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EXTENDED ABSTRACT

Improving the Creep Properties of Modified Clay with Nanosilica and Polypropylene Fibers (Case Study: Shahid Shahcheraghi Dam Central Borrow Pits)

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1. Introduction

Long-time Settlements or creep means the gradual increase in deformation of the soil over time, which is subjected to a constant load. The phenomenon of creep is very important in geotechnics and it is carefully investigated in cases where time and factors affecting it are involved, because when settlement occurs in the structure, many problems such as creating cracks, increase in deformation and stress are created, which , reduces the efficiency, utilization and useful life of the structure. Modifying the behavior of soil by using different additives is one of the important issues for the progress of researchers in civil engineering. Common additives such as lime, cement, bitumen, fly ash, wood ash, copper slag, iron slag, etc. have been investigated in previous studies, and nano and polymer materials, whose use in other branches of engineering science has led to fundamental changes and have unique characteristics, have been more interested in geotechnical engineering in recent years.

2. Methodology

The main test used in this research was the consolidation test. This test is performed according to the standard (ASTM D 2435-90). The program of laboratory tests of 9 types of samples, including clay without additives, clay with 0.25, 0.5, 1 and 2% of nanosilica and clay with 0.25, 0.5, 1 and 2% of polypropylene fibers were prepared. Also, 3 samples of each type were prepared and tested.

3. Results and discussion

3.1. Consolidation test on clay

At the beginning of the graphs, the slope is steeper, but after 24 hours, the deformations are almost fixed, and at the end, the slope of the graphs decreases and tends to become horizontal. With the increase of vertical overhead pressure in consolidation tests, the rate of increase of settlement increases. Also, the slope of the graph increases with applying pressure, as a result of which the secondary consolidation coefficient increases.

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3.2. Nanosilica

By applying different pressures with the increase of nanosilica up to 0.5 wt%, the amount of soil porosity is reduced and from 0.5% to above, the porosity ratio is 4% at 100kPa pressure, 12% at 200kPa pressure, 9% at 400kPa pressure and 5% at 800kPa pressure. By adding 0.25 and 0.5 percent of nanosilica to the soil, up to the stress of 400kPa, the soil became denser and the soil porosity ratio decreased. The percentages of 1 and 2% change with a steeper slope in the porosity-time graph, but the values of 0.25 and 0.5% were the same as the low stress levels, that is why the change process is different at higher stress levels (such as 400, 800kPa). When the pressure increases from 100 to 200kPa, the reduction of the porosity ratio is observed in the sample without additives as much as 5%, with the addition of 0.25% nanosilica 7% and containing 0.5% nanosilica 9%. In the soil sample containing 1 and 2% of nanosilica, the porosity ratio decreases by 2%, also by applying pressure from 200 to 400 kilopascals with the increase of nanosilica to 0.5%, the porosity ratio increases by 1% and then by increasing the nanosilica to 2% of the porosity ratio it is reduced to 1%. When the pressure increases from 400 to 800kPa in all samples, a significant decrease in the porosity ratio is observed up to 25%.

3.3. Polypropylene fibers

According to the obtained results, with the increase of polypropylene up to 2%, the porosity of the soil goes through a decreasing trend, and this decreasing trend is 0.5% for the case where nanosilica is used, and from this value onwards, the increasing trend of the porosity ratio is observed. As the stress increases from 100 to 800kPa, the porosity ratio decreases, so that a significant decrease of 23% has been observed with the increase of stress from 400 to 800kPa.

With the increase in the percentage of polypropylene fibers, the values of the porosity ratio decrease more than other types of fibers. Also, with the increase of overhead stress from 100 to 200 kilopascals, the values of settlement increased and still the effect of fibers is 2% more than other cases. The optimal point for polypropylene fibers is up to 0.5% and after that the changes are fixed.

4. Conclusions

The results obtained in this research are as follows:

1) In pure soil without additives, the secondary consolidation coefficient increases up to the applied load of 200kPa, and then the value of the secondary consolidation coefficient decreases. This means that the creep at the applied load of 200kPa is more than the other applied loads.

2) With the increase of nanosilica up to 0.5%, the initial consolidation time is similar to the soil without nanosilica, but after that process, this time decreases. This means that the stress caused by the tolerant soil skeleton and excess pore water pressure will be reduced sooner. Also, the value of the secondary consolidation coefficient increases, but then it goes down. That is, the amount of creep decreases with the addition of 2% nanosilica, and also the amount of creep increases with the increase of overhead.

3) With the increase of polypropylene fibers up to 0.5%, the value of the secondary consolidation coefficient, increases and then goes on a decreasing trend. By adding polypropylene fibers up to 2% to the soil, the amount of creep decreases significantly.

4) With the increase of polypropylene up to 2%, the amount of soil porosity goes through a decreasing process, which is a decreasing process for the case in which nanosilica is used. Its value is equal to 0.5% and from this value onwards, we saw the increasing trend of porosity.

5) Based on the results obtained from the experiments, it was found that the clay used in this research has a creeping property, and the long-term effects of creeping can be reduced by using nanosilica and polypropylene fibers.

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