



CAUSES AND MAGNITUDE OF DAMPNES OF BUILDINGS IN COASTAL REGION OF BANGLADESH; A STUDY IN KHULNA CITY

A.K.M. Kausarul Islam* and Kh. Mahfuz-ud-Darain
Architecture Discipline, Khulna University, Khulna 9208, Bangladesh

Abstract: Salinity has been considered as one of the major problems for building all over the world. The effect of salinity can be observed through the presence of dampness in building materials. Buildings in the coastal regions of Bangladesh are facing serious problems with dampness. Raised sub-soil water level and the presence of higher percentage of salinity in ground water are the common phenomena in this region. The building materials available in this region also contain higher percentage of salinity, which causes deterioration of the building materials. Khulna, one of the largest cities in Bangladesh is facing this problem. In recent years the sub-soil water level and saline intrusion into the soil has been increasing gradually. These factors are causing huge wastage of money yearly for protecting the buildings from dampness. Different attempts have been taken at the government and private levels for the prevention of dampness in structures. It has been observed that the conventional methods cannot cope with the increasing rate of the dampness. A proper research is very much needed to find out a sustainable solution and strategy to check dampness in the buildings. In doing this, it is important to find out the reasons for dampness and its magnitude so that the effective preventive measures may be taken. This paper intends to identify the source, distribution and magnitude of dampness in building materials in coastal regions of Bangladesh.

Key words: Dampness, building material, coastal region, Bangladesh

Introduction

Sustainability of a building depends upon the durability of its building materials and user's nature of use. Both of the parameters depend on the type and quality of building materials. It has been observed that dampness causes severe damage to building materials specially the bricks. Porous masonry draws in moisture by capillary action from underlying soil and it evaporates from the wall surface. When the soil contains appreciable amounts of soluble salts, these are drawn (in solution) into the network of pores in the wall, but cannot evaporate with the moisture. Consequently, the salts build up just beneath the wall surface where they grow as minute crystals (Young, 1997). The crystal growth is sufficient to rupture the masonry, causing fretting and crumbling, even of very strong materials. But not only bricks but also mortars are affected by this attack. The results are seen as the breaking down of plasters from the walls and slabs, blister effects of paints and above all losing of the material strength.

Due to close vicinity to Bay of Bengal salinity has become a major problem for the building industry, specially in Khulna region. The soil characteristics in the coastal area have been substantially deteriorated due to gradual accumulation of salt over the years (Rahman, 1992). In

* Corresponding author:

DOI: <https://doi.org/10.53808/KUS.SI.FRCC.2006.7-14-se>

coastal districts, most of the land which was once very productive and used to high production has now become unproductive due to salinization as the result of prolonged retention of saline water for shrimp growing (Karim, 2000). The salinity causes dampness in the buildings. Huge amount of money is wasted year round to check the adverse effect of dampness. Preventive measures should be taken before the construction so that less expense in maintenance is needed. It is unfortunate that most of our building owners and masons are not properly conscious about taking necessary measures to prevent dampness. Some of them don't know the techniques and some times information is not made available to them.

The general practice of the building owners is not to take suggestions from the experts about the prevention mechanism of dampness. It is the duty of government and its developments related organizations to disseminate the information. In most cases brick manufacturers are unaware of the measures that should be taken in order to eliminate saline content at the manufacturing stage of brick. So far many researches have been conducted on the field of remedial techniques of dampness. But its magnitude and detailed nature has not been properly studied specially in the coastal regions.

The other problem related to knowledge gap that provides insufficient information about the magnitude of dampness in the coastal region. This research focuses on identifying the reasons of dampness and its magnitude. For this purpose presence of salinity in building materials, and other local reasons are identified. It is expected that these findings will help in future researches in preparing prevention and controlling system of dampness in buildings.

Literature review:

Damp is an atmosphere wetter than 85 % relative humidity; and a material is damp if it is in equilibrium with this humidity (Oxley and Gobert, 2000). This high relative humidity causes dampness, which eventually culminates in the crystalline deposit on the surfaces of masonry, stucco or concrete. This effect is well known as efflorescence (Oliver, 1988). It occurs occasionally and it is difficult to predict the time of the occurrence. The source of the salts may be either the cement and or lime in the mortar, adjacent building materials such as brick, sand etc. The salts, which are the major sources of this problem, are Sodium sulphate, Sodium carbonate, Sodium bicarbonate, Sodium silicate, Potassium sulphate, Calcium sulphate, Calcium carbonate and Magnesium sulphate (L. Bucea and V. Sirivivatnanon, 2003).

The susceptibility of mortars and structural concrete to sulfate-bearing soils and waters has been known for many years. Naturally occurring sulfates of sodium, potassium or magnesium can chemically attack hardened cementitious materials in mortars and concrete, causing deterioration. To produce significant attack, aggressive chemicals have to be in solution above a minimum concentration and have to penetrate into the structure. In general, similar to other types of attack from external sources, the resistance of the concrete to sulfate attack relies on its physical and chemical aspects. In terms of physical resistance, dense and low permeability of concrete will provide improved sulfate resistance (Sirivivatnanon and Khatri, 1999).

Efflorescence occurs, if- i) there are soluble salts in the masonry; ii) there is a source of water in the masonry; iii) there is a path for the water to get to the surface of the masonry and to evaporate (Williamson, 1990).

Types of dampness: Dampness has been classified into number of types depending on its sources and nature of propagation. The causes are the as following.

i) rising damp or "salt damp" in brick walls and masonry; ii) poor drainage; iii) falling damp; iv) horizontal penetrating dampness; v) condensation dampness.

Objectives:

The Objectives of this study were i) to find out the origin/source of salinity in building materials in coastal region; ii) to find out the magnitude/extent of damage due to dampness; iii) to propose preliminary suggestions for checking dampness.

Materials and Methods

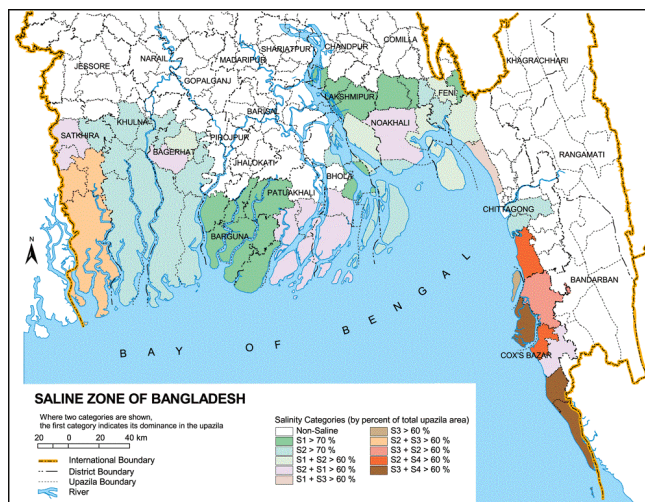
A literature review was performed to know the exact nature and extent of the problem i.e. dampness in the buildings of Bangladesh and other countries. Three major residential areas (*Nirala, Sonadanga and Khalishpur*) in the city of Khulna city, Bangladesh have been selected as the study area. Among the study areas 80 nos. residential buildings were selected randomly. Questionnaire interview, physical observation and photographs of the current situation were used in data and information collection in the present study.

Results

Dampness might occur from materials (brick, sand), water used in construction, improper construction details (wall thickness, Damp Proof Course) and improper coating on walls. In this study these aspects were observed to assess the severity and pattern of the problem.

Materials used in construction: It was found that about 80% of studied residences are constructed with load bearing brick wall system whereas 18% are constructed with R.C.C frame structures. The rest 2% are constructed with mixed type system. Almost all of the houses are affected by dampness.

Water used in construction: Water is a major gateway of salinity attack into building. The saline intrusion starts with the preparation of clay in the brickfield to curing of building. Primarily the water used for washing and soaking in a major source of salinity. It was found in the survey that 70% and 13% of water are collected from shallow and surface water respectively. Ground water in this region is affected by salinity (Fig.1.). Washing of brick and sand with fresh water can reduce saline content but the use of saline water caused increasing salinity rather reducing. During survey it was found that more than 90% of sand and 30% of bricks are were not washed before construction, which is another reason for saline intrusion in building.



Source: Bangladesh Agriculture Research Council

Fig. 1. Map of Bangladesh showing saline zones and relative location of study area. Source: Bangladesh Agriculture Research Council.

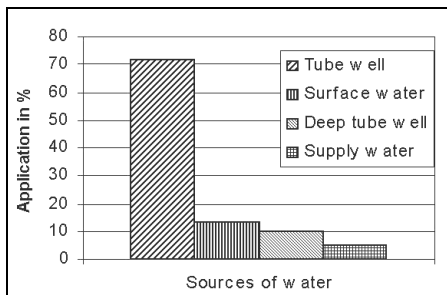


Fig 2. Sources of water used in construction.

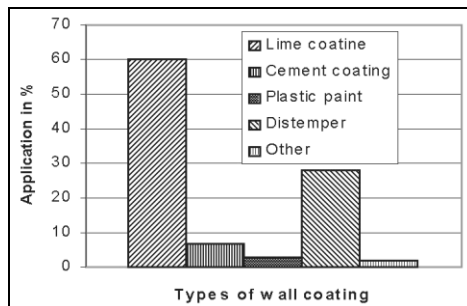


Fig 3. Types and use percentage of coating on walls.

Coating of wall: Different types of wall coating have different water protection qualities. Lime wash, distemper, plastic paint, cement coating are the common coating available now a days. Among these types, cement coating has greater preventive quality against water. Plastic paint is a good barriers but it also traps water in the walls and slabs, which is more dangerous for building materials. Plaster can reduce penetration of water in walls. It was found in the survey that more than 30% of residences have exterior walls with no plaster on external surfaces. So the exterior wall exposed to rain water is causing water penetration in the buildings (Fig. 12).

Discussion

In the study area basically four types of dampness have been found. Names of the types are given on the basis of water source and pattern of spreading.

Types of dampness in the survey area

- a. Rising damp: Caused by improper or no D.P.C[†] (Fig. 4, Fig. 5);
- b. Condensation: Happens due to moist air in spaces without proper ventilation, specially in bathroom (Fig. 6, Fig. 7);
- c. Horizontal dampness: Happens due to penetration of rainwater through external walls and roofs (Fig. 8, Fig. 9);
- d. Falling dampness: Occurs through different leakages of slabs and walls (Fig. 10, Fig. 11);

[†] D.P.C: Damp Proof Course

Fig. 4. Effects of rising damp causing due to faulty or no D.P.C



Fig. 5. Effects of rising damp causing due to faulty or no D.P.C



Fig.6. Effects of dampness due to condensation.



Fig.7. Effects of dampness due to condensation in trapped spaces (bathrooms).



Fig. 8. Effects of horizontal dampness



Fig. 9. Effects of horizontal dampness water is coming through the sidewalls laterally



Fig. 10. Presence of falling dampness coming.

Fig. 11. Presence of falling dampness, where water is through the cracks or voids of slabs.

Causes of dampness: Causes of dampness found in the study area were of the following types -

Use of material from saline prone areas: The study area has been identified as the highest saline prone (Fig. 1). Soil from the study areas used to manufacture bricks can be considered as the primary cause for the salinity.

Use of shallow tube well water: The intrusion of salinity greatly affect the shallow aquifer of coastal region. So the water obtained from these aquifer are subjected to significant magnitude of salinity. At a greater depth some aquifers contain fresh water. But the high cost for collecting

water from these greater depth and limited distribution of those aquifers compel people to install shallow tube well for water supply during construction period.

Improper washing of brick and sand before construction: Generally sand is deposited in river where there is a great possibility to attract salt if that location is a saline prone area. If people work with the sand mixed with salt without washing properly, then after getting moist it would come to surface to form a white crystalline deposit. Similar things happen in case of brick. If bricks are manufactured from the clay having excess of salt, and the salts are entrapped in the brick, which comes on the surface of brick after those are dissolved in water or moisture. If the brick and sand are washed well before construction, the salts on the surface of the brick could be considerably reduced. But the problem is, most of the people do not wash those building materials before construction. Moreover, those who wash the brick and sand generally use same water repeatedly. As a result the water used for washing is accumulating more salt after every wash that is resulting the increase of salinity in bricks.

Absence of plaster (expose to rain): Plaster is used in walls as barrier against penetration of moisture and water through wall. During the survey some of the houses were found to have exterior walls without plasters. It is mentioned earlier that reasons behind the fact are economic disability of the owners, carelessness and desire for future construction. These walls are acting as one of the major gateway for moisture to enter in the building (Fig. 12).

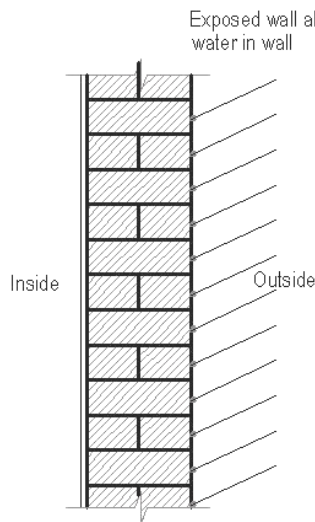


Fig. 12. Wall section showing rain water penetration

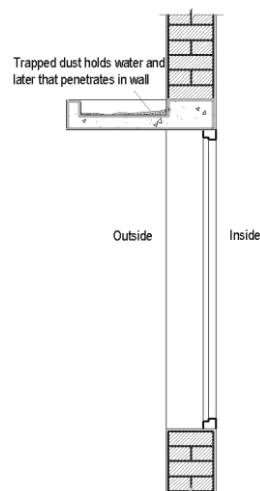


Fig. 13. Window section showing faulty detail of sunshade that holds dust and water.

Less use of water repellent coating on exterior walls: Paint is capable of acting as water repellent. At present along others new types of water repellents are available in the market. In most cases information about these repellents are not made available to the building owners.

Improper design and details: Several types of defects have been noticed in the design and construction of walls, foundations and slabs. These have been categorized as follows:

a. **Improper application of D.P.C:** D.P.C in building acts as barrier against rising damp. There are improper or defective application of D.P.C (Fig.15).

b. ***Improper rainwater discharge due to insufficient outlets and slope:*** Rainwater should be discharged as quickly as possible in order to avoid stagnant of water. Stagnant water causes seepages of water inside the R.C.C, which eventually cause efflorescence and splash of concrete and plaster from the reinforcing bars (Fig.14).

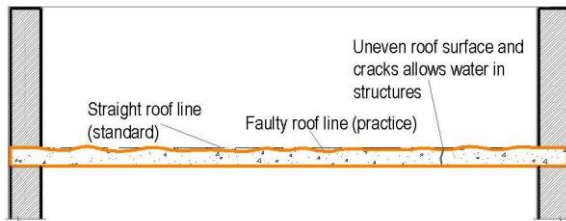


Fig. 14. Roof section showing construction defects.

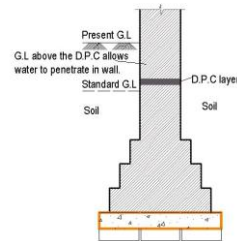


Fig. 15. Foundation section showing settling down of buildings in ground.

Improper compaction of R.C.C: It has been observed that due to improper construction method (insufficient or no compaction of R.C.C) and supervision there existed voids in the R.C.C. These voids generate seepage lines, which allow more possibilities to flow water into the R.C.C (Fig. 14).

Defects in building projections: During survey it was noticed that some of the defective types of building projections such as sunshade, cantilever verandah; projected roof with parapet wall etc. were responsible for penetration of water into the built form. The major types of defects were a) inadequate gradient or slope b) small weep holes c) absence of drip course etc. These defects hold water for long time and allow water to penetrate in wall and RCC.

Stagnant air in and around building: Airflow helps in evaporating moisture from the trapped spaces. Trapped air with higher percentage of moisture causes condensation resulting in dampness (Beall, 1993). In the study area it has been found that buildings are placed too close to each other and sometimes airflow between them remained stagnant. Higher percentage of moisture in this stagnant air percolates into the building materials. Insufficient ventilation in bathrooms also causes moisture penetration in its surrounding walls.

Lack of relevant information to building owners: In most of the cases information about latest technology and suitable material are not available to owners and masons. Owners are found less interested to consult with the experts or engineers about improved materials and latest technology including the preventive measures of dampness. For this coastal region Government Authorities related to building industries (HBRI, PWD, KDA etc)[‡] are not disseminating these knowledge to the owners and masons.

Lack of monitoring and maintenance: Monitoring during and after construction and maintenance thereafter are very much important to ensure durability and life span of building specially for this coastal region where salinity is a major problem.

[‡] HBRI: House Building Research Institute, PWD: Public Works Department, KDA: Khulna development Authority

Conclusion

It is natural that clay, the source material for bricks, water, sand etc contain salinity in the coastal region. Using ground water to get rid of this salinity is extremely difficult and expensive. At this situation fresh water may be used in all phases of construction. Information about latest building material and technology may also help to improve the deteriorating situation. Training and workshop may also be arranged to educate the construction workers and building owners. It is extremely difficult to arrest the ever-increasing level of salinity in soil so it wise to monitor the preventive measures before and during construction. In addition maintenance work would be done regularly in order to check dampness in buildings.

Acknowledgements: We would like to express our indebtedness to Research Cell, Khulna University for giving financial support to carryout this research. Special thanks to audience for the comments and suggestions given at 1st Khulna University Research Cell Conference 2006. Thanks to all field supervisors for taking patients during the survey.

Reference

- Beall, C. 1993. *Masonry Design & Detailing*. McGrawHill, USA, pp. 219-226.
- Branch, Department of Environment and Natural Resources, Department of Environment and Natural Resources, Adelaide, pp.1.
- Bucea, L. and Sirivivatnanon, V, 2003. Salinity Hazard and Deterioration Mechanisms in the Built Environment, CMIT Doc. 2003-242, CSIRO.
- Karim, M.R. and Shah, M.S., 2000. Brackish water shrimp cultivation restricts the coastal agriculture. *Khulna University Studies*. Volume 2, no. 1, pp. 123-134
- Oxley.T.A. and Gobert, E.G. 2000. *Dampness in Buildings*. Butterworth-Heinemann, Great Britain.
- Oliver, A.C. 1988. *Dampness in buildings*. BSP Professional books, Oxford.
- Rahman, K. et al., 1992. *Salinity intrusion and its effects in south west coastal region of Bangladesh. Proceedings of the workshop on coastal zone management in Bangladesh, 27-31 December, Dhaka, Bangladesh.*
- Sirivivatnanon, V. and Khatri, R.P. 1999. *Performance Based Specification for Sulphate Resisting Concrete*, pp.1097-1106. In: Swamy, R.N (ed) *In Vision for the Next Millennium*, Proceedings of the International Conference held in Sheffield, Sheffield Academic Press, UK.
- Williamson, D.R.. 1990. Salinity - An old environmental problem, Year Book of Australia, Special Article, ABS cat. no. 1301.0
- Young, D. 1997. *Rising Damp and Salt Attack: The South Australian Perspective*. State Heritage of Australia

Islam, A.K.M. K. and Darain, K.M. 2006. Causes and magnitude of dampness of buildings in coastal region of Bangladesh; a study in Khulna city. *Khulna University Studies*, Special Issue (1st Research Cell Conference): 06-13.