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Original Research Article

Influence of burnt clay brick salinity on moisture content evaluated by non-destructive electric methods

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ABSTRACT

This paper presents the results of tests of mass moisture content in saline burnt solid clay brick by the non-destructive dielectric, resistance and microwave methods. Several groups of bricks, kept in respectively aqueous nitrate, chloride and sulphate media varying in their ion content, and in salt-free water (as the reference) were subjected to tests. It is shown that brick salinity considerably influences the indications of the dielectric meter and the resistance meter and this influence is similar for different salt concentrations, resulting in the significant overrating of the evaluated moisture content relative to the real moisture content. It is also shown that brick salinity has little influence on the indications of the microwave meter. The test results were generalized by determining appropriate correlations between mass moisture content U_m and indications X of the dielectric, resistance and microwave meters, to be used in building practice.

1. Introduction

The excessive build-up of moisture in the burnt clay brick walls of buildings is mainly due to their ineffective damp insulation. In historic buildings the primary cause of excessive moisture build-up in their walls is the lack of any damp insulation (such insulations were simply not made in the past) [1–3]. Whereas in younger buildings the ineffectiveness of the damp insulations is due to their faulty execution, mechanical damage or degradation [4]. As a result the walls are in contact with water coming from the ground or from the rainwater containing dissolved salts harmful to the structure of the masonry, and undergo damage. The bricks, the mortar and the plaster on the surface of the walls are affected (Fig. 1).

Groundwater together with the salts contained in it rises due to capillary action to ever higher parts of the walls made of capillary-porous materials, such as burnt clay brick, brickwork joint mortar and plaster (Fig. 2). Also the concentration of salts in the brickwork and plaster components increases by the year [5–11]. The negative effects of the excessive build-up of moisture in the wall include: a decrease in brickwork strength, susceptibility to frost damage, falling off plaster, spalling mortar in the joints between bricks, an increase in the heat transfer coefficient of the building envelope and susceptibility to fungal decay and mouldiness [12–18].

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Fig. 1 – Brickwork degradation caused by excessive moisture build-up.

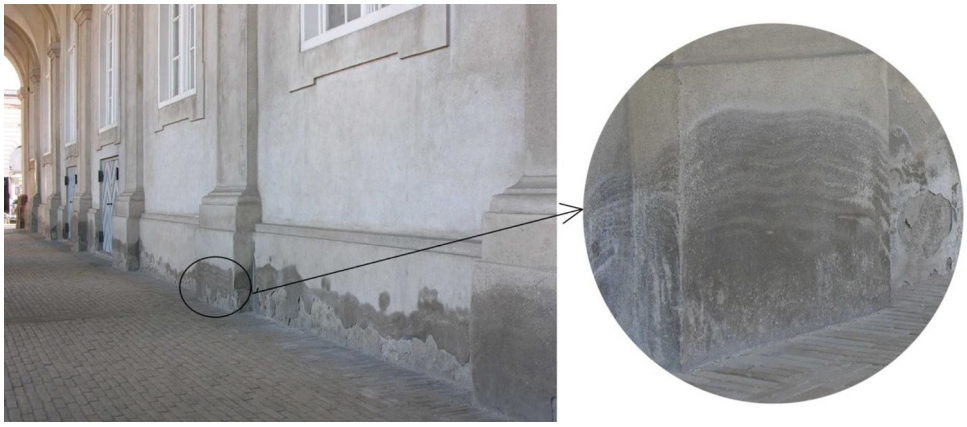

Fig. 2 – Increasing by year moisture build-up in wall.

Table 1 shows the classification (adopted in the literature on the subject) of moisture build-up in brickwork depending on the mass moisture content [3,19]. However, Table 2 shows the classification (adopted in the literature on the subject) of salinity in brickwork [3,19].

The removal of the causes and effects of excessive moisture build-up in brickwork should be preceded by specialist moisture content tests [19,20]. The most reliable moisture content testing method is the non-destructive moisture balance method [21–23]. However, because of its invasiveness (samples need to be taken), its use is limited, especially in historic buildings. In building practice, non-invasive (non-destructive) methods are commonly used to test the moisture content in brickwork. Usually they are electric methods [19, 22–26]. Their advantages are: test simplicity, quickness and repeatability (in the same place and at different times).

From among the non-destructive electric methods the most popular are: the dielectric method and the resistance method [25], and recently the microwave method [27–30]. Also the new impedance tomography method [23,31] and the method based on the frequency dispersion of permittivity [32] are counted among the electric methods. Pilot studies have shown them suitable for measuring moisture build-up in brickwork.

The non-destructive electric methods of moisture content testing are indirect methods. The tests consist in measuring different physical characteristics of the damp material, not the

Table 1 – Classification of moisture build-up in brickwork [3,19].

Mass moisture content U_m, %	Moisture build-up classification
<3	Brickwork with permissible moisture content
3–5	Brickwork with elevated moisture content
5–8	Brickwork with medium moisture content
8–12	Brickwork with high moisture content
>12	Wet brickwork

Table 2 – Classification of brickwork salinity [3,19].

Type of salt	Classification depending on salt content, [%M]		
	Low	Medium	High
Chlorides (Cl^-)	<0.2	0.2–0.5	>0.5
Nitrates (NO_3^-)	<0.1	0.1–0.3	>0.3
Sulphates (SO_4^{2-})	<0.5	0.5–1.5	>1.5