated with water and

crystalline was applied as a slurry coat to treat the exposed steel and reinstate a passive alkaline barrier around the reinforcement. A high-build repair mortar for the patching and resurfacing of deteriorated concrete was then used to repair back to contour with the surrounding concrete. Crystalline coating was uniformly applied to all concrete surfaces with a semi-stiff bristle brush. It produced a harder finish, providing enhanced concrete durability and additional waterproofing integrity.

A dense, fully-developed crystalline structure had formed within the capillary tracts of the concrete to completely block the flow of water after application of crystalline at a depth of 50 mm into the concrete sample at 28 days. A curing compound of self-dissipating (2-3 days), non-film forming product was applied as a fine mist spray, both during and after the coating to accelerate the crystalline process and assist in product curing for optimum performance.

(Source: ReBuild Vol.4, No 4, Oct-Dec 2010 and excerpted from News Bulletin of ACRA , Australian Concrete Repair Association)

7.0 Remedial Waterproofing and Restoration Measures of a Multi-storied Building

The basement floor of a multi-storied building in Pune, India had problems of leakage, dampness and pools of water on the floor. This posed problems of moving around and using the floor and also proved dangerous as the basement housed electrical circuits and a DG set. A fully dry environment was necessary to ensure safety to life and property against electric shocks and fire. The physical observations made at the time of inspection revealed the following distress at the site:

- Dampness in walls with water oozing out at several locations
- Water oozing out of the floor
- Ponding of water at certain isolated locations
- Puncturing of RC slab due to high pressure of water at few points.
- The main cause was rising moisture through the floor slab and masonry walls. This was further aggravated by the presence of a high water table.

The restoration measures were aimed at arresting the leakage of water and rising dampness by provision of suitable treatment to walls and floor.

a. Treatment of floor

- I. Removal of existing cement plaster,
- II. Pressure grouting of slab with neat cement slurry modified with plasticizing cum expanding additive and curing.
- III. Provision of 1:2:4 dense concrete overlay: The concrete was modified with integral waterproofing admixture mixed at a dosage of 130 ml per bag of cement and a w/c of 0.45 and curing was done.
- IV. Provision of acrylic polymer modified coating in two coats to a thickness of around 1 mm.
- V. Provision of 25 mm thick 1:3 mortar screed: The screed was modified with the addition of integral waterproofing

admixture at a dosage of 130 ml per bag of cement.

b. Treatment to walls

- I. Removal of existing plaster to a height of 1 m above the floor system.
- II. Raking of masonry joints to a depth of 25 mm and cleaning them.
- III. Pointing the joints with 1:3 cement sand mortar. The mortar was modified with integral waterproofing admixture added at 130 ml/bag of cement and cured.
- IV. Fixing of keys J pins to facilitate fixing of chicken mesh reinforcement.
- V. Provision of acrylic polymer coating, to a thickness of around 1 mm in two coats.
- VI. Provision of 25 mm thick, 1:3 cement mortar screeds reinforced with chicken mesh. The screed was modified with integral waterproofing admixture added @ 130 ml per bag of cement.

c. Treatment to walls

- I. Excavation of soil along the periphery of the walls to a depth of 1.2 m and a width of 0.8 m to form a trench, the bottom of which was compacted
- II. A PCC bed of 1:3:6 was provided at the bottom to a thickness of 150 mm.
- III. Side wall of the trench was constructed in stone masonry.
- IV. A concrete overlay of 1:2:4 was provided over bed concrete to a proper slope and this was continued and connected to a natural water source.

(Source:<http://www.constructionupdate.com/products/constructionworld/2002/JUNE2002/017.html>)

8.0 Cavity Drained Membrane Waterproofing System Introduced in an Existing Basement in a Business Park

The project was to waterproof an existing basement under a country house business park in Bowcliffe Hall, Bramham, UK. The customer needed a solution that would give a completely dry internal environment as the room was to hold state-of-the-art computer equipment, telephone lines and power supplies. The contractor finalized the most reliable and trouble free waterproofing option available. They decided on the cavity drain membrane system to make the basement dry and fit for its intended use. The vaulted ceiling and walls were lined in cavity mesh membrane, which allowed for plaster directly onto it. This maximized space and ensured the shape of the vaulted ceiling was retained. The floor was lowered and a new concrete slab installed with a recess at the wall/floor junction in to which base drainage conduit was applied then the whole slab was overlaid with cavity mesh clear membrane. Water collecting in the drainage conduit was then managed into a predesigned sump which was equipped with two medium duty NP400 Pumps. Those were controlled by an automatic control Panel which provided alternate pumping, programmed pump testing, alarming in the

event of a pump failure, and switching to a battery backup in the event of a mains power failure. The floor had to be load-bearing as some computer equipment weighed up to 500 kg. Another layer of concrete was applied on top of the floor membrane to give the required strength. All other tasks such as joinery and plastering, avoiding any future split responsibility issues were provided with an insured guarantee for the waterproofing.

(Source: http://newton-membranes.co.uk/wp-content/uploads/2011/05/CaseStudy_Newton-Basement_BowcliffeHall_Bramham_Dec10.pdf)

9.0 Combined Cementitious and Cavity Drained Membrane Waterproofing Systems used to Combat Extreme Water Ingress

A century old property in the idyllic countryside location of Lingfield, Surrey, UK had undergone a significant renovation programme including the full underpinning of the existing property to create an expansive basement living area. During the construction the existing footings were exposed and a full underpinning schedule was initiated during the same period (summertime) and no evidence of water was present and the concrete placement. The slab construction was performed within a timely manner. However, after a prolonged period of rainfall the surrounding areas reached saturation and the property was subjected to extreme hydrostatic pressure which in turn resulted in over 20,000 litres of water entering the property overnight.

The source of the water ingress was through the drypack construction joints between the existing brickwork footings and the underpin. With the situation looking desperate, the design and build contractor called a specialist basement contractor to provide a fully guaranteed basement waterproofing solution.

With such extreme amounts of water entering the through the pins, the flow of water needed to be slowed down significantly in order to put in a maintainable and guaranteed basement waterproofing system into the construction. Two basement contractors specialized in cementitious system and cavity drained waterproofing system respectively put together a combination of fast setting cementitious products into the specification to deal with the problem. Initially the flow was impeded using a water plugging compound, a fast acting cementitious product which cures within 40 seconds of contact with water. Once the same product was applied to a 300mm band each side of underpins then followed by two coats of flexible cementitious slurry to support and stop as much water as possible. Once the cementitious slurry products were applied then the full internal drained cavity system was installed (Fig.1). This included cavity mesh wall membrane curtain hung down (Fig.2) the earth retaining walls terminating into the base drain for allowing the water to be drained to the sump for further pumping.



Fig. 1: View of cavity drain installation



Fig. 2: Cavity mesh wall membrane curtain being hung down during installation

(Source: http://newton-membranes.co.uk/wp-content/uploads/2011/05/CaseStudy_Newton-Basement-Waterproofing_Lingfield-Surrey_Nov10.pdf)

10.0 Cavity Drained Membrane Waterproofing System in a Refurbished Basement Waterproofing Project

The project was to install a waterproofing system to the basement vaults of the east residence of the British Museum, London. This highly sensitive listed structure needed to be waterproofed to a Grade 3 Habitable environment in accordance with BS8102. The area was previously waterproofed with a Type A cementitious system which had failed and the artifacts stored in the area were subjected to water damage. The cavity drained membrane system was installed with cavity mesh applied to the vaulted arches and walls with base drain installed within a rebate at the wall floor junction. A rendered finish was applied and cavity mesh was laid to the floors with a screed finish. The base drain allowed for non pressurised movement of water to the sump and pump system for removal.

(Source:http://newton-membranes.co.uk/wp-content/uploads/2010/01/Case-Study_BritishMuseum_Aug09.pdf)

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Topic : Entrepreneurship in Waterproofing, Structural Protection and Repair of Concrete Structures

Date : 30th July to 10th August 2012

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Date : 12th & 13th July 2012

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Date : 26-27 July 2012

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Organised by : NITTTR, Chandigarh & DFI-SPR

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Date : 4th August 2012

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• Collaborative Training Programmes

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Venue : Institute of Architects, Guwahati

Topic : Polymeric Materials for General Building Repair

Date : 25th August 2012

Venue : Indian Concrete Institute (ICI), Pune

Topic : Chemical Admixtures for Concrete- Chronology, Applications & Compatibility

Date : 1st Sept. 2012

Venue : PWD, Akola

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Date : 14th Sept. 2012

Venue : Ramdeo Baba College of Engineering and Management (RBCOEM), Nagpur

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Date : 22-23 Aug. 2012

Venue : The Civil Training Institute and Research Centre, Borivali, Mumbai

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Topic : Waterproofing of Concrete Buildings and General Repairs

Date : 28-29 Aug. 2012

Venue : PWD, Worli, Mumbai

Organised by : DFI-SPR & PWD, Maharashtra

• Students' Training Programmes

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Colleges: Shriram Polytechnic, Airoli, Md. Saboo Siddique College of Engineering, Byculla, K.J. Somaiya Polytechnic, Vidyavihar, Government Polytechnic, Mumbai, D.Y.Patil College of Engg., Pune, G.H. Rasoni College of Engg, Pune, Imperial Collge of Engg. Pune, Rajarshi Shahu College of Engg, Pune, Vishwakarma Institute of Technology (VIIT), Pune, Shivaji College of Engineering, Akola.

• Presentation

Mr. T. P. Banerjee presented on various topics of Waterproofing in 'QIP Programme' conducted by Civil Engineering Dept. of IIT Delhi from 16 to 20th July, 2012

Mr. E. Gopalkrishnan presented on "Advanced Diagnostic Services for Concrete Structures" - on Engineers Day celebration at MAHAGENCO, Mumbai

Forthcoming Training Programmes

DFI-SPR has scheduled the following training programmes for the upgradation of knowledge base of Practising Engineers, Waterproofing and Repair Contractors, Consultants, Architects, Faculties and Students from Engineering Colleges.

Sr. No.	Date	Venue	Topic	Fees	Details of the topic
1	17 - 18 Jan 2013	DFI - SPR, Andheri (E), Mumbai	Building Maintenance Waterproofing and General Repairs	₹ 4000	<ul style="list-style-type: none"> • Manifestation of weathering distresses in concrete buildings • Diagnosis and condition assessment • Advanced Waterproofing Materials, Systems and Application Methodologies • Understanding cracks - classifications and patterns • General repair techniques and materials • Strategic planning and maintenance of buildings
2	7 March 2013	DFI - SPR, Andheri (E), Mumbai	Corrosion in Concrete and Protection Measures	₹ 2000	<ul style="list-style-type: none"> • Principles of corrosion and consequent damages in concrete • Diagnosis and evaluation of corrosion distresses • Protection measures - techniques and materials

Corporate Training Programme

In addition to the above scheduled programmes, we do organize separate corporate training programmes on specific topics as per the needs of the customer.

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Contact Details:

The Dean - SODE, NICMAR, 25 / 1, Balewadi, N.I.A. Post Office, Pune - 411045.

Phone : (020) 2729 2671 / 2729 2512 (Extn. 202) Fax : (020) 2729 1057, Email : code@nicmar.ac.in

Forthcoming Conference

Indian Institute of Technology Madras, Chennai, India is organising an International Conference on "**Rehabilitation and Restoration of Structures**" on February 13-16, 2013. The conference of sub-themes are experimental testing (in-situ, laboratory; including NDT), numerical modelling, structural strengthening, new materials for repair, seismic response and retrofit, case studies.

Conference Secretariat:

BTCM 2013 Conferences, Room 205, Building Sciences Block, Department of Civil Engineering, Indian Institute of Technology Madras, Chennai, 600 036, Telephone: +91 44 2257 5255 Fax: +91 44 2257 4252, Email: btcmconf2013@gmail.com

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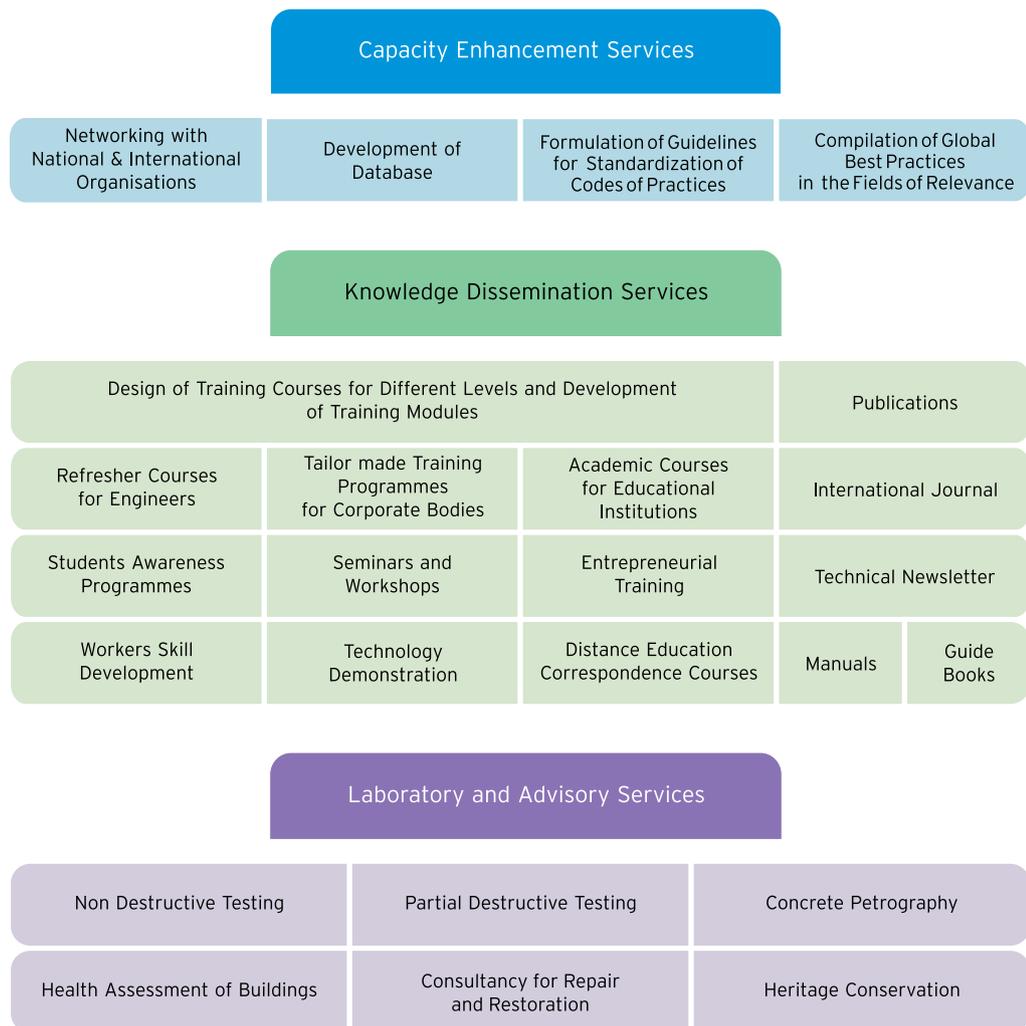
VISION

To become a premier national knowledge and skill development centre for capacity enhancement in waterproofing and other areas of repair, restoration and renewal engineering based on sustainable and green technologies.

MISSION

To act as a platform of national and international networking for sharing of knowledge and practices in the fields of waterproofing, repair, restoration, and renewal engineering in the context of life cycle assessment of the built environment for adoption of best practices by the country's construction industry.

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Our Newsletter is focused on good concreting practices, waterproofing, repair, rehabilitation and maintenance of concrete structures and buildings. Any reader, who wishes to contribute his or her experience or achievements in this field to our Newsletter for wider dissemination, may send the details to:

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