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USING CHALK INSTEAD OF PAINTS IN PAPER PLASTER

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Instead of using paint, it is possible to manufacture white paper plaster by adding chalk to its ingredients. The moisture buffer values (MBVs) of paper plaster mixtures with chalk ranged from 1.8 to 2.9. The higher the chalk content was, the lower the MBV of the paper plaster was. Only the mix with the highest chalk content, where the percentage of chalk was 90, had a moisture buffering capacity below 2.0, i.e., not excellent (MBV > 2.0).

Keywords: *Chalk, moisture buffer value, Nordtest, paper plaster, recycling, wastepaper.*

1. INTRODUCTION

Plaster is defined as a combination of binder, aggregate, and water [1]. An intelligent use of hygroscopic plaster components may enhance the interior climate and occupant comfort by minimising indoor humidity changes. Due to these reasons, there is a strong interest in defining the moisture transmission and buffering capabilities of porous building materials [2]. Covering the surface of a plaster with paint may significantly reduce the moisture capacity of the systems [3]. In this paper, we concentrate on paper plaster modified with the addition of chalk, aiming to obtain a white colour without using white paint. It has been shown that paper plasters perform excellent moisture buffering capacities [4]. The current study is to determine the impact of different proportions of chalk on the moisture buffer values (MBVs) of paper plaster.

Recycling of different waste materials is of utmost importance [5]–[8]. In the recent period, the landfilling of organic wastes has been prohibited in several countries [5]. The demand for looking novel pathways to reuse waste materials, including wastepaper, rises rapidly, as the circular economy and recycling become more and more important [6], [9]. At the same time, it should be kept in mind that in the case of covering finishing materials (as plasters) with less permeable coats, the moisture buffering capacity of different materials decreases remarkably and leads to the increased amplitude of daily indoor relative humidity [10].

Wastepaper is among the materials that can be recycled through the production of different building materials [11]. For example, the effect of incorporating cellulose fibers from waste paper recycling into cement mortar was studied by Stevulova et al. [12]. The results of a recent study showed that paper plaster is applicable as an interior finishing material, as it does not turn mouldy in the environment typically favourable to moulds [13].

The MBV of paper plaster is inhibited when covered with paint [14]. The aim of this study is to specify the impact of chalk on the MBV of paper plaster, and the quantity of chalk that has to be added so that the plaster becomes sufficiently white and, as a result of this, does not need additional painting.

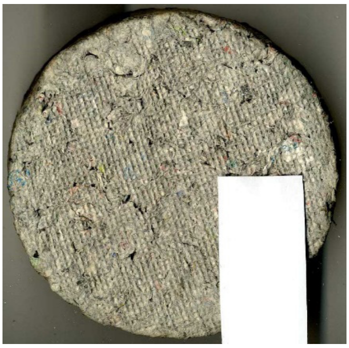
2. MATERIALS AND METHODS

The methodology utilised in this study is described in great detail by Rode et al. [15] and follows the lines presented in [14]. The Nordtest methodology defines a test protocol for experimental determination of the moisture buffer value *via* climatic chamber tests, where a specimen is subjected to environmental changes that come as a square wave in diurnal cycles [15]. It aims providing relative humidity (RH) variations of 75 % during 8h and 33 % during 16h. A partially sealed sample is subjected to repeated fluctuations in ambient relative humidity, while the temperature remains unchanged at 23 °C. The change in relative humidity (RH) causes the variation on specimen's weight, and this change is evaluated by periodic weighing. The weight change over time may be interpreted as an expression of the test specimen's MBV.

The specimens were made in three identical by composition copies according to the recipes that contain the components and/or additives given in Table 1. The plaster samples were prepared using wastepaper (newspaper), glue (Metylan Universal Premium, manufacturer Henkel) and chalk (powder). Chalk was added in different amounts (0–90 % of the total weight).

Table 1. The Composition of Plaster Samples (Ratio of Paper and Chalk by Weight)

Plaster group	Paper/chalk ratio	Density, g/cm³
1	100/0	0.22
2	90/10	0.24
3	80/20	0.27
4	70/30	0.31
5	60/40	0.39
6	50/50	0.42
7	40/60	0.61
8	30/70	0.74
9	20/80	1.08
10	10/90	1.15



Plaster group 1

Plaster group 2

Plaster group 3

Plaster group 4

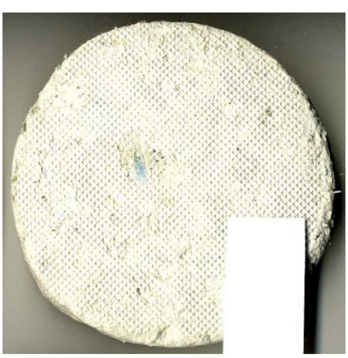
Plaster group 5

Plaster group 6

Plaster group 7

Plaster group 8

Plaster group 9



Plaster group 10

Fig. 1. Examples of specimen.

The paper was soaked in water for about 24 hours (ratio: 1 kilogram of paper and 30 L of water). The extra water (approximately 20 L) was then drained. Glue (40 g per 1 kg paper) and chalk (in 9 different amounts) were applied to the resulting paper pulps. The saturated and mushy paper was crushed by hand. Metylan Universal Premium adhesive powder, modified wallpaper glue produced from starch and including anti-fungal ingredients, was dissolved to form the glue. Paper pulp was added to the glue. A mold with a height of 2.5 cm and a diameter of 12.0 cm was used to make the test specimens. The test pieces were dried for 2 weeks at a room temperature (20−23 °C). The area needed to calculate the MBV was measured from the dried specimens. A total of 10 different mixtures were prepared (samples of them are shown in Fig. 1), three test specimens from each mixture.

3. RESULTS

The moisture buffering capacity of the mixtures tested in the experiment ranged from 1.75 to 2.89 (Table 2, Fig. 1). Only the mixture with the highest chalk content, where the ratio of chalk paper was 90/10, had a moisture buffering capacity of less than 2.0, i.e., not excellent (MBV > 2.0). The results of the tests show that the addition of chalk reduces the moisture buffering capacity of paper plaster. Figure 2 indicates that there is a linear relationship between plaster density and MBV.

Tabel 2. The MBV for Paper Plasters

Plaster sample	Paper/chalk ratio	*$MBV_{8/16h,}$ g/(m^2 %RH)	
1	Paper 100/0	2.9	excellent
2	Paper 90/10	2.8	excellent
3	Paper 80/20	2.9	excellent
4	Paper 70/30	2.7	excellent
5	Paper 60/40	2.9	excellent
6	Paper 50/50	2.7	excellent
7	Paper 40/60	2.8	excellent
8	Paper 30/70	2.4	excellent
9	Paper 20/80	2.1	excellent
10	Paper 10/90	1.8	good

*negligible (0−0.2), limited (0.2−0.5), moderate (0.5−1.0) good (1.0−2.0), excellent (2.0−…).

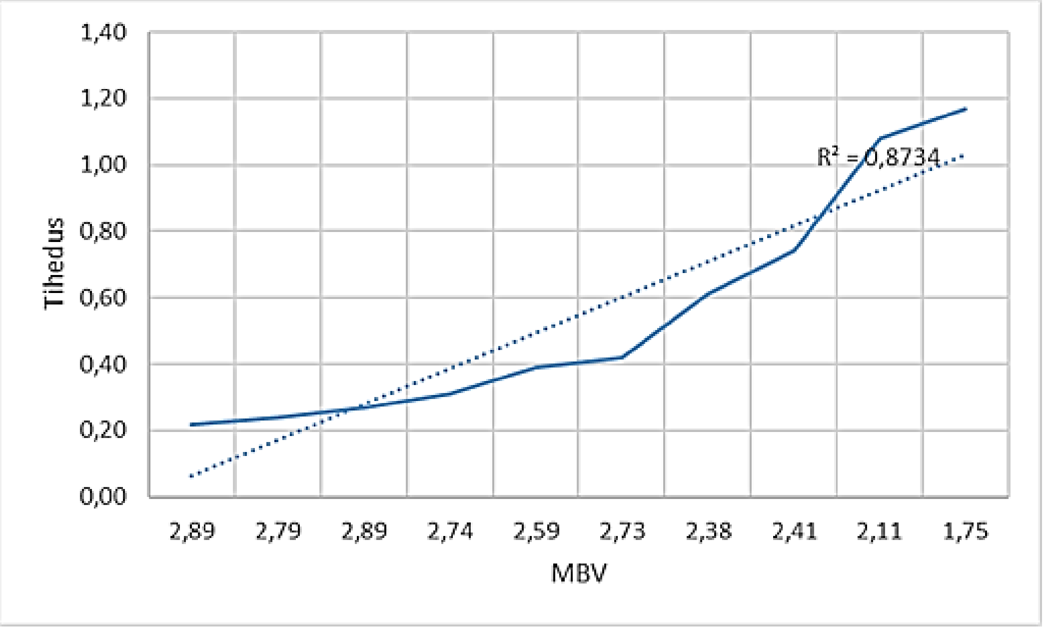


Fig. 2. The relationship between plaster density and MBV.

4. DISCUSSION

Powdered chalk has traditionally been used as a white pigment, a filler in pigments, a basis for organic pigments, and in the production of painting grounds. As an aggregate in lime plasters, powdered chalk behaves similarly to marble powder and dry lime plaster powder. Powdered chalk results in a white plaster with a yellowish tint [17].

Chalk including plasters are lime plasters. Lime plaster manufacture comprises many phases of preparation that must be meticulously completed in order to generate a high-quality product. To begin, quicklime powder is created by burning rocks (often limestone, chalk, and marble) at very high temperatures (>700 °C). After that, the lime is combined with water to create a plastic putty that can be applied and sculpted. The plaster keeps its resistant qualities and has a firm surface after drying. Technological advancements in the production of lime plaster included the inclusion of various materials to give the plaster additional features, such as greater binding capabilities or water resistance [18]. The last mentioned is a good advantage in plaster production.

The results of the experiment showed that the addition of chalk for the purpose of increasing the MBV was not practical. The more chalk added to the paper plaster, the lower the moisture-buffering capacity of the plaster. Previous experiments have shown that clay (clay plaster) added to paper plaster reduces the moisture buffering capacity of the plaster [6], [19].

In this study, we have analysed the effect of colour to the plaster. Coloured plasters are made by combining colour pigments with an uncoloured substance. An example of white pigment is chalk. Previous tests of coating paper plaster with casein paint with added chalk showed that the more layers of paint, the lower the moisture buffering capacity [14]. When the surface of the plaster was covered with chalk-based casein paint (1, 2, 5, 10, 15, and 20 times), it was revealed that MBV steadily decreased. If the MBV was 2.70 for 1 coating, the MBV for plaster coated 10 times was 1.61, and after 15 coats, the MBV did not change but remained 1.43. If chalk is added immediately to the plaster mixture during its preparation, the MBV (paper90/chalk10) is 2.79, and a mixture consisting largely of chalk (chalk90/paper10) has an MBV of 1.75, i.e., higher than when coating the plaster with casein paint containing chalk 15 times.

5. CONCLUSIONS

The results demonstrated that MBVs of paper plaster mixtures with chalk ranged from 1.75 to 2.89. The higher the chalk content, the lower the MBV of the paper plaster. In spite of this fact, only the mix with the highest chalk content, where the ratio of chalk to paper was 90/10 by weight, had a moisture buffering capacity below 2.0, i.e., lower the level of "excellent" (MBV > 2.0).

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