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Comparison of shrinkage of the rammed earth prepared from illitic and illitic-kaolinitic clay

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Abstract. The paper senses the comparison of the impact of different types of clay on the rheological properties. Illitic and Illitic kaolinitic clay have been used in this study. The creep and shrinkage of rammed material was observed. The influence of material composition on rheological behaviors was observed. Finally, comparison of both materials was realized.

Introduction

Material properties are needed for structural design [1, 2]. Supporting structures made of unburned clay can have great variability of properties. The paper attempts to contribute by comparing different blend designs to the type of clay and the amount of water in the blend design. Load-bearing capacity is a very important piece of information [3]. The creep under load and shrinkage from drying to such properties includes.

Materials The rammed earth was prepared from two types of clay. The first one has label 1 – KR5. It was prepared using the Illitic – kaolinitic clay [4]. The second one mixture marked 2 – AGL9 was prepared using the Illitic clay. Both clays differ in their ability to bind water to their structure.

The specimens were prepared from a mixture of water sand and appropriate clay. Table 1 reports the composition of mixtures and the amount of water in the mixture. The difference between the two mixtures was in the clay type and the amount of mixing water. Its amount is based on the weight of the clay used. The sand used was 0 - 2 mm with continuous grain size curve.

Creep and shrinkage of stewed clay is experimentally measured on specimens made of rammed earth. The specimen length is 70 mm. The bodies are made in the form of beams with an octagonal base with a distance of opposite sides of approximately 20 mm. The shape of the specimens is shown in Figure 1. The specimens are subjected to loads for the required time, which corresponds to the load in the elastic area of the material.

Table 1: Composition of both materials

Description	Clay	Sand	Clay / water
1 – KR 5	20	80	0.37
2 – AGL 9	20	80	0.45

Deformation increases at the start of the test in these cases. Drying of the material causes to stop shrinking and only a slight increase in creep rammed earth. Creep rammed clay prepared from Ilitic - kaolinitic clay exhibits sensitivity to temperature, which is seen on the right hand graph in Figure 2. Ambient temperature during the measurement is changed by ± 1 ° C.

Measurement A comparison between the two different mixtures is shown in Figure 2. The creep values of both graphs are in dimensionless quantities. The first mixture (left) achieved a very significant creep value immediately after the specimen load. Both remaining specimens shoved the same trend of creep growth. The mixture prepared from Illitic - kaolinitic clay behaved differently. The deformation increased suddenly after loading. Consequently, the deformation was still noticeably increasing for one day. Then the increase in deformation stopped.

Fig. 1: Specimens for creep and shrinkage tests prepared from Illitic clay.

Mixture No. 2 contained a higher proportion of water in the mixture as shown in Table 1. More plastic blend No.2 showed a sudden increase in strain under load. In contrast, mixture No.1 reacted gradually to the load. This is shown in Figure 2 (right).

The second phenomenon, creep size is also evident from the comparison of the both graphs of Figure 2. The drier mixture of No.1 reached several times lower creep values than the mixture No.2. This phenomenon is also related to the amount of mixing water. Although both mixtures contained the same amount of clay, the amount of water significantly affected the rheological properties of the rammed earth. The difference in the amount of water both mixtures was 0.08 weight relative to the amount of clay.

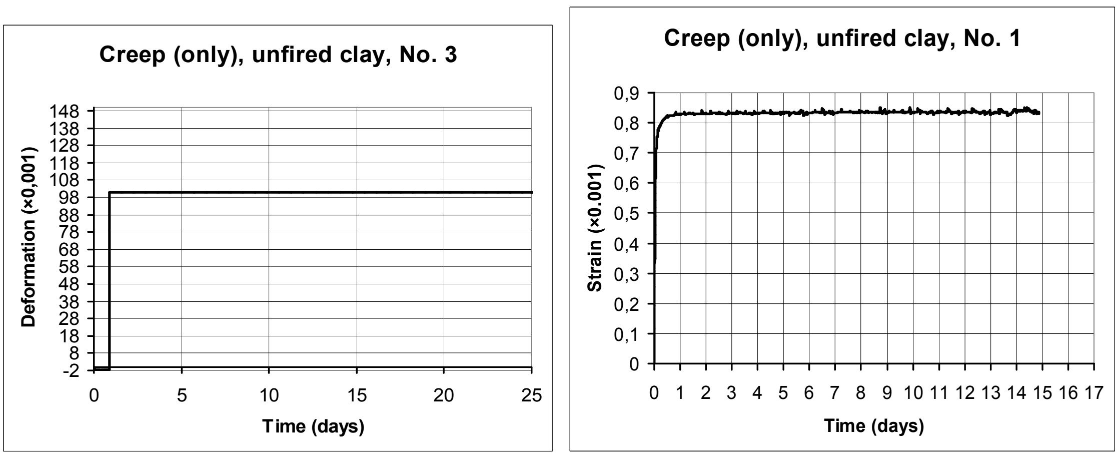

Fig. 2: Comparison of creep of rammed earth prepared from Illitic clay (left) and from Illitic-kaolinitic clay (right).

The result of the shape and size of the creep curve shows that a small change in the amount of mixing properties can significantly affect rheological properties. The creep of both mixtures did not increase after the initial increase in deformation. The phenomenon is related to the increase in the strength of rammed earth. Drying of the mixture causes an increase in strength.

Similar behaviour is observed on the shrinkage curves of both materials, see Figure 3. The left graph shows the shrinkage curve of the second Illitic clay mixture [5]. The rammed earth with a lower content of mixing water showed less shrinkage. Higher shrinkage was measured on rammed earth from Illitic clay with higher water content.

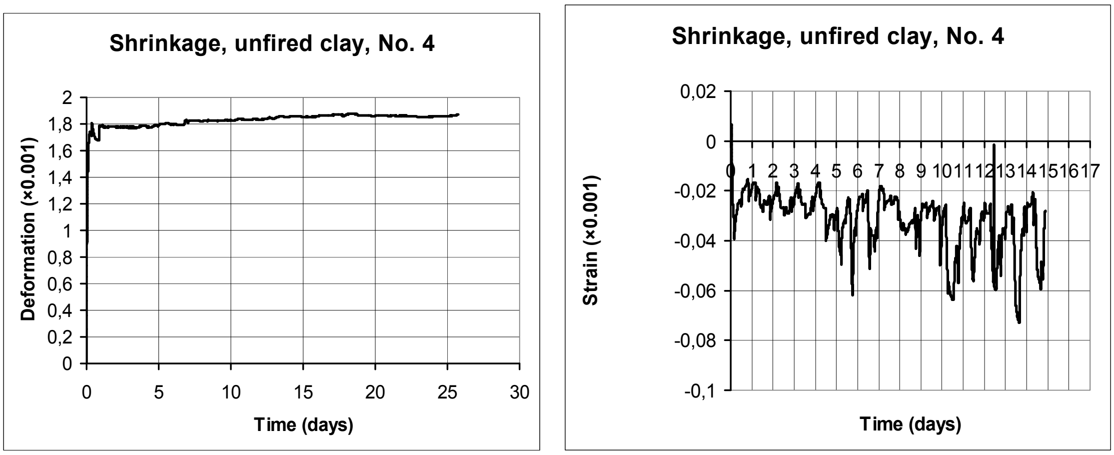

Fig. 3: Comparison of shrinkage of rammed earth prepared from Illitic clay (left) and from Illitic-kaolinitic clay (right).

Illitic - kaolinitic clay tends to expand instead of shrinking. This is shown in the graph in Figure 3 on the right. The shrinkage of this rammed earth is in the tens of microstrain. On the other hand, rammed earth No. 2 had shrinkage in milistrains. This mixture showed shrinkage. There was no expansion, as in the first case, see the graph on the left in Figure 3.

The mixture prepared from Illitic clay reacted more sensitively to the temperature changes shown in Figure 5 on the left. Decreasing the temperature by 1.5 ° C caused an increase in deformation around 13 days from the start of the test. The deformation increase was approximately 0.1 milistrain. The clay prepared from Illitic - kaolinitic clay was not affected by temperature [6].

Fig. 4: Specimen for material test prepared from Illitic – kaolinitic clay.

The temperature was steady for the duration of the test, as shown in Figure 5 on the right. The initial increase in clay deformation 2 is caused by instrumentation of the measurement. In both cases, the measurement principle was the same. The higher water content was more sensitive to the shrinkage measurement method as shown in the graph to the left in Figure 3.

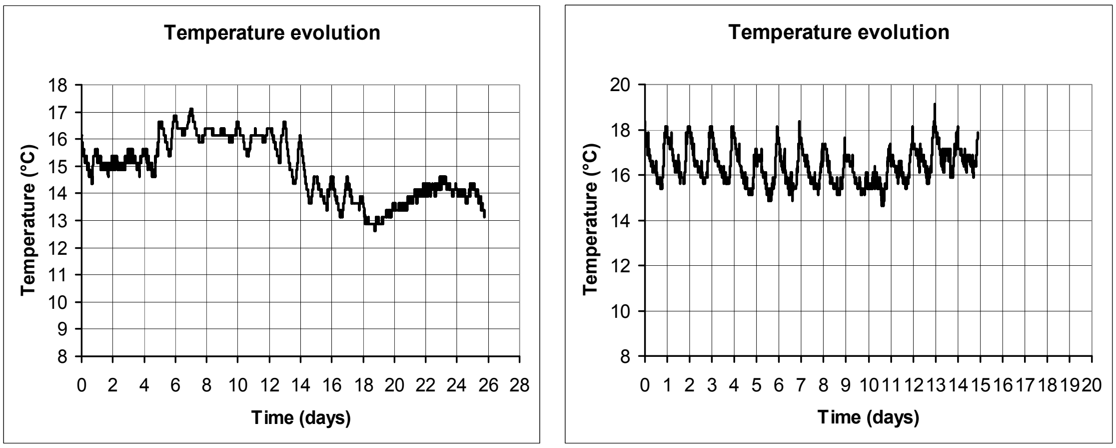

Fig. 5: Temperature evolution of ambient in laboratory during testing of materials; Illitic clay (left) and from Illitic-kaolinitic clay (right).

Figures 1 and 4 illustrate the difference in structure between the two materials. Illitic - kaolinitic clay with lower water content creates a surface structure with a higher proportion of sand grains, see Fig.4. On the other hand, a mixture with a higher water content better on the surface envelopes the sand grains, and the structure looks more homogeneous. The influence of the water content plays an important role for higher plasticity of the material. The mixture better fills the mould when ramming, see Figure 1.

The colour difference of bodies is caused by the use of two different types of clays. Illitic clay stains the material in light brick colour.

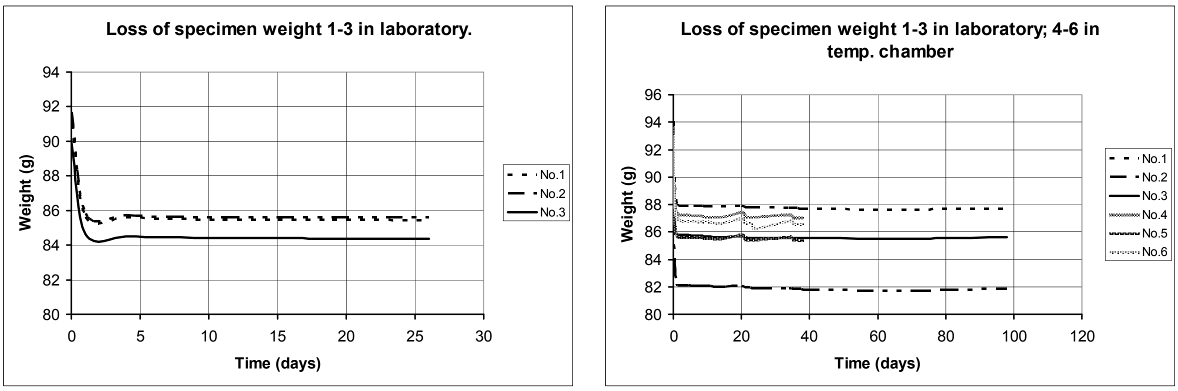

Fig. 6: Evolution of specimen weight during the test of materials; Illitic clay (left) and from Illitic-kaolinitic clay (right).

Figure 6 accompanies the idea of material drying rate. The weight of the specimens at the creep measurement point is measured throughout the tests. The main change in specimen weight of 20 × 20 × 100 mm occurred in the first two days of both measurements. Measurements of the weight change of illitic-kaolinic clay were accompanied by weight measurements under steady-state conditions in the air conditioning chamber. A temperature of 20 ° C and a relative humidity of 50% was maintained throughout the measurement. The laboratory measurement curves and measurements in the air-conditioning chamber are the same, see the graph to the right in Figure 6. The bulk density in both cases at the end of the test was 2150 kg / m^3.

Table 2: Size of creep and shrinkage.

Name of composition / specimen	1 (KR 5)	2 (AGL9)
1	0.831	38.106
2	1.363	-1.463
3	0.988	100.788
4	-0.028	1.858
5	0.009	1.453
6	-0.001	0.223

Conclusions Behaviour of rammed clay depends significantly on the amount of water. As can be seen in Table 2, the creep of the mixture with a higher water content was significantly higher than the creep of the No. 1 mixture. The creep and shrinkage values in the table are in microstrain. The shrinkage of the mixtures is also different.

Rheological properties of rammed clay are also significantly affected by drying the material and reaching the final strength.

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