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Study of the moisture behavior of newly developed plasters applied on brick pillars

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Abstract

As part of research works devoted to the development of silicate thermal insulation materials, two mixtures of plasters based on lightweight aggregate and on traditional and alternative binders were designed. The laboratory-prepared plasters were applied to masonry columns, in which probes were incorporated for monitoring changes in moisture. After the plasters had hardened, the structure fragments were flooded with water of a constant level for the whole duration of the long-term measurement. For monitoring the moisture profile, 2 methods of measurement were used. It was electrical impedance spectrometry and determination of moisture content using a capacitive hygrometer.

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Keywords: Thermal insulation plasters; thermal conductivity; capillary absorption coefficient; moisture transport; porosity

1. Introduction

Moisture is one of the factors which have a strong influence on the thermal insulating function of building materials. The development of thermal insulation plasters therefore requires materials that possess good thermal-technical properties and can be applied in places with high moisture. For decades now, The Faculty of Civil Engineering of Brno University of Technology has been concerned with research in new promising and eco-friendly plasters with excellent thermal insulation properties. This research often uses not only conventional raw materials but also alternative ones, mainly those which put a low impact on the environment. Another important property is

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the porosity of the materials. It is closely connected with the capillary activity of plasters, which comes into play especially in implementing those parts of a building exposed to moisture [1,2,3].

Many domestic as well as foreign experts deal with the development of thermal insulation plasters. There is a visible trend in terms of incorporating natural raw materials as well as making use of a number of chemical additives for improving the plaster properties, mainly air-entraining agents and hydrophobizers [2,3,4,5,6,7,8].

The paper focuses mainly on the investigation of the moisture progression of 2 mixtures of newly developed thermal insulation plasters applied on fragments of a structure that was permanently subjected to moisture load. For comparison, 1 fragment had a reference plaster applied. It was a thermal insulation plaster widely available on the construction market in the EU. The goal was mainly the investigation of the capillary activity of the new plasters and their possible application.

Nomenclature

Z	electrical impedance
R	electrical resistance
U	voltage
I	current
j	complex number unit
X	reactance
G	electrical conductance
f	frequency
r	radius of pore
g	acceleration
γ	surface tension
Θ	contact angle

2. Materials and methods

The raw materials were selected based on previous studies and research in the development of thermal insulation plasters. Lightweight aggregate based on expanded glass supplemented by milled limestone constituted the basis of the matrix of the new mixtures (Mixture 1 and 2). The binders used were cement CEM I 42.5 R (Mixture 1) and white cement CEM I 52.5 R (Mixture 2) combined with metakaolin; a pozzolana active admixture. These mixtures were used mainly for the purpose of observing the influence of chemical additives. Mixture 1 contained additives based on hydroxyethyl cellulose and methyl cellulose, in order to improve its workability in fresh state, and an air-entrainment additive based on olefin sulfonates. Mixture 2 contained the same chemical additives, but in a different ratio, and in addition to those, also a hydrophobing agent based on oleates and stearates. The detail of the composition of the mixtures is in Table 1 below.

Table 1. Composition of mixtures (*g*)

Component	Mixture 1	Mixture 2
Lightweight aggregate	9182	9182
Finely ground limestone	1888	1888
Lime hydrate	1328	1328
CEM I 42.5R	664	-
CEM I 52.5R white	-	1000
Metakaolin	664	664
Chemical additives	130	330
Water	10000	8086