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Creep of Unfired Clay Mortar Based on Illitic Clay

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Abstract. Paper focuses attention on production and preparation of test specimens of unfired clay. The material of unfired clay consists of illitic clay, sand and a specified amount of water. The shrinkage and creep measurements are started the second day after production. The result of measurement is to determine the size of the length changes of unfired clay and monitoring long-term behavior of the material. The resulting creep and shrinkage curves are related to temperature changes in the laboratory.

Introduction

Problems of the properties of unfired clay have not preference like a other modern material, today. Buildings made of unfired clay accompany mankind since time immemorial [1]. Yet there are no reliable data for their safe design. The absence of information can be one of the reasons why earthen structures are not space for their implementation. Buildings made of unfired clay have their benefits, such as high-quality indoor environment, environmentally friendly materials and good availability [2].

One of the material information is a behavior of the structure, or the material from the perspective of rheology [3]. The size of creep and shrinkage are very important in terms of the design of structures made of unfired clay. This issue is dedicated the article. Specifically, it is focused on rheology rammed clay which was prepared from the illitic clay [4].

Fig.1 The specimens used for measurement of creep and shrinkage, prepared from illitic clay.

Material testing

Tested material was prepared from illitic clay, sand and water. The sand was composed of two fractions, 0-1 and 1-2 mm. Smooth line granularity was created using of both fractions in the ratio of 60 : 40 (fine and coarse part). Both fractions of sand were mixed before production of the dry clay mixture. The clay was in a mixture represented 25 % of weight, and sand accounted for 75 % of weight of the dry mixture. Water ratio is defined as the relation of the weight of mixing water and clay. Its size was 0.37 for the mixture. The mixture was compacted - rammed into the molds and then tested and non-fired [5].

The start of the measurement was the second day after the made of specimens. Measurement time was 34 days. During the measurement, a steady temperature with a deviation of ±1° C was maintained in the laboratory as shown in Figure 2.

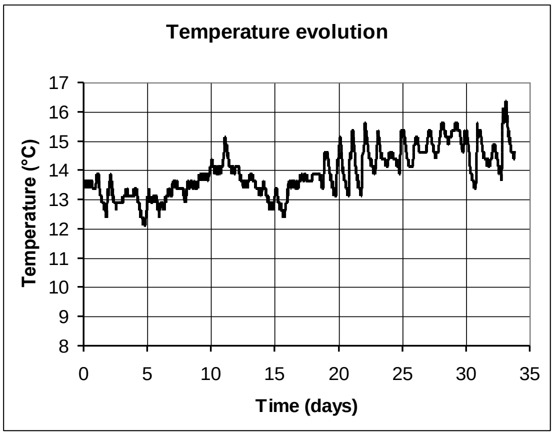

Fig.2 Evolution of temperature during the test.

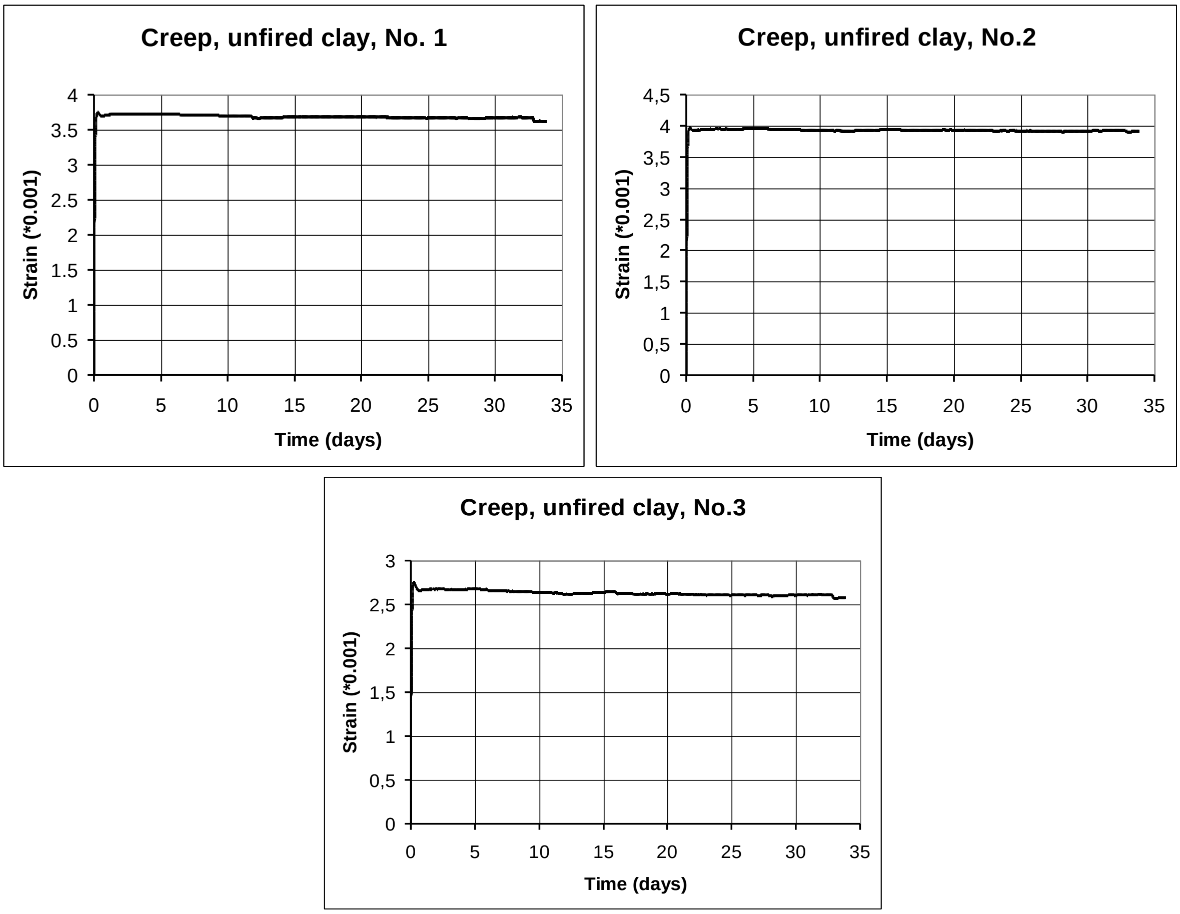

Fig.3 The curves of the creep measured on the specimens 1-3 prepared from described clay.

A temperature increase of 1° C occurred after 20 days of measurement. This increased ambient temperature in the laboratory did not affect creep curves, as shown in Figure 3.

The test was carried out with three specimens for measurement of creep and 3 of the body for measuring the shrinkage. Used specimens are displayed on Figure 1. The base of bodies was octagonal. The body has a length of 70 mm, which is suitable for measuring creep and shrinkage in lever mechanisms [6]. Load lever mechanism having a size 59N. Bodies intended for measuring creep was so loaded. The load represents approximately 10% load capacity of perpendicularly to the ramming of rammed clay. The moisture from the body during measurement can freely escape [7]. The transport of moisture was not blocked.

Shrinkage measurements were also carried out in lever mechanisms, but without load. The shrinkage measurement results are shown in the graphs in Figure 4.

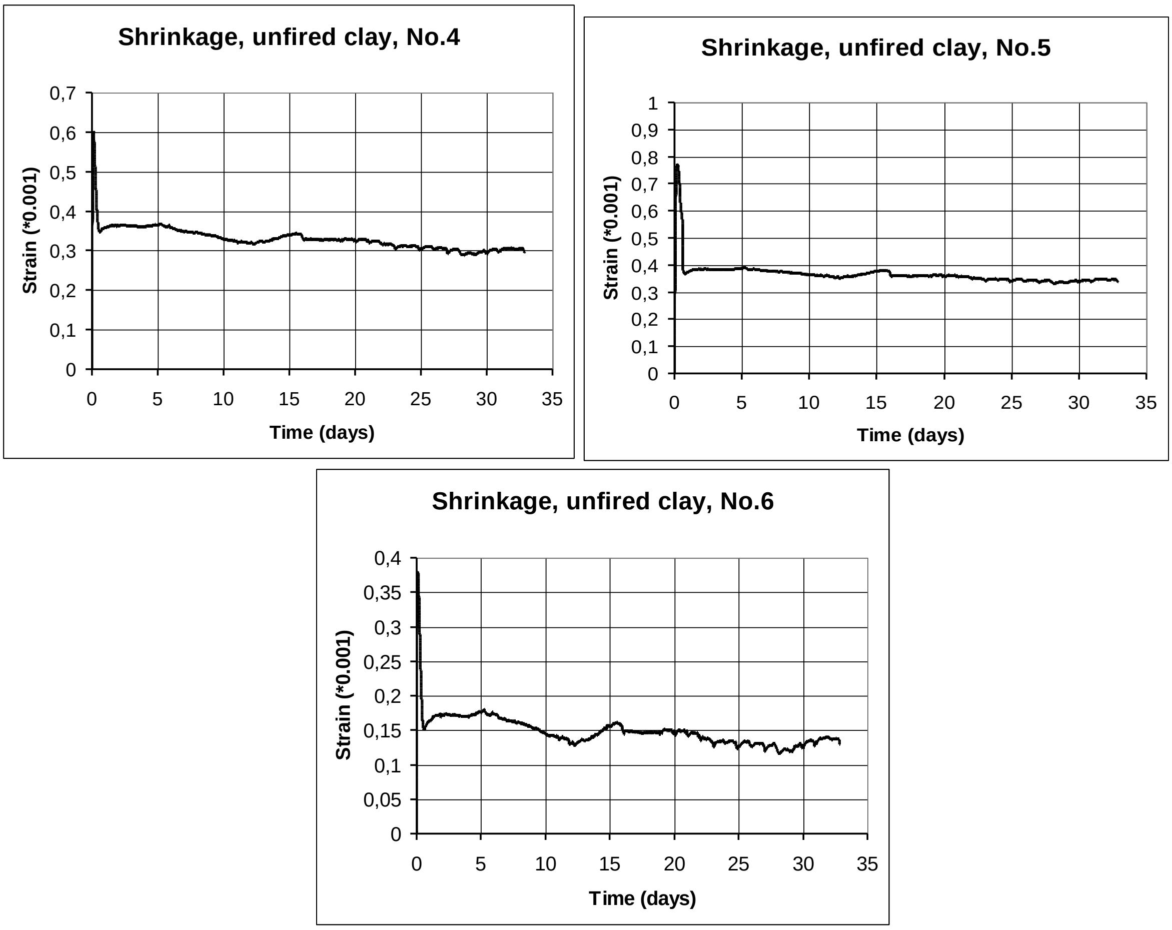

Fig.4 The curves of the shrinkage on the specimens 4-6 prepared from described clay.

During the measurement, a possible change of weight with changes in the humidity in the laboratory was compared using control bodies in the temperature chamber. The same bodies were used to compare. Three of them were placed near the measurement and three bodies in the temperature chamber. Weight loss is caused by moisture removal from clay. The course of weight loss is shown in Figure 6. Bodies 1-3 were located at the creep measurement point, and body 4-6 was located in the temperature chamber. The temperature chamber maintained 50% humidity and 20° C. By comparing the shape of the curves, it appears that a stable temperature and humidity environment was maintained during the measurement [8]. Measurement of shrinkage and creep as was done in a steady environment, and the results are affected only by the behavior of the material.

The greatest loss of moisture occurs during the first two days. At the time of the loss of free water from the bodies, the strength increases. The rammed clay hardened at that time.

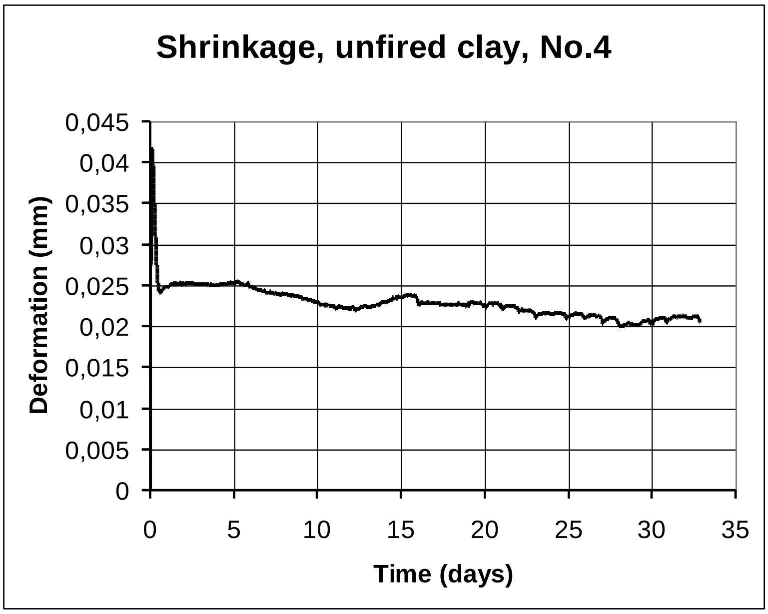

Fig.5 The imported curve of evolution of temperature during the test.

Results

Only body No.3 showed a decreasing value over time of creep. For explanation, it means increasing of strain the shrinkage and diminishing the values of strain the expansion. Bodies 1 and 2 practically did not change the initial creep value throughout the test period. The increase in shrinkage occurs almost only in the beginning, after loading the specimens. Size creep is around 3 milistrain. Creep results include the effect of shrinkage.

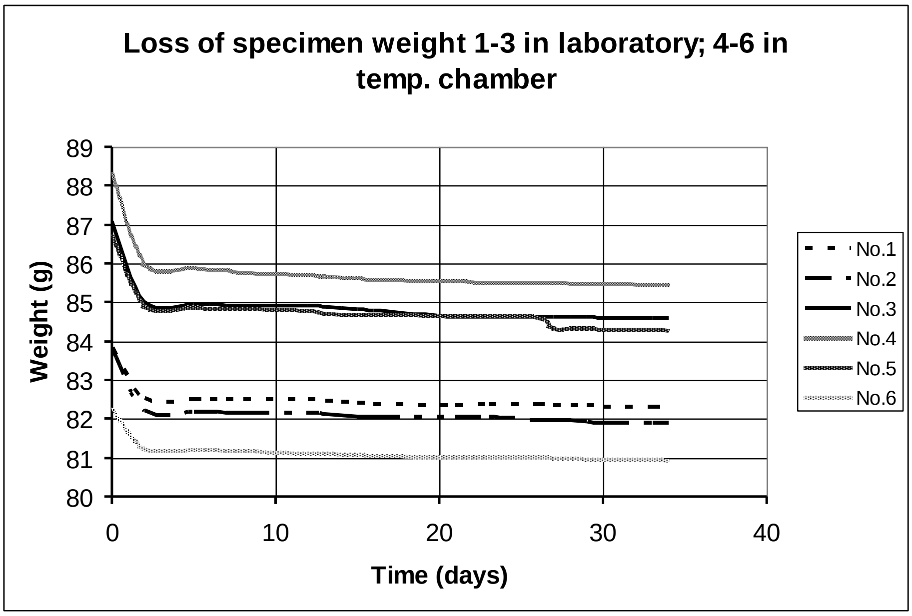

Fig.6 The change of the weight of specimens during the test.

In contrast, the shrinkage changes throughout, as shown in Figure 4. The strain diminished by 0.05 milistrain in all three bodies. This means that during the entire test, the specimen length was increased under steady temperature and humidity conditions. The reason is probably the ability of the illitic clay to expand even at steady air humidity. Very well, this is shown in Figure 5, where the deformation of the 70 mm bead body is plotted on the vertical axis of the graph. It is seen that the elongation value is 5 microns. Initial deflection of the strain is caused by clamping the specimens into the measuring devices.

Conclusions

Rammed clay has a very interesting perspective creep properties. The main change of creep occurs in the early stages of measuring after the loading. Totally interesting result is the size of shrinkage after 30 days. This reached a value of 0.05×10^{-3} milistrain in the direction of expansion. It can be confirmed that this behavior is not random, but corresponds to the behavior of unfired and rammed clay [1]. The results of testing 3 specimens for creep and 3 elements for shrinkage are very consistent even though they are the rammed clay. It can be deduced from the results that illitic clay tends to expand even at steady air humidity.

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