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

a. Watermarks due to capillary rise at floor of basement wall
b. Brown marks indicating the reinforcement corrosion in basement floor
c. 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 m^2 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