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Shrinkage, abrasion, erosion and sorption of clay plasters

Retracción, abrasión, erosión y absorción de revoques de barro

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SUMMARY

At the Buildung Research Institute (FEB), Faculty of Architecture, University of Kassel, Germany, in the last years several hundred tests were made to study the characteristics of different loam mortars in respect of their linear shrinkage, absorption of humidity and their resistance against abrasion and erosion. In order to get data about abrasion and erosion new test methods and special apparatusses were developed. The mortars tested, chosen from the market, showed extremely varying test results.

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Keywords: loam plaster, shrinkage, abrasion, erosion, absorption.

RESUMEN

En el Laboratorio de Construcciones Experimentales (FEB) de la Facultad de Arquitectura, Universidad de Kassel, Alemania, fueron testeados cientos de diferentes pruebas de revoque de barro para estudiar su contracción durante el secado, su absorción de humedad y su resistencia contra abrasión, erosión y absorción. Para recibir datos sobre abrasión y erosión, nuevas aparatos y metodos fueron desarrollados. Los resultados de los revoques comprados en el mercado muestran gran diferencias en los valores.

Palabras clave: *barro, revoque, retracción, abrasión, erosión, absorción.*

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1. Linear shrinkage of clay plasters (after DIN EN 1015-3, d = 140 mm)

2-3. Hand and laboratory apparatus to test the abrasion resistance of surfaces, developed by FEB

Samples		Shrinkage [mm/m]
CO 1-1	Commercial clay base coat with straw	8,3
CO 1-2	Commercial clay finishing coat	14,0
CO 1-3	Commercial fine clay render with cellulose	7,7
CO 2-1	Commercial clay base coat	17,5
CO 2-2	Commercial clay finishing coat	16,2
CO 2-3	Commercial fine clay render	26,7
CO 3-1	Commercial clay finishing coat with straw	14,2
CO 3-2	Commercial clay base coat with straw	27,8
CO 3-3	Commercial fine clay render	14,1
CO 4-1	Commercial clay base coat	7,9
CO 4-2	Commercial clay finishing coat	11,4
CO 4-3	Commercial earth mortar	8,1
CO 7	Commercial earth plaster	13,7
CO 9-1	Commercial earth plaster	14,3
CO 9-2	Commercial earth decor plaster	27,7
CO 10	Commercial clay base coat	10,5
CO 11-1	Commercial fine clay render	10,5
CO 11-2	Commercial clay base coat with flax	11,2
CO 11-3	Commercial fine clay render with flax	12,1
CO 12-1	Commercial clay base coat	18,8
CO 12-2	Commercial fine clay render	7,2
CO 13	Commercial earth plaster	24,3
RM 1	Raw material without fibres	6,2
RM 2-1	Raw material clay base coat with straw	17,4
RM 2-2	Raw material clay finishing coat with hemp	19,5
RM 2-5	Raw mat. clay finishing coat without hemp	19,8
RM 2-6	Plaster with Typha and Hemp	17,9
RM 2-7	Plaster with Typha and Hemp	19,6
Plaster+ 1	Plaster+ Product	33,4
Plaster+ 2	Plaster+ Product	30,5

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The word clay plaster herewith is used for all plasters, where clay is the only binding agent for silt, sand and sometimes also gravel. In some countries other words like mud plaster or earth plaster are used for it. If there are other binding agents as well, like cement, lime, cellulose, bitumen or polymers, we talk about stabilized clay plasters.

Mineralogists and other scientist might be interested to investigate or analyse the amount of clay, the kind of clay, the granularity, the liquid and plastic limits, the plasticity index, etc. but for a

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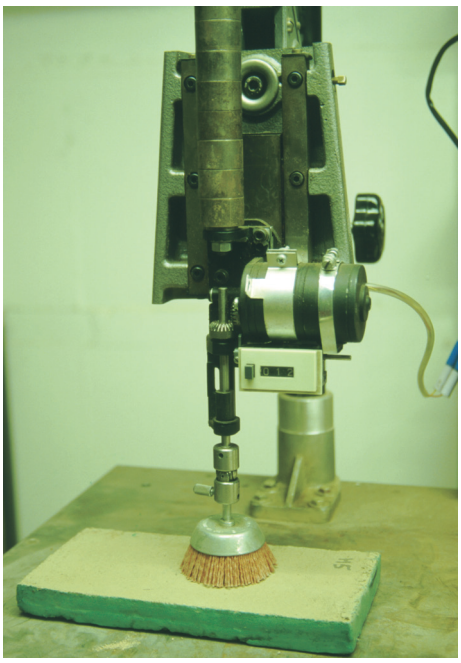

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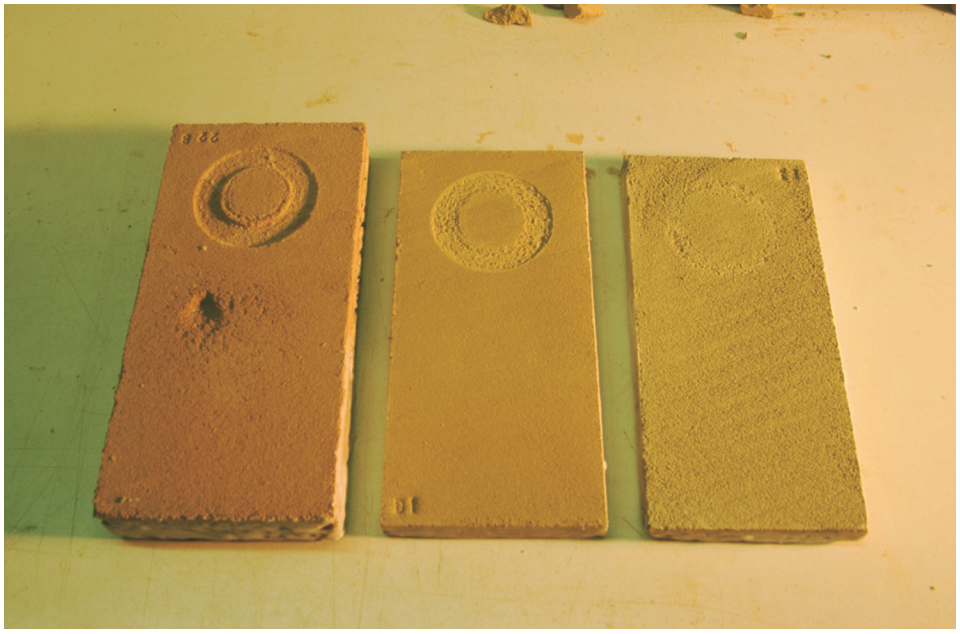

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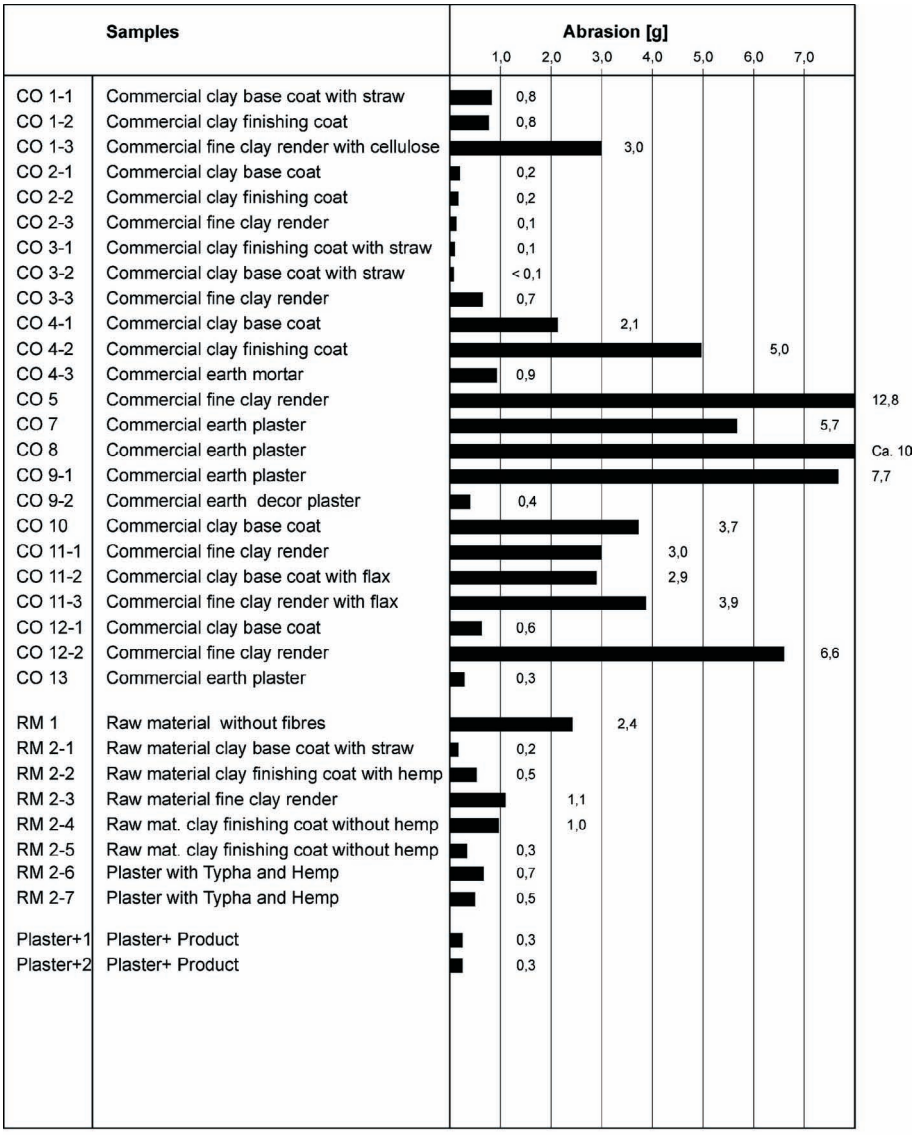
4-5. Results of abrasion test, conducted with laboratory test apparatus shown in Figure 3



Abrasion of Loam Plasters (Flow Consistency 140mm), after FEB

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6. Test apparatus to simulate extreme rain, developed by FEB

practitioner there are only 4 important properties, which we should know:

- the linear shrinkage
- the abrasion of the dry surface
- the erosion, if it is an exterior surface
- the absorption, if it is used in interior spaces.

At the Forschungslabor für Experimentelles Bauen FEB (Building Research Institute) University of Kassel, in the last years several hundred tests were made to get data of these 4 characteristics of various clay mortars used as plaster, which are on the European market.

A high shrinkage means in practise many cracks, which normally brings high effort in treatment or repair.

Figure 1 shows the linear shrinkage of 15 different loam plasters, available on the German market, which were tested with equal consistancy. The results range from 0.54 % to 3.85%.

Clients sometimes complain about the high abrasion which occurs, if they rub the surface of a plastered wall and sand comes off. At the FEB a test method was developed to measure and compare the resistance of plasters against abrasion.

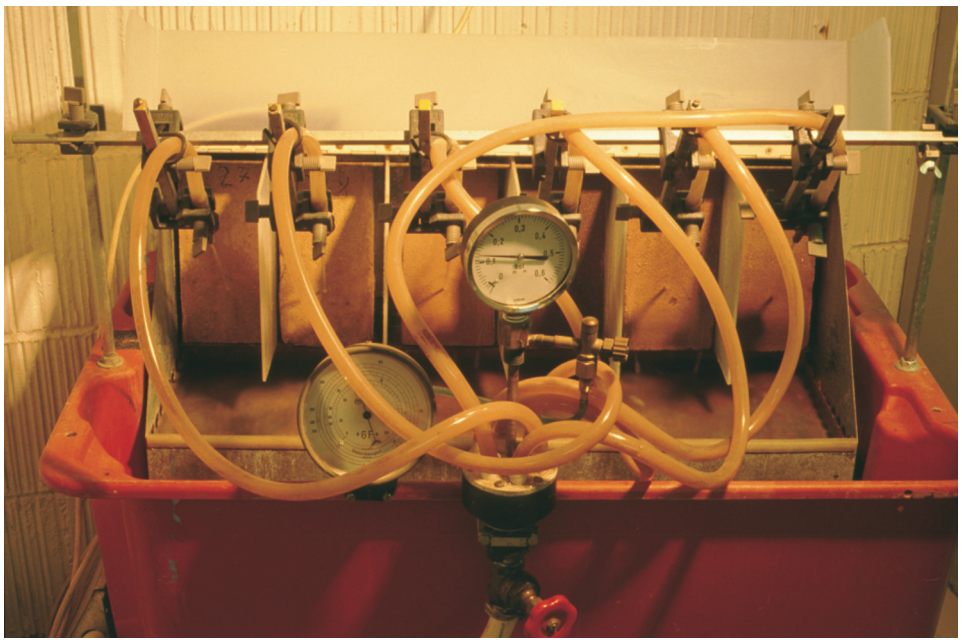
Figure 2 shows the hand test apparatus, and Figure 3 the laboratory test apparatus. Both have a rotating hard plastic brush, which is pressed by a weight of 2 kg against the loam surface. After 20 circles the amount of loose material which came off is weighed. This method is accepted as a standard test by the German “Dachverband Lehm” (4).

Figure 4 shows the result of 3 different clay plaster surfaces after the test and Figure5 the results of 24 different clay mortars, which are available on the European market. The results vary from 0.1 g to 12.8 g abrasion (1).

For outdoor surfaces, which are reached by rain the resistance against running water is important. In order to simulate an extreme heavy rain, a test apparatus was developed at the FEB (Figure 6), where a waterjet of 4 mm diameter with a velocity of 3.24 m/s hits a loam surface under 45 degrees.

Figure 7 depicts the result of the erosion tests of different stabilized loam plasters in comparison with non stabilized ones. The ends of the black lines mark the beginning of the erosion. While the pure loam plaster started to erode after 3 seconds, some stabilized ones withstood the waterjets for more than 6 days without showing any erosion.

In the right part of Figure 7 the weight of abrased particles, due to the test described, is shown for the same mortars.



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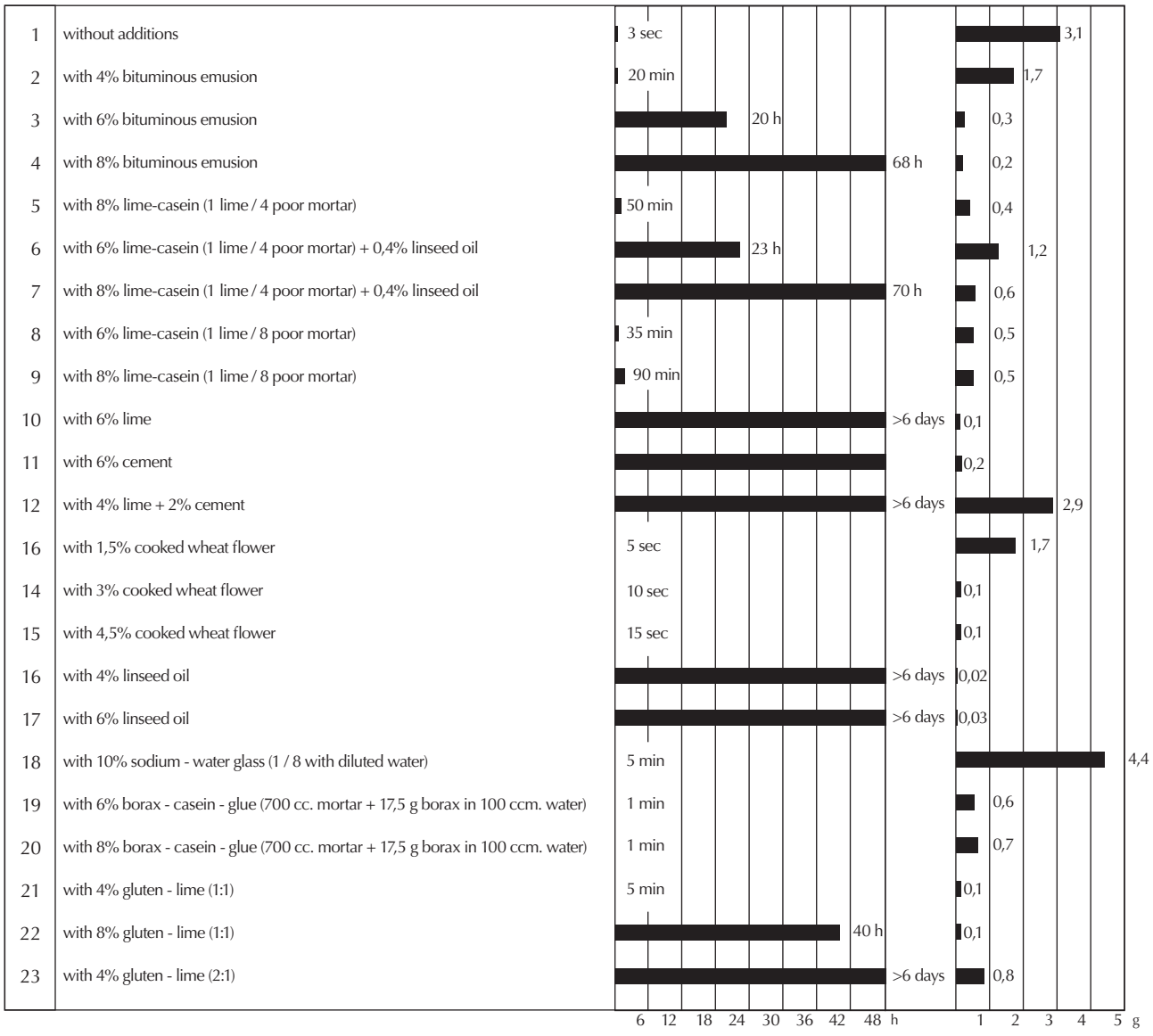

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7. Erosion and abrasion of stabilized clay plasters in relation to an unstabilized clay plaster (1)

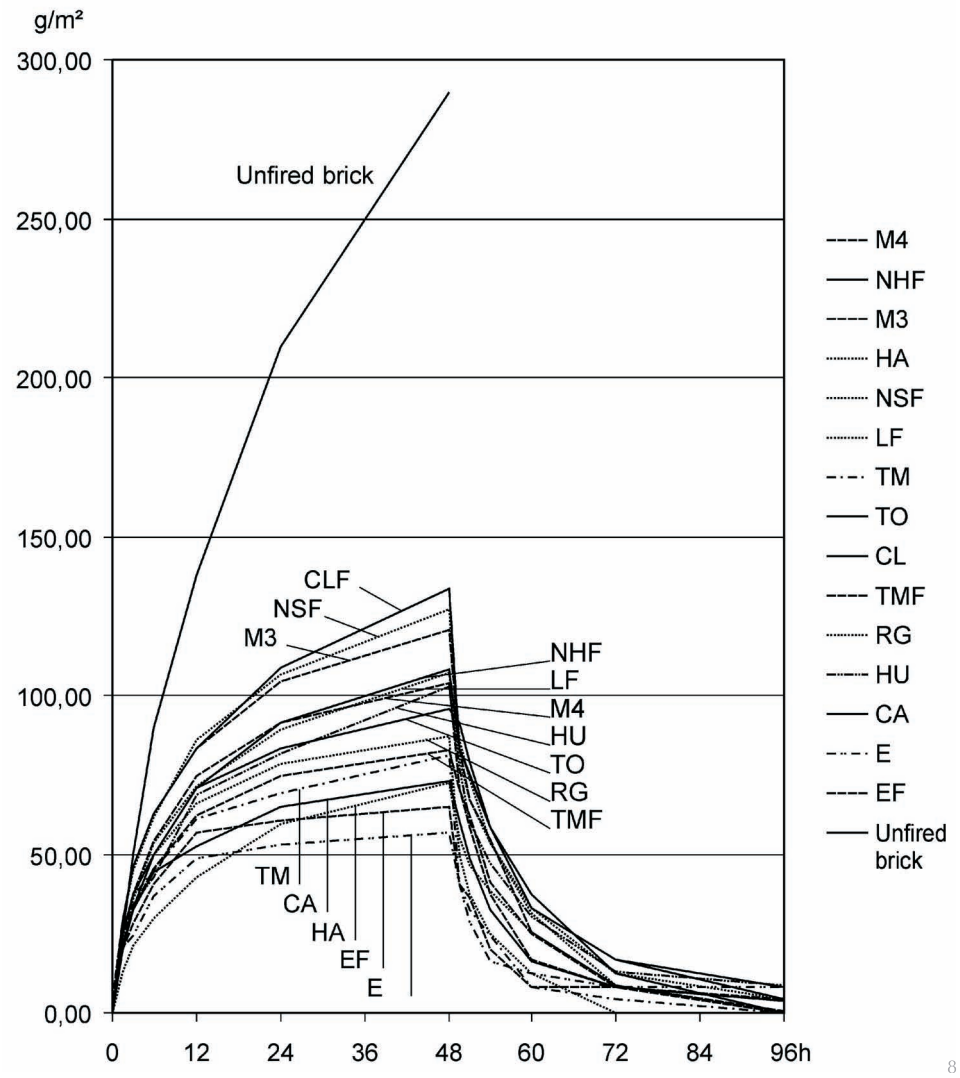
In general, mortars with low resistance against erosion also have low resistance against abrasion (show high abrasion). All data where taken as average value of 3 respectively 5 samples.

The humidity sorption effect of clay is a special argument for selling loam products in Europe. 20 years ago, it was already tested by the FEB that the surface of an uncooked brick, a socalled green brick, absorbs after 2 days about 300 g of water/ m^2 if the humidity of the air is raised from 50% to 80%, whereas a burnt brick under the same conditions only absorbs about 30 g/m^2, and a clinker about 6 g/m^2 (2), (3).

Figure 8 shows the absorption rates of 15 clay mortars which are available on the German market in relation of the rate of a green (unburned) brick. Each sample was sealed at 5 faces so that humidity could only pass through one surface. The samples had to stay in a climatic chamber at a level of 50% relative humidity and 21 °C up to 3 weeks until the equilibrium moisture content was reached (until no change of weight was to be measured). The measurement was done with an accuracy of 0.01 gram). When no more changes of weight could be measured, the relative humidity in the chamber was suddenly increased to 80% and the increase of weight measured after certain times in an ongoing process. The data were taken as average value of 3 respectively 5 samples. (The symbols refer to the brand and cannot be made public).

The amount of absorption of loam plasters depends on their clay content, the kind of clays (montmorillonite absorbs more than caolinite) and if organic fibres or cellulose particles are added. Obviously the tested plasters show quite different absorption rates.

8. Absorption rate of clay plaster samples, 15 mm thick, at 21° C after a sudden increase of relative humidity from 50% to 80%



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