

Waterproofing Challenges and Suggested Remedial Measures for High Rise Buildings: A Case Study

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Abstract— Leakage can occur in both old and new constructions. Mostly it has been witnessed in old constructions. This indeed is a major problem faced by the buildings. As it is affecting both exterior and interior look of the buildings and also causing damage to structural members. It also harms paint of the wall. The problem includes survey of not only leakage, but also dampness and seepage in the residential blocks. This study provide a better and more scientifically based understanding of the role of waterproofing materials to assist the prevention of moisture from penetrating sub-grade walls and slabs. The significance of the research topic is to provide a review of the development of waterproofing materials in implementing waterproofing system in building industry with some case study reference in the current market in India.

Key words: Water Proofing Chemicals, Dampness, Leakage, Moisture, Damp Proofing

I. INTRODUCTION

Now a day's waterproofing process is one of important treatment which is given to the building during construction work. In waterproofing process there are taking precautions and care for leakage proof buildings. Water proofing is a treatment on a surface or structure to resist the passage of water in the presence of hydrostatic pressure. Waterproof or water-resistant describes objects relatively unaffected by water or resisting the ingress of water under specified conditions. Such items may be used in wet environments or underwater to specified depths. One of basic requirements in case all the buildings is that the structure should remain dry as far as possible. If this condition is not satisfied, it is likely that the building may become inhabitable and unsafe from structural point of view.

The following two important treatments to be given to the buildings to control damp, water leakage and termites will be discussed:

- Damp-proofing
- Water proofing

A. Damp Proofing:

One of basic requirements in case of all the building is that the structure should remain dry as far as possible. If this condition is not stratified, it is likely that the building may become inhabitable and unsafe from structural point of view. Hence, in order to prevent the entry of damp in to a building the courses, known as the damp-proofing courses, are provided at various levels of entry of damp in to building.

1) Causes of Dampness

The dampness in a building is universal problem and the various causes which are responsible for the entry of dampness in a structure are as follows:

- Rising of moisture from the ground.

- Action of rain.

- Exposed tops of walls Condensation.

2) Importance Sources of Dampness:

Some important sources of dampness are listed as follows:

- Defective junctions between roof slab and parapet wall.
- Defective roof covering of pitched roofs.
- Faulty eaves and valley gutters.
- Improper rain water pipe connections.
- Inadequate roof slope.
- Moisture from wet ground below foundations.
- Splashing rain water.
- Unprotected tops of walls, parapets and compound walls etc.

B. Water Proofing:

Over the past two decades, the construction industry has had technological advances in waterproofing materials, including integral waterproofing systems as well as more advanced membrane materials. Integral systems such as hycrete work within the matrix of concrete structure, giving the concrete itself a waterproof quality. There are two main types of integral waterproofing systems: the hydrophilic and the hydrophobic systems.

1) Hydrophilic System:

In hydrophilic system typically uses a crystallization technology that replaces the water in the concrete with insoluble crystals. Various waterproofing agents available in the market claim similar properties, but not all can react with a wide range of cement hydration by product, and thus require caution.

2) Hydrophobic System:

Hydrophobic systems use fatty acids to block pores within the concrete, preventing water passage. Sometimes the same materials to keep water out of buildings are used to keep water in such as for a pond liner or pool liner. Generally new technology in waterproof membranes relies on polymer based materials that are extremely adhesive a seamless barrier around the outside of a structure.

Comparison between above two methods of Waterproofing shown in Fig.1.

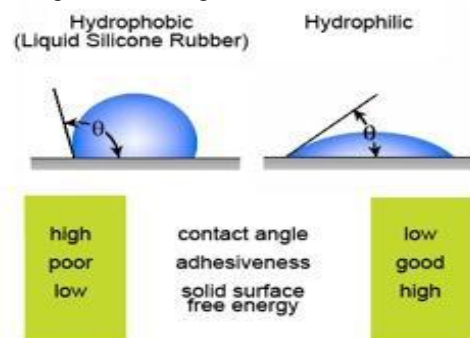


Fig. 1: Hydrophilic System and Hydrophobic System

II. LEAKAGE

Leakage is said to be the accidental admission or escape of water through a hole or crack.

The water leakage term in buildings is used to mean the coming out of water from components like walls and floors of the buildings.

To prevent water leaks in the house, you need to address all the possible causes of this problem. Find the areas where water leakage is prominent and check these areas every once in a while, around every 6 months or so. This will help you also keep your home in good condition because you will be able to observe all of the parts of your home. In case water leaks in your house already, you need to be smart and solve the problem immediately, may it be through your own hard work or by hiring a professional repairman.

Some signs of leakage are:

- Active water leakage, water ingress through any part of the building, or from the pipe work / waste pipes.
- Dampness, moisture, wetness or signs of dampness on the floor, wall, ceiling or roof of the building.

Some location where leakage is caused is:

Underside of roofs, Ceiling with internal areas, Wall, Floor and Window, Basement, Drains or pipes.

There are various effects of leakage that can damage other building finishes and can also cause health problems due to growth of molds, mildew, dust mites, and other biological air contaminants.

A. Why Does Water Leak Though Joints?

The phenomenon of the leakage through the building joints is shown in Fig.2.

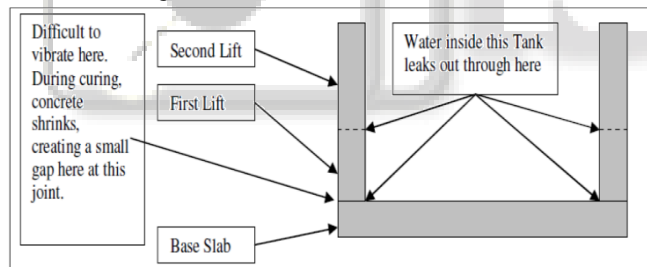


Fig. 2: Schematic diagram of water leaks through joints

B. Why Leakage in Structural Components:

Following are some key reasons for the building leakages are:

- Poor ratio of concrete mix.
- No proper vibration while concreting.
- Concrete not being dense.

Location of Leakage	Possible Causes
Underside of roofs (such as flat roof, podium roofs) and bottom of light wells	Damage or deterioration of waterproofing layer.
	Leakage at access doors or top hatch doors.
	Deterioration of corrugated steel roofing materials and joints.
	Defective enclosure for water tanks.
Ceiling with internal areas above	Leakage from bathroom or kitchen above usually caused by seepage from fitments, bathtubs, shower trays, buried pipes or drains due to improper construction of joints.
	Mal-function of waterproofing in nearby external features such as balconies or external walls above.
Wall	Water penetration through external wall defects such as cracks, joints, honeycombs, spalling, weak points, holes, punctures, leftovers of debris.

- Poor water curing.
- Poor selection of concrete raw materials.
- Bad workmanship.
- Damages caused to the building by various other agencies can also be a reason for building leakages.
- Construction, Expansion or Extension joints not joined as per specifications.

III. OBJECTIVES

The main object of the project is study of leakages and its causes and finding appropriate remedies. Some other objectives of the project are listed below.

- Study of leakage and their identification methods.
- Study of waterproofing and their methods.
- Visual Inspection of leakages, dampness & seepage.
- Determining the probable causes.
- Finding and finalizing effective remedies for the same.

IV. STUDY OF WATER LEAKAGE LOCATION AND ITS CAUSES

The study was conducted in new construction Residential site Vicenza high breeze: Tower A, B, C, D, E and F. The interested area for the study was taken as Wash, toilet, balcony, terrace, common toilet and garden area where the maximum chances of leakages.

The purpose of selecting an ongoing construction is to repair it at an early stage to improve its life period.

Once the survey work is completed, the next work is to find and suggest proper remedies for the same. The basic idea of this project is to ensure that the remedies suggested by us prove to be effective in curbing the menace of leakage and seepage problems. The remedial measure must not be only effective but also economic. It should be easily available. The implementation must be simple and not time consuming.

V. METHOD AND MATERIAL

Initial inspection: This included identify the water leakage location and its causes by the physical verification.

Market Survey: It includes local market survey on waterproofing material available for waterproofing process.

Analysis of different Water proofing Materials: It involved estimation & costing of the waterproofing area based on the market survey.

Finally after above all steps we suggest the economical waterproofing material against conventional method used on site.

A. Site Investigation for Water Leakage:

	Water penetration through defective external wall finishes such as loosened mosaic tiles, cracked ceramic tiles & paint surface.
	Water leakage through partition walls between units of pre-fabricated elements or between buildings.
Floor	Defective bathroom fitments such as bathtubs, shower trays or hand wash basins, or the improper installation of pipework or necessary sealants.
	Temporary floods and overflow.
	Seepage from defective pipe-works or sanitary fitments.
Window	Improper fillings around frames.
	Deformation of frame, defective gasket, sealant or putty for window glass setting or frames.
	Air conditioning box or platform tilting inwards.
	Insufficient sealant around air conditioning units.
Basement	Inadequate or damaged waterproofing tanking.
	Deterioration of water stops at Construction/movement joints.
Buried or underground drains or pipes.	Seepage through defective joints or pipes caused by poor installation or differential movements / settlements, movement of building structures or ground or water table.
	Corrosion of pipes at junctions with floors or walls.
	Invasion of water into conduits and distribute throughout the network.
	Blockage leading to excessive pressure built up.
	Attack by rodents or roots of plants.

Table 1: Water Leakage Location and Its Causes

B. Conventional (Brick Bat Coba) Method used On Site:

All existing treatment, coatings on roof slab top is to be removed and surface cleaned by hard wire brush and washed with water. The surface should be free from any oil, grease, dust etc. Remedial measured by provided to all structural cracks. Expansions joints should be treated as per standard practice as shown in Fig. 3.



Fig. 3: Laying of brick bats

1) Procedure of Brick Coba Method:

- On the above green mortar, a layer of brick bats, soaked overnight in water, is laid, having an average thickness of about 110 mm, about 70 mm near rain water pipe and 150 mm at ridge.
- The gaps between the brick bats are generally kept between 15 and 20 mm. These gaps are filled with cement sand mortar, 1:4, admixed with water proofer. In hot and dry weather, the surface should be covered with wet gunny bags immediately after finishing. Curing should start next day and continued for 7 days.
- The top surface is then finished smooth with 20 mm thick cement sand mortar, 1:4, admixed with water proofer. All liquid admixtures should be mixed with the mixing water. The surface when green is marked with 300 mm false squares. Curing is to be done by pounding.

The procedure also describes by the Figs. 4 and 5.



Fig. 4: Cementing after brick bates lying



Fig. 5: Testing procedure after 7 days

C. Market Survey:

There are umpteen companies available and wide material available for different waterproofing materials of different level and different problems.

Few companies are:

- Dr. Fixit
- Zydex
- Sika

- K-fix

Few technical specifications or information of waterproofing material from above listed companies are shown in below Tables.

Properties	Specification	Results
Nature	-	Two component
Mixing ratio, By weight (Base : Hardener: Water)	-	1:1:1
Consistency	-	Free flowing smooth paste
Pot life at 30C, Minutes	-	40 minimum
Surface drying	-	5-6

time at 30C, hrs		
Intercoat periods, at 30°C, hrs	-	6-8
Water absorption at 38°C	ASTM C 870 : 90	Nil
Adhesion strength, N/mm ²	ASTM D 454: 02	2.5 (Failure occurred in the system)

Table 2: Technical Information of Dr. Fixit Dampgaurd

Properties	Result
Nature	Two -component
Consistency after mixing	Free flowing fine paste
Pot life at 30°C	1-1.5hrs
Time period between two coats at 30°C	6-8hrs

Table 3: Technical Specification of Kem Proof 75

Application	Mixing properties				Consistency
	Cement (in kgs.)	Kemproof 75 (in kgs.)	Sand (in kgs.)	Water (in litres)	
Water proofing	1.5	1	-	-	Brushable
Bonding coat	1	1	-	-	Brushable
Polymer mortar	2.5	1	7.5	3	Brushable

Table 4: Usage Guidelines of Kem Proof 75

D. Material Analysis:

Material used: brick bates, sand, cement, waterproofing chemical.

1) Details of Material:

a) Brick Bats:

- Class of Brick: First class
- Type of Brick : Standard
- Size of Brick : 19cm × 9cm × 9cm
- Size of Brick bates :
- Length : 9 to 10 cm
- Width : 8 to 9 cm
- Height : 8 to 9 cm

b) Cement:

- Brand of Cement : Ultratech
- Grade of Cement : 50

c) Waterproofing Chemical:

- Company: K-Fix Proof 75
- Proportion: 1 Lit. Chemical: 100gm Cement: 1 Lit. Water (The prepared mix applied on the surface area)

E. Labour Analysis:

On theory basis there are requirement of labours are as follows:

Male Labour	Female Labour	Bhisti	Mason
2	3	3/4	1/4

Table 5: Labour Requirement of B.B.C.C Work for 2.83 m³

Mistry	Labours	Bhisti	Mason
1/2	16	3	8

Table 6: Labour Requirement of Finishing Work for 10 M³

But on site there are 1 male labour and 1 female labour or sometimes 1 labour is work for whole process for one operation.

F. Schedule of Rates:

Based on the market survey and standard SOR following table has been prepared.

Sr. No.	Description of Work	Rate In Rs.	Per
1	B.B.C.C.(Material + Labour Charge)	55/-	Sq. ft.
2	Filling (For Tower A)	5500/-	Flat
3	Filling (For Tower B to F)	4000/-	Flat
4	Waterproofing Chemical	3100/-	10Lit.

Table 7: Standard Rates Taken for Case Study

VI. SITE CALCULATION

Based on the measurement and schedule of rates following table has been prepared for Tower A to F which includes the total quantity and total cost.

Tower	Description of Work	Total Quantity	Unit
A	B.B.C.C (1:3:6)	24000	Sq. ft.
	Filling Work	32	No.
B to F	B.B.C.C (1:3:6)	78500	Sq. ft.
	Filling Work	160	No.

Table 8: Total Quantity for Tower A to F

Total Quantity	Description of Work	Rate	Per	Total Amount
24000	B.B.C.C (1:3:6)	55	Sq. ft.	1320000
32	Filling Work	5500	No.	176000
78500	B.B.C.C (1:3:6)	55	Sq. ft.	4317500
160	Filling Work	4000	No.	640000

Table 9: Total Cost for Tower A to F

Following shows the total quantity of water proofing.

- For tower A : 30,400 sq. ft
- For tower B to F : 7,20,000 sq.ft.
- For terrace of tower A : 8000 sq.ft
- For terrace of tower B,C & D : 27,500 sq.ft.

So total area of water proofing is 1,37,900 sq.ft. For the above total area, total cost of waterproofing for whole project is Rs. 84,00,500/- and that per Sq. ft. is Rs. 61/- (or per m² is Rs. 655/-)

VII. RESULT

Based on the above research following table has been prepared as a result got on the site.

SR. NO.	PROPERTIES	CHEMBOND	DR. FIXIT
1	Permeability at 5kg/cm ²	18 mm	11 mm
2	Compressive Strength in N/mm ²	12.20	16.71
3	Cement in Bags	65	50
4	Coverage in per kg per coat	7.5m	8.5m

Table 10: Comparison between two Waterproofing Chemicals

VIII. CONCLUSION

From the above result we can conclude that the permeability of Dr. Fixit damp proof is reduced by 38.88% compared to that of Kembond K-Fix 75. Hence we can say that on site the best suited chemical is Dr. Fixit damp proof so as to increase the life of structure.

We can also conclude that the construction process needs proper supervision, better workmanship, use of chemicals in required amount, qualitative materials and importantly maintenance of structural components.

Final conclusion from the above project is that the total cost of waterproofing is reduced by Rs.3, 63,000.00 /- and also we can say that workability of chemical suggested in this project is more efficient than the chemical which was used on site.

IX. SUGGESTED PREVENTIVE MEASURES:

From the study, we can suggest following preventive measures are:

- Prevent leakage or passage of water and water vapor.
- Provides protection against penetration through the exterior enclosure of buildings of groundwater and rainwater.
- Prevent water to penetrate into a building via capillary action and hydrostatic pressure.
- Waterproofing membranes are applied to the outside or "positive" side, of the structure.
- A selection of a waterproofing material should consider the cost, site condition (a soils engineer should be consulted to determine the types of soil that are present and how they will impact the system's performance, while a waterproofing consultant offers guidance on problem soils), expected performance qualities of the waterproofing material (in terms of withstand hydrostatic pressure, chemical attack and vapour permeably) and life expectancy.
- Other factors include ease of application, problems with protecting the material during construction, availability in local condition and, of course, side of application.

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