INVESTIGATION OF THE BEHAVIOR OF PILES IN A COLLAPSIBLE SOIL STABILIZED THROUGH A LEADING HOLE

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At the present time, in most multistory large-panel buildings constructed on loesslike collapsible soils, use is made of pile foundations. Despite the fact that they exhibit many favorable characteristics, such foundations in collapsible soils have a substantial defect – they lower the bearing capacity when the soil is wetted.

Since the pile rests on a practically noncollapsible soil, the decrease in the bearing capacity after wetting depends basically on the decrease in the strength of the soil on the lateral pile surfaces. For this reason in soils of the first collapsibility type it is possible to increase the strength of the soil on the lateral surfaces, which, however, is not permitted for soils of the second collapsibility type.

In order to establish the possibility of increase of the soil strength (first collapsibility type), the writer carried out experimental investigations on the basis of which a method of stabilizing collapsible soils through leading holes was developed.

The stabilizing material used was a sodium silicate grout, since loess soils are chemically active and their constructional properties are considerably improved with single-grout silication [1, 3].

The stabilization of the collapsible soil around a pile through the leading hole was carried out in the following way: a leading hole (200 mm in diameter for a 30 x 30 cm pile section, and 300 mm in diameter for a 40 x 40 pile section) was drilled and through a hose from a truck tank a sodium silicate grout of working consistence was injected, after which the pile was sunk or driven. The grout penetrated into the soil by free infiltration during the period of filling of the hole, under the pressure created by the sunk pile, and by expulsion of the nonreacting grout under compaction of the soil around the pile. As a result, around the lateral surface of the pile a conical mass of stabilized soil was formed which exhibited strong cohesion with the pile, and under its tip the stabilized and compacted soil formed a strong core having a diameter equal to 1.0-1.5 the pile diameter.

The investigation of the pile behavior in the stabilized soil was carried out in the 15th residential district of the city of Naberezhnye Chelny. The soils at the site consist of quaternary deposits of interbedded loesslike sandy and ordinary loams. The thickness of the collapsible soil is 14-14.5 m. Below, there is a layer of cellar soil, underlain by noncollapsible loams of hard consistency. The physicomechanical characteristics of the soils at the site are presented in Table 1.

The soils in the test area belong to the first collapsibility type, and ground water is not present to a depth of 26 m.

The holes were drilled by a BTS-150 rig on a T-100M tractor, and the piles were driven by an S-1047 tubular diesel hammer mounted on an MKG-25 crane. The piles were sunk from a previously excavated pit whose bottom elevation was -2.4 m, which corresponded to the elevation of the basement floor.

An investigation was carried out to determine the comparative labor-consumption of pile driving with lead holes filled with sodium silicate grout, and without them. The labor consumption was determined from the number of blows of the diesel hammer required to drive the piles to the design depth. The results of the
investigation showed that with leading holes the labor-consumption of pile driving is reduced on the average by 50%, the piles are not destroyed during driving, and the accuracy in driving them to the design depth is improved.

Subsequently, investigations were carried out on the techniques for stabilizing the soil through a leading hole and on the regimes of filling of the hole with grout. It was found that part of the grout filtered from the soil during the period of filling of the hole, which took 5–8 min. The quantity of grout penetrating into the soil during this period depends on the hole depth and amounts to 16 to 30% of its volume. For an 8-m deep hole, this quantity is 40 liters. During the first 30 min after complete filling of the hole with grout, an additional 10–15 liters filters from the soil. As time elapses, the decrease in the grout level in the hole takes place more and more slowly and after 14 hours it ceases entirely. The hole walls are strengthened and become fully impervious.