CONSOLIDATION CHARACTERISTICS OF ARIAKE CLAY MIXED WITH PALM LEAVES FIBERS

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INTRODUCTION

The natural fibers inclusion in a soil matrix has confirmed their effectiveness in soil improvement. Namely bamboo fibers, characterized by a high water absorption, addition to cemented soil has improved the permeability and mechanical properties [1]. From the other side, where the palm fibers are widely available and are very cheap, the use of palm fibers on soil reinforcement is limited. In short term, they are not biodegradable and could be used for controlling the erosion and ensuring the stability of embankments and their durability can be enhanced by coating with phenol and bitumen [2].

OBJECTIVE

The consolidation and compressibility are problematic for soft soils, in the purpose of investigating the effectiveness of the natural inclusions in this type of soil, in this paper the liquid limit and the consolidation behavior of Ariake clay mixed with natural palm leaves fibers are evaluated.

RESEARCH MATERIAL

Fibers preparation

The fibers are made from dried palm leaves considered as waste materials from Okinawa island, Japan. The palm is of the Livistona Chinensis type original from Eastern Asia and also present in South Africa and different locations in the American continent.

To avoid break of leaves while cutting, preparation of the fibers was made after two days soaking of the leaves in water. The soaking provides a more flexible texture to the fibers and facilitates the cutting. The length of the fibers is limited to 12 mm for the mixing and molding facilitations. The maximum width is defined regarding the main veins of the leaf and limited to 1.2 mm. To evaluate the effect of the length and width variation, the fibers are prepared at 12 and 6 mm length and 1.2 and 0.6 mm width. After the preparation of the fibers, they are exposed to air drying. The fibers are included on the soil matrix at 1, 2, and 3 % content by dry weight of soil.

Soil characteristics

Ariake Clay is used to investigate the effect of the natural fibers inclusion effect on the consolidation characteristics. The clay origin is from Ariake Sea, the original sample is having a high initial water content w_i =300 %. The liquid limit is of w_L =175 % and the plasticity limit is of w_P = 69 % the density of the soil particles ρ_s = 2.59 g/cm^3.

EXPERIMENTAL PROGRAM

Sample Preparation

The fibers are added randomly to the soil and the mixing is done manually to avoid the break of the fibers. It is mixed thoroughly until a uniform mixture is obtained and then kept for a curing period of 24h in sealed bags for allowing water content homogenization.

For the preparation of the soil samples for the consolidation test, the material used is presented in Fig. 1. After a curing time of 24h, the mixture is placed in a cylinder, with 6 cm diameter and a porous bottom, two filters are placed in top and bottom of the soil. A second cylinder with a porous bottom is placed on top of the soil. With

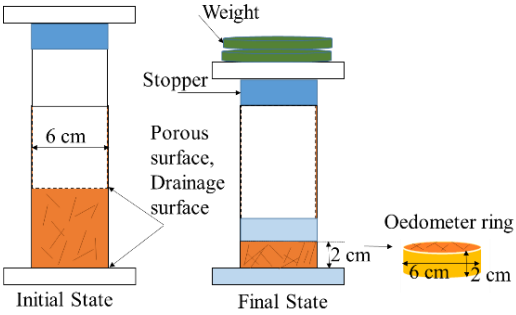

Fig. 1: Sample Preparation for consolidation test

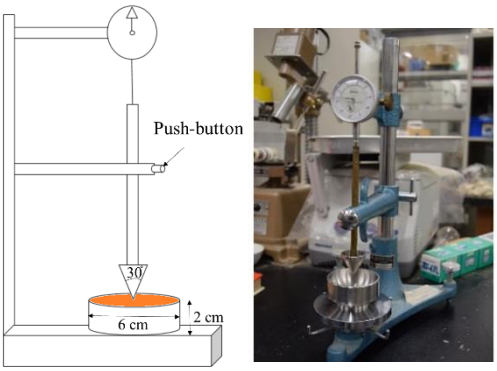

Fig. 2: Cone penetrometer test apparatus

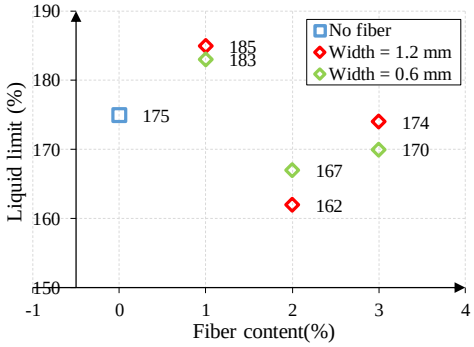

Fig. 3: Liquid limit with respect to fiber content

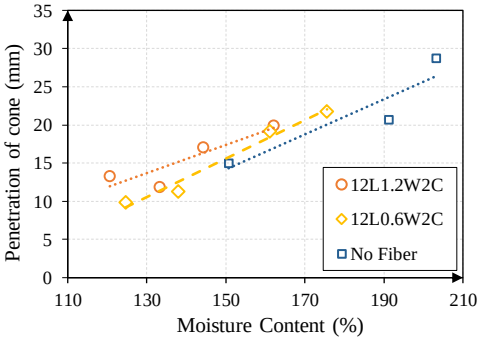

Fig. 4: Cone penetrometer results for 2% fiber content and no fiber inclusion

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placement of some weight, the sample is pre-consolidated and water is drained to obtain the water content around the liquid limit of the Ariake Clay and a sample of 2 cm height. The sample is placed directly in the oedometer ring for the consolidation test.

Cone Penetrometer Test [3]

The BS 1377:1975, Test 2(A), is a British method helping determination of the liquid limit. It consists of the measurement of a standard cone penetration in the soil (Fig. 2). The sample is mixed with water and placed in a standard cup of 60 mm diameter and 30 mm depth. After the placement of the cup under the cone and adjusting the cone at the flatted surface of the soil. The button is maintained pressed for 5s and the cone is allowed to fall and penetrate the soil. After four tests with different water contents of the soil, the penetrations readings are plotted in respect to the water content and the cone penetration at 20 mm corresponds to the liquid limit.

Consolidation Test

One-dimensional consolidation tests are conducted according to JGS 0411-2009 on an Ariake clay sample without fiber inclusions and with 1% random fibers inclusion of 12 mm length and 0.6 mm width. The aim of this test is to assess the effect of the inclusion on the consolidation parameters; settlement, volume compressibility and permeability.

RESULTS AND DISCUSSION

Cone Penetrometer Test

The cone penetrometer results have shown in Fig. 3 that the results of 1.2 and 0.6 mm are not very different. At Fig. 4, the variation of the fibers content has given fluctuating results with a mean value around the liquid limit of the soil. The fibers have a water absorption potential their inclusion is expected to decrease the liquid limit of the mixture, thus the results of 1% are to be revised.

Consolidation Test

Fig.5 shows a decrease in the compression index and the consolidation yield stress by the random addition of 1% fibers of 0.6 mm width. The initial void ratio was half the initial void ratio of the soil with no inclusions. In Fig.6, the coefficient of consolidation was reduced to 10% by the fibers addition and the time to reach the primary consolidation has increased. As for the coefficient of permeability, Fig. 7 shows that at same void ratio, the permeability of soil with fibers is higher than the soil with no inclusions. The reduction of the void ratio and increase of the permeability by addition of the palm leaves fibers is justified by the high water absorption potential of the natural addition. The results are in accordance with the results obtained from polypropylene and coir fibers [4] addition to a soft soil. The decrease in the compression index at a fiber content less than 0.6% and 0.8% respectively. It is reported that more fibers increase the compression index probably due to the increase of fibers volume and the fiber compression would be dominating.

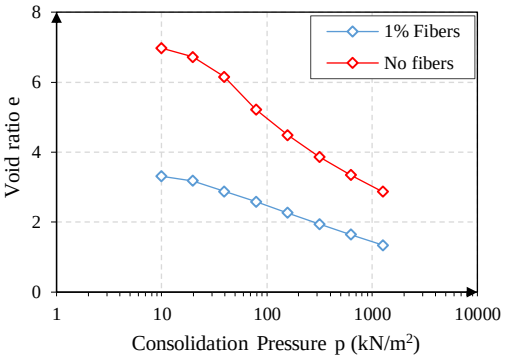

Fig. 5: Compression curve

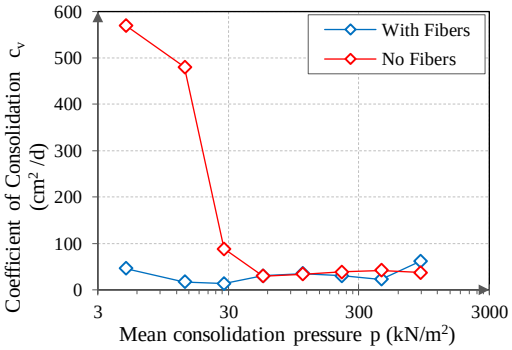

Fig. 6: Coefficient of consolidation with respect to the mean consolidation pressure

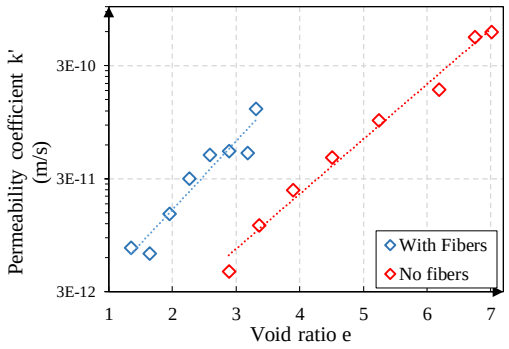

Fig. 7: Permeability Coefficient graph.

CONCLUSION

The addition of palm fibers in Ariake clay with different widths does not give variant results from each other for the liquid limit and the addition at different contents gives fluctuating results around the liquid limit of the clay with no fibers. As for the consolidation parameters, by addition of 1% fibers, the consolidation coefficient was 10 times reduced and the permeability increased by half almost it could be justified by the water absorption potential of the leaves. For the future study, the use variation of the width and content will be studied to evaluate the effect on the consolidation parameters.

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