DIAGNOSIS OF RISING DAMP AND SALT ATTACK IN TO RESIDENTIAL BUILDINGS

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ABSTRACT – Buildings are expected to be constructed with materials which have the tendency to resist the effects of water throughout their service lives. For buildings to perform this function there is the need for correct design and maintenance throughout their service lives. Moisture that should not be present in buildings is known as dampness. Buildings are said to have dampness problems when the materials in the buildings become sufficiently damp, leading to materials damage or visible mold growth. India, a country with hotter and drier climate, has experienced dampness for several years. In a study to identify the most dominant type(s) of dampness in residential buildings in India, all the surveyed buildings were identified to have symptoms related to either rising dampness, condensation, or water penetration (including leakages). However, the most dominant type of dampness was found to be raising dampness as it was identified with many of the buildings surveyed.

Key Words**: Permeable concrete as a road pavement**

1. INTRODUCTION

All buildings are expected to be constructed with materials which have the tendency to resist the effects of water throughout their service lives. For buildings to perform this function there is the need for correct design and maintenance throughout their service lives. Moisture that should not be present in buildings is known as dampness. Buildings are said to have dampness problems when the materials in the buildings become sufficiently damp, leading to materials damage or visible mold growth. India, a country with hotter and drier climate, has experienced dampness for several years. In a study to identify the most dominant type(s) of dampness in residential buildings in India, all the surveyed buildings were identified to have symptoms related to either rising dampness, condensation, or water penetration (including leakages). However, the most dominant type of dampness was found to be raising dampness as it was identified with many of the buildings surveyed.

Buildings by their very nature are composites of differing materials and forms of construction each having their own specific performance characteristics. The demands placed on a building or an element of its construction by occupants and users relate to its location and siting, climatic and environmental conditions, the manner in which it is used, current and past levels of damage, deterioration and decay, etc. Despite the lasting qualities of buildings, all buildings, be it old or modern types of construction are susceptible to natural and man-made mechanisms of deterioration. If these buildings are not properly maintained they would not survive in an acceptable state beyond the generation that built them. Of all defects associated with buildings, moisture is the most frequent and dangerous, and contributes more than 50% of all known building failures.

Hygroscopic salts that led to surface efflorescence, decayed skirting, dampness below 1.5 m, and mold growth on walls up to 1 m high were among the symptoms identified with rising dampness in the surveyed buildings. The study recommended a more detailed investigation on selected buildings to identify the root cause of the problem. This dissertation involves a laboratory study to examine the problem of rising damp and salt attack in the walls of residential buildings. It sought to determine the types of soluble salts and their concentrations in the soils and accumulated percentages in the walls over time and whether there exists any linkage between the salts in the walls and those in the ground. Two buildings in different geological settings in Ambala Cantt, Haryana, are selected as case studies.

2. LITERATURE REVIEW

Rising damp is one of the most severe phenomena that leads to decay and deterioration of both old and modern types of buildings. It is a well-known phenomenon around the world and occurs when groundwater flows and raises through porous masonry materials. For several years now, researchers across the world have identified the deterioration at the base of walls as a problem related only to the phenomenon of rising damp, and the focus of remedial treatments has been on the installation of damp-proof courses (DPCs). However, in countries where the climate is hotter and drier and the soils are more saline, there are greater rates of water evaporating from the walls of buildings leading to accumulation of soluble salts at the evaporation zone in the masonry.

A. G. Ahmed and F. Abdul Rahman (2010) [1] According to them, the problems of rising damp and salt attack are closely related since moisture from rising damp can dissolve existing salts in a building material. Groundwater may sometimes contain salt and can find its way through the walls of a building by capillary action.

British Research Establishment (BRE) (1997) [2] concluded that the water rises up the wall, about a metre or more high, and often deposits a horizontal "tide mark." Below this mark, there is discoloration of the wall with general darkening and patchiness, and there may be mould growth and loose wallpaper. The height to which the absorbed water rises depends on the water absorption capacity of the masonry, how wet the soil is and how quickly moisture can evaporate. The water contains soluble salts (from the ground or dissolved out of the bricks or mortar) and, as the water evaporates, the salts crystallize out on the wall surfaces, often concentrating in the tide mark.

R. Burkinshaw (2012) [3] analyzed that; there are three preconditions for rising damp: ground contact; ground moisture; and porous construction.

Thomas Worthington (1892) [4] described rising damp in his essay and recommended that a damp proof course (DPC) should be used to disconnect the whole of the foundations from the superstructure. Rising damp was reported to occur if the moisture content of mortar samples was above 5% and it was found that 54% of the properties suffered from rising damp at heights of 0.3m above the floor level.

Trotman et al. (2004) [5] he reported that soluble salts were drawn up into the structures affected by rising damp and became deposited in the walls. When the water evaporated and the salt solution became more concentrated at the surface and crystallized out of solution, blocked the pores, reduced evaporation, and raised the height of the level of dampness.

3. OBJECTIVES OF THE PROPOSED WORK

To identify the origin of the salts in the walls of the buildings, salt analysis is conducted on soil samples collected from the two cases. This is to establish whether there exists any linkage between the salts found in the walls of the buildings and those found in the soils. From the studies it is found that sodium chloride, sodium sulphate, sodium nitrate, potassium sulphate, potassium chloride, potassium nitrate, magnesium sulphates, magnesium chlorides, and magnesium nitrate salts are present in the soil samples collected. But from this research work we are trying to find out if these salts are present in the dampness or not.

4. MOISTURE CONTENT OF MORTAR SAMPLE

Figure shows a graphical comparison of moisture contents at different heights of mortar samples for different depths of walls. The results show that, for the mortar samples collected from all the three depth ranges, moisture contents decreased with increasing heights. Mortar samples collected at heights of 300mm in all the cases had the highest moisture content followed by the samples from heights of 600mm in that order.

The results further show that the moisture contents varied with depths. Thus, the moisture contents increased from the depths of 0–25mm up to 50–75 mm. Also, the results show that, throughout the various heights in the two cases, moisture contents recorded in Case 2 exceeded those in Case 1.

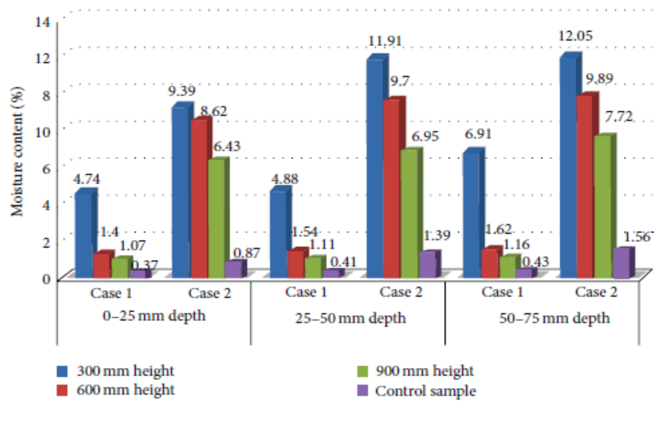

Fig. 4.1 Comparisons of Moisture Content at Different Heights for Differing Depth of Walls

These higher values recorded for Case 2 indicate that the water body close to the site influenced water ingress into the building. The control samples collected above the height of visible dampness (i.e., 900mm) at the various heights recorded the lowest moisture contents in all the cases. These samples are original and collected above the height of visible dampness.

As a result, no significant dampness is found in those areas of the walls. The higher moisture contents recorded at the bases of the walls (300 mm) indicate a probable source of water ingress from the soil into the buildings. The above results imply that, at the maximum height of visible damp, most of the water in the walls had evaporated leaving behind efflorescent salts, a phenomenon typical of rising dampness. A common source of water that contributes to rising dampness in masonry walls is groundwater and this is responsible for the severity of the dampness in Case 2 compared to Case 1.

5. RESULTS AND ANALYSIS

Results for ionic contents of mortar samples from Case 1

Height	Cations					Anions						
	Na^+	NH_4^+	K^+	Ca^{2+}	Mg^{2+}	F^-	Cl^-	Br^-	NO_2^-	NO_3^-	PO_4^{2-}	SO_4^{2-}
Depth 0 – 25 mm												
300	0.022	0.00	0.013	0.010	0.060	0.001	0.065	0.00	0.00	0.005	0.00	0.11
600	0.036	0.00	0.027	0.001	0.068	0.000	0.082	0.00	0.00	0.014	0.00	0.103
900	0.086	0.00	0.039	0.003	0.106	0.005	0.086	0.00	0.00	0.018	0.00	0.165
Control	0.012	0.00	0.001	0.001	0.012	0.002	0.006	0.00	0.00	0.002	0.00	0.015
Rank of ions at 900mm	2nd	5th	3rd	4th	1st	4th	2nd	5th	6th	3rd	7th	1st

Results for ionic contents of mortar samples from Case 1

Height	Cations					Anions						
	Na^+	NH_4^+	K^+	Ca^{2+}	Mg^{2+}	F^-	Cl^-	Br^-	NO_2^-	NO_3^-	PO_4^{2-}	SO_4^{2-}
Depth 25 - 50 mm												
300	0.032	0.00	0.013	0.006	0.035	0.005	0.061	0.00	0.00	0.004	0.00	0.52
600	0.039	0.00	0.016	0.008	0.068	0.001	0.063	0.00	0.00	0.015	0.00	0.107
900	0.042	0.00	0.029	0.003	0.086	0.004	0.107	0.00	0.00	0.016	0.00	0.144
Control	0.018	0.00	0.019	0.002	0.019	0.003	0.003	0.00	0.00	0.002	0.00	0.016
Rank of ions at 900mm	2nd	5th	3rd	4th	1st	4th	2nd	5th	6th	3rd	7th	1st

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Height	Cations					Anions						
	Na^+	NH_4^+	K^+	Ca^{2+}	Mg^{2+}	F^-	Cl^-	Br^-	NO_2^-	NO_3^-	PO_4^{2-}	SO_4^{2-}
Depth 50 – 75 mm												
300	0.023	0.002	0.014	0.003	0.032	0.000	0.070	0.00	0.00	0.004	0.00	0.109
600	0.047	0.00	0.014	0.004	0.088	0.002	0.077	0.00	0.00	0.004	0.00	0.115
900	0.056	0.00	0.016	0.006	0.093	0.002	0.84	0.00	0.00	0.023	0.00	0.165
Control	0.018	0.00	0.013	0.005	0.008	0.003	0.005	0.00	0.00	0.004	0.00	0.006
Rank of ions at 900mm	2nd	5th	3rd	4th	1st	4th	2nd	5th	6th	3rd	7th	1st

Results for ionic contents of mortar samples from Case 2

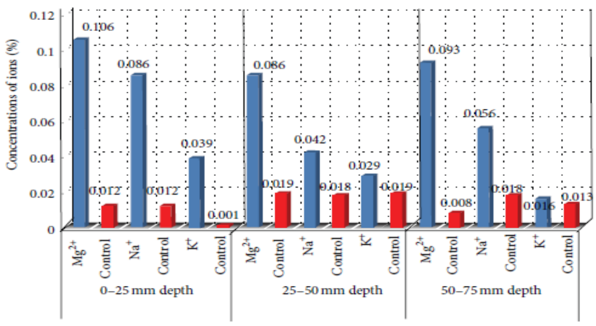
Height	Cations					Anions						
	Na^+	NH_4^+	K^+	Ca^{2+}	Mg^{2+}	F^-	Cl^-	Br^-	NO_2^-	NO_3^-	PO_4^{2-}	SO_4^{2-}
Depth 0 – 25 mm												
300	0.018	0.000	0.016	0.005	0.057	0.001	0.008	0.000	0.000	0.004	0.000	0.018
600	0.021	0.00	0.020	0.002	0.097	0.001	0.039	0.00	0.00	0.004	0.00	0.056
900	0.091	0.014	0.046	0.001	0.197	0.001	0.069	0.00	0.00	0.085	0.00	0.263
Control	0.006	0.003	0.014	0.007	0.005	0.000	0.007	0.00	0.00	0.005	0.00	0.019
Rank of ions at 900mm	2nd	4th	3rd	5th	1st	4th	3rd	5th	6th	2nd	7th	1st

Results for ionic contents of mortar samples from Case 2

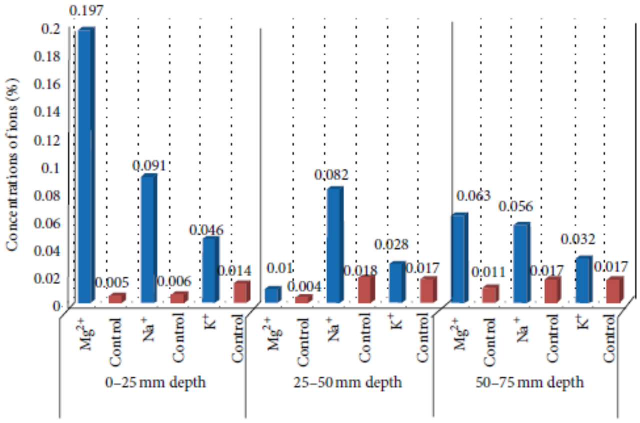
Height	Cations					Anions						
	Na^+	NH_4^+	K^+	Ca^{2+}	Mg^{2+}	F^-	Cl^-	Br^-	NO_2^-	NO_3^-	PO_4^{2-}	SO_4^{2-}
Depth 25 - 50 mm												
300	0.007	0.000	0.014	0.002	0.149	0.001	0.005	0.000	0.000	0.003	0.000	0.015
600	0.010	0.000	0.020	0.004	0.189	0.001	0.005	0.00	0.00	0.005	0.00	0.046
900	0.082	0.000	0.028	0.005	0.101	0.000	0.073	0.00	0.00	0.040	0.00	0.222
Control	0.018	0.000	0.017	0.001	0.004	0.001	0.013	0.00	0.00	0.014	0.00	0.016
Rank of ions at 900mm	1st	5th	2nd	4th	3rd	4th	2nd	5th	6th	3rd	7th	1st

Table 4.3 Results for ionic contents of mortar samples from Case 2

Height	Cations					Anions						
	Na^+	NH_4^+	K^+	Ca^{2+}	Mg^{2+}	F^-	Cl^-	Br^-	NO_2^-	NO_3^-	PO_4^{2-}	SO_4^{2-}
Depth 50 - 75 mm												
300	0.005	0.000	0.014	0.005	0.062	0.001	0.009	0.000	0.000	0.003	0.000	0.013
600	0.020	0.000	0.025	0.003	0.086	0.001	0.010	0.00	0.00	0.011	0.00	0.070
900	0.056	0.003	0.032	0.002	0.063	0.000	0.065	0.00	0.00	0.020	0.00	0.183
Control	0.017	0.000	0.017	0.001	0.011	0.000	0.012	0.00	0.00	0.013	0.00	0.004
Rank of ions at 900mm	2nd	5th	3rd	4th	1st	4th	2nd	5th	6th	3rd	7th	1st



Comparison of Ionic Concentrations of the most Predominant Cations from Case 1 and Case 2 at Heights of 900mm for Different Depths



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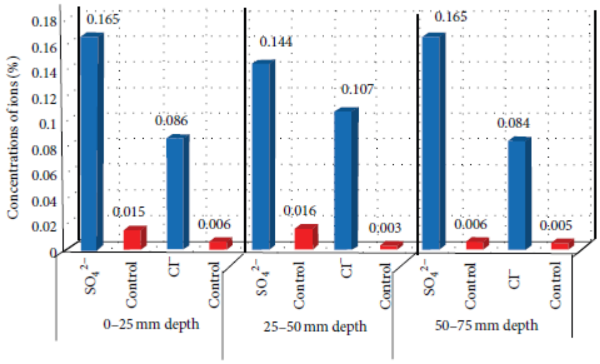

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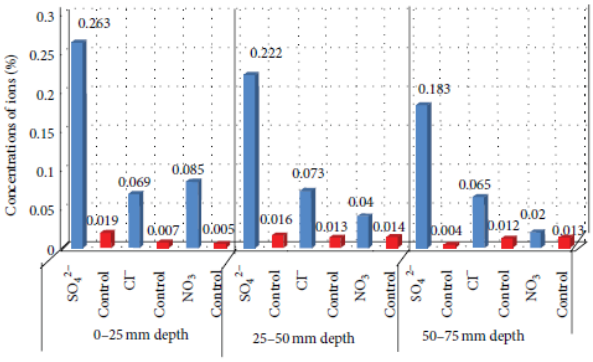

Comparison of Ionic Concentrations of the most Predominant Cations from Case 1 and Case 2 at Heights of 900mm for Different Depths

6. CONCLUSIONS

1. The soils on site 1 consisted predominantly of silty sandy gravel with some clay particles and those on site 2 consisted of silty sandy soil with some clay and traces of gravel.
2. The study identified the main salts in the walls of the buildings as predominantly magnesium sulphates, magnesium chlorides, magnesium nitrate, sodium sulphate, sodium chloride, sodium nitrate, potassium sulphate, potassium chloride, and potassium nitrate.
3. However, of all these identified salts, the most damaging and dangerous are magnesium sulphate, magnesium chloride, and sodium sulphate salts. The same salts are also identified in the soil samples from the trial pits. The results therefore indicate a linkage between the salts found in the ground and those found in the walls and

therefore confirm the presence of rising dampness. Identifying predominant salts in the walls of the affected buildings is critical to the search for appropriate treatment for the rising damp problem.

The study recommends more research to be carried out on buildings located within different geographical locations. More laboratory tests and scientific analyses on salts should be carried out to have a better understanding of how to handle the problem of rising damp and salt attacks

7. FUTURE SCOPE

A holistic approach to dampness investigation is employed to examine the problem of rising damp in the walls of two residential apartments in Ambala Cantt (Haryana). The study sought to determine the types of soluble salts and their concentrations that have accumulated in the soils and the walls of the buildings over time and whether there existed any linkage between the salts in the walls and those from the ground. Identifying predominant salts in the walls of the affected buildings is critical to the search for appropriate treatment for the rising damp problem.

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