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EARTH BUILDING PERFORMANCE OPTIMIZATION WITH BYOPOLIMERS

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Earth building, rammed earth, compacted earth blocks and biopolymers.

ABSTRACT

One of the main problems of earth building consists of its reduced performance when in contact with water. Without an adequate protection, the water action can disintegrate the superficial layers, as well as causing a decrease of the mechanical resistances and the material collapse. On the other hand, the water vapor permeability of earth building materials is the most important thing to be preserved to keep not only a healthy but also quite comfortable space to live in. Therefore, one must be especially careful with the selection of additive materials to incorporate in the earth building so that it does not produce an excessive waterproof. One other item to be taken into account is the possibility of appearing some fungus on the walls' surface when organic materials are used.

There are many ways of overcoming these problems, such as using physical resources, like architectural solutions in order to minimize the water rains' contact on the walls, the application of a waterproof covering layer or through a physiochemical action by adding materials that increase the stabilization and cohesion of the soil and avoid its collapse.

Since early times that different additives are used in earth building, as well as coverings, mortars and paints based on clay to minimize these problems. Recently researchers have been revising this theme, studying different additions, and sometimes trying to recover ancient knowledge and adapt it to present know-how.

INTRODUCTION

The main purpose of this study is to analyse the effect of diverse biopolymers under water presence, the influence of these additives towards water absorption capacity and the material stabilization, providing a better mechanical behaviour when in water presence.

One also has the goal of searching for the appropriate demands of this sort of material (which sometimes seems contradictory when considering the waterproof and the water vapour permeability) and simultaneously avoiding the appearance of fungus on the walls' surface as well as verifying its application in the construction practice.

MATERIALS AND METHODS

Biopolymers effect in sandy/clay soil

In this research study it was tested the effect of three biopolymers: amide, linseed oil and glycerol with vegetable origin.

A sandy/clay soil was prepared in the laboratory with 80% of sand and 20% of kaolin to maintain in all the tests similar and reproducible conditions, that is to say, a neutral soil without organic matter.

One has also prepared cylindrical samples with 30 mm of diameter and 40 mm of height, made by static compaction with a hydraulic press. Some samples of simple soil and soil with each additive were prepared with the following percentages of soil mass: 0.4% of amide, 1.0% of linseed oil and 1.0% of glycerol.

Furthermore, the following tests were performed: simple compressive strength, in dry and saturated state (achieved by capillarity of water within 24 hours) in order to evaluate the mechanical resistances; water absorption by capillarity test and subsequent dry test to evaluate the behaviour with water contact.

Complementary effect of an agglutinant additive

One has also prepared and tested similar samples with the same percentages of soil, amide, linseed oil and glycerol by adding to each mixture an agglutinant additive of 0.1% of soil mass.

Complementary effect of sodium chloride

To evaluate the effect of adding sodium chloride in the mixtures, samples containing 0.1%, 0.25% and 0.5% of NaCl in relation to the soil mass were prepared and tested.

However, it was performed an electronic microscopy study with the mixtures with the best performance in water absorption.

MAIN RESULTS

As far as the biopolymers addition to the simple soil is concerned it was verified that linseed oil considerably increased the compressive strength, with glycerol the increase was small and with the amide there was a little decrease. In the behaviour with water absorption the linseed oil had a better performance after six hours, while the glycerol had better values in first six hours and the amide presented a similar behaviour to the reference soil. In dry test the linseed oil had the better drying while the glycerol had the reduced drying.

The complementary effect of the agglutinant had the best compressive strength results with the simple reference soil and soil with amide, reducing the resistances in the mixtures with linseed oil and glycerol. The best result in water absorption was achieved with the soil with the agglutinant and with the soil with glycerol and agglutinant (see Figure 1), having a similar behaviour with the dry test.

Concerning the complementary effect of sodium chloride the results of the compressive strength showed a better behaviour only in the addition of 0.1% in saturated conditions. The best performance was obtained in the water absorption test with a reduced absorption with the mixtures with 0.1 and 0.5% of sodium chloride and similar behaviour was achieved in the dry test.

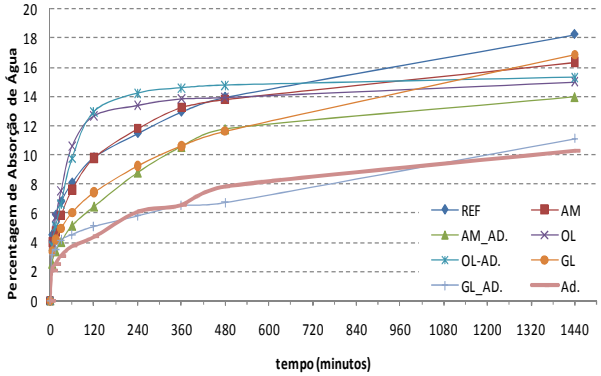
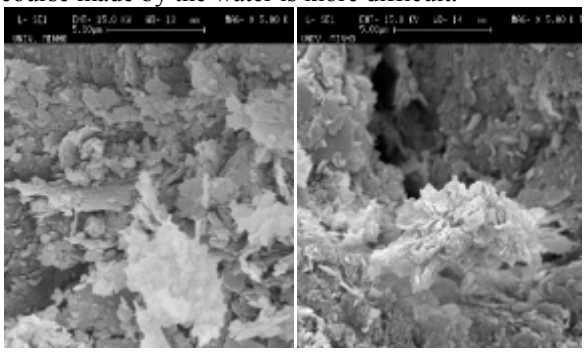


Figure 1: water absorption test of mixtures of soil, biopolymers and agglutinant

In the electronic microscopy study (see Figures 2 and 3) the soil mixtures with sodium chloride (0.1% NaCl) and with amide, agglutinant and sodium chloride presented a large flocculation and a face to edge effect in the clay particles. This means that this flocculation effect and the dispersion followed by a reconnection of the clay particles can be the essential cause of the best results in the water absorption by capillarity, since the course made by the water is more difficult.



Figures 2 and 3: microscopic images of two different mixtures with sodium chloride

CONCLUSION

This research allowed the analysis of these biopolymers' effect, as well as the agglutinant effect and the addition of sodium chloride result.

Based on the obtained results one can see that there is no direct relation between the mechanical resistances and the water absorption behaviour or dry tests. After that being verified the better resistances were obtained with linseed oil addition but the better performance in water absorption was obtained with the agglutinant additive.

The electronic microscopy study allowed an enhanced analysis about the physicochemical phenomenon occurred in soil particles, especially with the clay.

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