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Evaluation of mortar samples obtained from UK houses treated for rising damp

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A B S T R A C T

Mortar samples were obtained from a variety of dwellings in the UK with the majority from houses with rising damp. This paper aims to evaluate the mortar attributes and their influence on rising damp. The samples were characterised in the laboratory in terms of pH value and water absorption characteristics and examined using scanning electron microscopy to reveal the microstructure. It was found that the water absorption characteristics varied considerably, with older mortars having a higher sorptivity and higher concentration of soluble salts. The majority of building mortars treated for rising damp in this survey were approximately 100 years old and had a typical pH value of 9. A good understanding of the relationship between rising damp and mortar characteristics was developed, which may be practically employed to assess and mitigate rising damp problems.

1. Introduction

Rising damp describes the movement of moisture upwards through permeable building materials by capillary action. The dampness and associated salt leaching can cause aesthetic degradation and/or structural damage to exterior building façades. Serious rising damp can lead to a building becoming inhospitable due to mould growth, paint blistering, plaster crumbling and wallpaper separation [1]. It is a vexatious and persistent problem requiring a great deal of effort and financial resources in addressing its manifestation, typically with varying degrees of success. In addition, thermal insulation properties for bricks and mortar are generally considered to be attributed to the porosity of the building materials. When water is absorbed, the effectiveness of heat retention and thermal insulation of building materials is significantly reduced due to the considerably higher heat capacity and thermal conductivity of water compared to air [2,3].

Mortar is a paste used to bind construction blocks together and fill the gaps. It becomes hard on setting, resulting in a rigid aggregate structure. Mortar is typically made from a mixture of sand, a binder such as cement or lime, and water. Rising damp in buildings is dictated by the nature of the particular brick and mortar. It has been widely recognised that characteristics of the mortar have a strong influence on rising damp problems and solutions [4]. Therefore, an understanding of the characteristics of mortar is of importance and significance in combatting rising damp problems in existing buildings.

According to the Sharp Front model, the height of rise of the damp front is governed by the following equation [5];

$$H = s\left[\frac{b}{2e\theta}\right]^{\frac{1}{2}} \tag{1}$$

where H is the height of the rising damp front, s the sorptivity (the suction of water into the mortar), b the wall thickness, e the rate of evaporation per unit area of the wetted surface, and θ is the moisture content of the wetted region (the volume of water per unit volume material).

As can be seen in Eq. (1), when the sorptivity of the material and the thickness of the wall increases, so does the height of rise. With consideration of the Sharp Front model variables, it was decided that a range of mortar samples characteristic of the types found when treating dwellings against rising damp would be tested. It is known from the Sharp Front model that sorptivity is a key variable that needs to be considered when investigating rising damp. The sorptivity is a measure of the suction or absorption of water into the material and has a strong influence on the height of the rising damp front. Additionally, the pH of the mortar is an important parameter regarding the subsequent rising damp treatment of the wall and this was also investigated in the study.

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2. Experimental

All samples obtained for this investigation are listed in Table 1. Fig. 1 shows the different locations in the UK where the mortar samples were sourced. It should be noted that it is not always possible to obtain a sample piece of mortar from the wall jointing. In some instances, only drilling dust or render pieces were available for this study.

An aqueous suspension of each mortar was produced by first crushing 5 g of mortar and dispersing the powder in 50 g of de-ionised water. The suspension was then allowed to stand for 24 h and the pH measured (Hanna Instruments; pH 209). The different suspensions from the pH study were then filtered and analysed for water soluble salts by Inductively Coupled Plasma (ICP) analysis.

The water uptake of the samples was determined by the sorptivity, which is defined as the gradient of the graph of volume of water absorbed per unit area with regard to the square root of time.

Sorptivity measurements were made by placing pieces of dried mortar in contact with water on the lower surface only. The mortar was dried at 55 °C to constant weight prior to this measurement. The weight increase as a function of time was then measured and a plot of the volume of water absorbed per unit area was produced. The test was carried out using flat pieces of mortar with dimensions of approximately 2 cm × 2 cm as they were the largest pieces that could be collected (it was difficult to make sorptivity measurements on smaller sized samples).

The pore structure was assessed by scanning electron microscopy (SEM) (JEOL; JSM 6100). All specimens were sputtered with approximately 10 nm thick layers of gold and palladium consecutively prior to examination.

3. Results

3.1. pH value measurement

The pH results in Fig. 2 show a reduction in the pH value of the mortar with an increase of the age of the property. The pH eventually reaches a value of approximately 9. The pH values exhibit a large degree of scatter between samples. This could be attributed to differences in local materials used for house building and differences in the extent of carbonation of the cement and lime based mortars. The general reduction of pH with time can be attributed to carbonation [6,7].

Table 1
A list of mortar samples collected for this study.

I.D.	Approximate year house was built	Age (2007)	pH	Location	Type of wall
0	2007	0	12.1	Horsham	Brick solid
1	1600	407	7.9	Kent	Brick solid (painted brickwork inside)
2A	1900	107	8.6	Kent	Brick solid
2B	1900	107	9.4	Kent	Brick solid
3A	1920	87	8.6	Kent	Brick cavity
3B	1920	87	10.3	Kent	Brick cavity
4	1900	107	9.5	Southsea	Brick solid
5	1951	56	11.9	PO22 6JF	Brick cavity
6	2003	4	10.2	PO22 6JF	Brick cavity
7	1904	103	9.3	RH12 2QS	Brick solid (single skin)
8	1900	107	9.2	FY8	Brick solid (terraced property)
9	1920	87	9.0	PR1	Brick solid (terraced property)
10	1900	107	8.3	PR1	Terraced – cavity
11	1950	57	7.7	Walsall	Brick cavity
12	1850	157	9.0	CM7	Solid stone wall – lime mortar
13	1978	29	8.6	Weston-S-M	Brick cavity
14	1978	29	9.4	Exeter	Solid stone wall
15	1992	15	11.9	Burnham	Solid stone wall
16	1897	110	9.2	Weston-S-M	Solid stone wall
17	1855	152	8.6	SR6 0PH	Stone outer brick inner
18	1850	157	12.1	NE2 4LQ	Brick solid
19A	1900	107	9.9	EH4 1LW	Brick solid – internal render
19B	1900	107	8.3	EH4 1LW	Brick solid – external mortar
20A	1850	157	9.9	EH42 1XE	Solid stone wall – mortar
20B	1850	157	8.6	EH42 1XE	Solid stone wall – render
21	1850	157	8.5	Harrogate	Solid stone wall
22	1878	129	9.1	Leeds	Solid stone wall
23A	1880	127	10.8	RH12 3SQ	Brick cavity
23B	1880	127	8.4	RH12 3SQ	Brick cavity
24	1900	107	9.0	TN13 2TF	Solid brick wall
D	1950	57	11.0	RH12	Brick cavity
H	1870	137	9.0	BN3 3YV	Brick wall
PC	1600	407	8.7	Warsaw	Stone wall

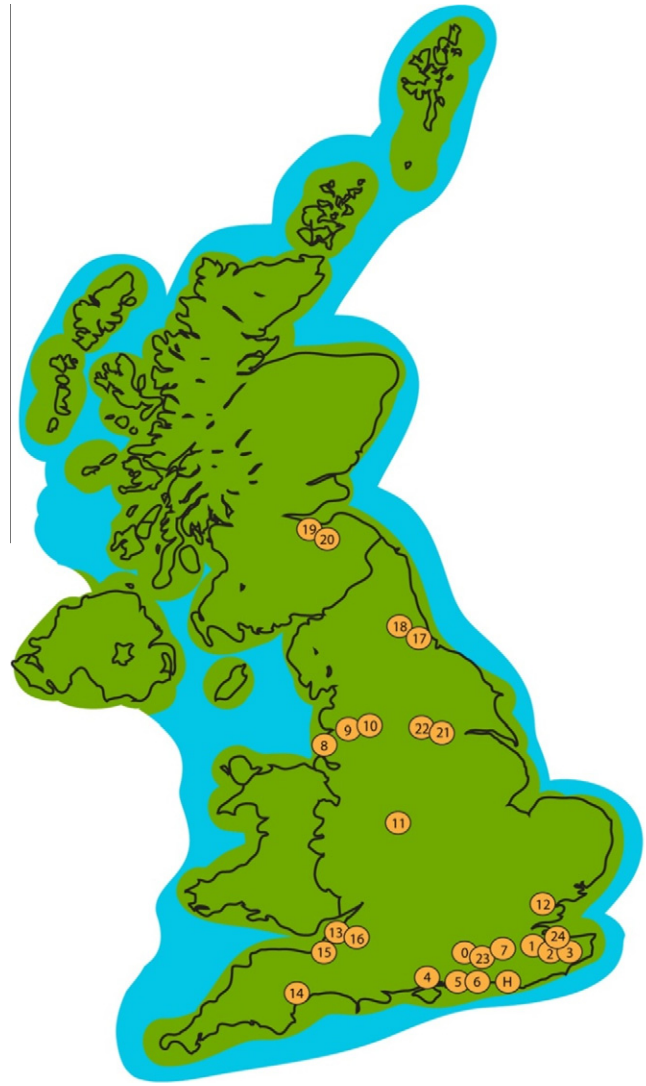

Fig. 1. Location map of mortar samples in UK.

3.2. Soluble salts

A number of samples were analysed in order to develop an understanding of the types of soluble ions present and the extent of variation as listed in Table 2. There is quite a wide variation in the salt levels of the different samples. Mortar samples No. 4 and No. 15 have low levels of below 500 mg/l whereas samples No. 1 and No. 17 show values of over 2000 mg/l. The most abundant soluble ions were calcium, potassium, sodium, chloride and sulphate.

Looking at the relationship with time, there is a general tendency for salt levels to increase with the age of the property as shown in Figs. 3 and 4, indicating an increase in soluble calcium and total soluble salts. The results are plotted here as a set of spot measurements of data points.

An interesting observation is the high levels of salts found in sample No. 17. This was taken from a property near the coast and high levels of magnesium, sodium, sulphate and chloride were