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Laboratory Experimental Studies on the Properties of Highly Sedimentary Lyos Soils when their Moisture Changes Over Time

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Abstract: *Research on lyoss soils in Central Asia has been going on for a long time. However, these works were mainly descriptive in nature. However, in connection with the rapid development of construction in the lyoss soils of Central Asia, regular fundamental research on lyoss soils is carried out. Lyoss gruts are found in a low-bonded, vigorous, sometimes scattered state. The degree of salinity in them depends on the amount of water-soluble salts in dry soils. Chemical analysis of such soils showed that the gravitational force of the water shells surrounding the hard rocks is 1600-11560 mg/kg, their ions are 180-1410, and sulfate is 620-2530 mg/kg.*

Key words: *Air humidity, building material surface temperature, dew point, condensation humidity, relative humidity.*

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1. Introduction. Research on lyoss soils in Central Asia has been going on for a long time. Since the content of water-soluble salts in lyoss soils does not exceed 11-12%, they cannot be included in the category of sandy rocks. But they can have a very detrimental effect on concrete.

The task of laboratory research is to study the occurrence of deformation and strength of various lyoss soils in the regional (bordering districts, regions, states), to determine their deformation and strength. The results of laboratory studies are necessary to calculate the design of the foundation of buildings and structures and to determine the degree of primacy of soils.

In order to determine the deformation properties of Lyoss soils, laboratory studies have already been carried out on the basis of GOST and norms available in mass scale, compression devices and odometers. However, it is not possible to use the data of the results of studies obtained in different laboratories, because the reports of the results of studies obtained in laboratories do not contain the necessary information about changes in compression modulus compression according to changes in moisture content of lyoss soils over time [1-5]. In addition, many data conducted and published separately to determine the deformation properties of lyoss soils, given the results of laboratory studies on the final values of moisture, there is no information about the gradual change of moisture in lyoss soils over time. In the published data, there are no data on the change in compression of lyoss soils, which are of the same origin, even when they are wetted differently, as the experiments conducted on rheological studies of lyoss soils.

Thus, in relation to the above task, our laboratory studies show that compression is based on the results of long-term studies.

determine the value of the compression modulus, determine the change in compression modulus depending on the degree of change in moisture content of lyos soils, determine the change in compression modulus in compaction according to the change in moisture content. the change in compression modulus in compaction over time depending on the loaded samples of lyos soils and lyos soils of different moisture content. Since the natural porosity values of lyoss soils (especially large amounts of macro porosity) vary greatly depending on the location, the study needs to be repeated many times to exclude random factors.

2. The main part. Laboratory research was conducted in the laboratory SamDAQI. The research was conducted on a hydroproject compression device. The tag surface area of the tested lyoss soil samples is 40 cm2.

Laboratory studies were conducted in the only method studied as follows. Moisture of the soil completely saturated with water and all the physical properties of the tested lyoss soils were determined.

To determine the deformation properties of the soil, its compression under the influence of a vertical R load is checked. This experiment is performed on a compression device [6-12]. This device provides compaction of the soil in only one direction. If the deformation is in one direction and zero in the other two directions, then such experiments are a one-dimensional problem of the theory of elasticity.

Based on the above, the relationship between the porosity coefficient - e and the applied load - R is studied, because the deformation of the soil under the influence of the cast load is due to a decrease in the volume of pores in it. This experiment is performed on an odometer and is called compression bonding in soil mechanics. From the compression curve constructed as a result of experiments on the compression device, the compression coefficient of the soil is determined - m_0. Two other parameters representing soil compaction: the relative compression coefficient - mv and the modulus of deformation - E_o are determined by calculation.

A common method of constructing a compression curve is to determine the porosity coefficient e_i by the vertical deformation S_i formed by the compaction of the soil sample under the influence of an external load P_i. This experiment is performed on a compression device.

Tools, equipment and tools required for the experiment: Odometer; compression table; soil sample (monolith); filter paper; knife; measuring stones; with beams, clock indicator, drying rack, technical scales.

Tests for Lyoss soils are performed on compression devices (devices), the soil was brought to a certain humidity before the start of the test. Compression test experiments were performed for three different values of humidity, corresponding to three recorded levels of humidity [13-20].

Basic soils obtained from a test site in the laboratory studied. The results of studies to determine the physical properties of soils (table 1) showed that the characteristics of most soils with a depth of up to 5 m change insignificantly. Density of soil particles ρ_s =2,70 г/см^3. Density of soil ρ =1,48$\div$1,70 г/см^3. The natural moisture of the soil W_o=0,056$\div$0,185. Density of dry soil ρ_d =1,36$\div$1,46 г/см^3. Porosity coefficient e=0,76$\div$0,94. Moisture at the solidification boundary of the soil W_p=0,177$\div$0,192. Moisture at the flow limit of the soil W_L=0,26$\div$0,294. The amount of plasticity varies slightly. I_p =0,06$\div$0,10.

Table 1

Sampling depth, m	ρ_s - Density of soil particles,г/см^3	ρ - Density of soil, g / cm3	ρ_d - The density of dry soil is g / cm3	n- porosity of the soil	e- Porosity coefficient	W_o - The natural moisture of the soil	Water saturation coefficient	W_P- N at the joint boundary of the soil намлиги раскатывания	W_L AT THE GROUND FLOW LIMIT намли	I_p - Number of plasticity
Physical properties of soil samples taken from №1										
0,5	2,68	1,52	1,38	48,11	0,947	0,115	0,334	0,202	0,261	0,061
1,0	2,72	1,60	1,43	47,22	0,89	0,119	0,37	0,191	0,295	0,012
1,5	2,70	1,61	1,44	46,41	0,885	0,120	0,35	0,192	0,295	0,085
2,0	2,69	1,68	1,46	45,21	0,845	0,151	0,49	0,191	0,287	0,087
2,5	2,68	1,64	1,42	47,31	0,910	0,162	0,50	0,193	0,257	0,066
3,0	2,69	1,72	1,44	46,71	0,867	0,181	0,57	0,194	0,271	0,075
3,5	2,70	1,73	1,47	45,81	0,839	0,171	0,56	0,193	0,275	0,086
4,0	2,72	1,82	1,53	43,11	0,770	0,181	0,67	0,191	0,291	0,104
4,5	2,69	1,80	1,50	44,51	0,810	0,201	0,67	0,192	0,280	0,083
Physical properties of soil samples taken from №2										
0,5	2,69	1,49	1,37	50,11	0,950	0,056	0,149	0,191	0,295	0,106
1,0	2,71	1,58	1,43	44,71	0,884	0,057	0,166	0,186	0,232	0,045
1,5	2,70	1,56	1,44	47,21	0,885	0,073	0,212	0,193	0,292	0,097
2,0	2,71	1,60	1,43	47,1	0,847	0,126	0,346	0,205	0,274	0,070
2,5	2,68	1,60	1,44	47,11	0,909	0,111	0,344	0,197	0,293	0,093
3,0	2,69	1,61	1,40	50,01	0,869	0,135	0,346	0,178	0,278	0,090
3,5	2,68	1,70	1,47	46,11	0,840	0,170	0,512	0,196	0,276	0,092
4,0	2,72	1,67	1,55	44,21	0,780	0,160	0,518	0,193	0,282	0,091
4,5	2,70	1,71	1,49	45,91	0,850	0,179	0,564	0,105	0,288	0,090
5,0	2,71	1,81	1,60	43,21	0,790	0,186	0,664	0,197	0,287	0,094

Two points are selected from the "load-bearing" curve obtained by compression tests using an odometer, ie at their boundary the curve approaches a straight line, where the pressure at the first point corresponds to $\rho_1 = 0{,}15$ Mpa, corresponding to the pressure from the soil layer above it, to the second point. and the applied pressure is equal to $\rho_2 = 0{,}4$ -MPa corresponding to the pressure coming from the soil layer above it and the total pressure that can fall together with the building or structure to be built on this foundation [21-25]. It is assumed that the distance between the two pressures selected from the curve is as straight as possible, we use the following formula to calculate the deformation Eo MPa of the compression module

$$E_o = \frac{(p_1 - p_2)(1+\mu_o)(1-2\mu_o)}{(e_1 - e_2)(1-\mu_o)}(1+e_o) \qquad (1)$$

$$e_1 = e_o - (1 + e_o)\frac{s_i}{h} \quad (2)$$

where e1 and e2 are the values of the porosity coefficients corresponding to the pressures r1 and r2;

e_o is the initial porosity coefficient obtained along the *e* axis;

μ_o is the Poisson's ratio of the soil, μ_o = 0.4 is assumed;

Sediment formed as a result of $S_i - p_i$ pressure;

h is the height of the sample soil.

We know that clay soils swell when wet, so before wetting a sample of lyoss suglinok soil, a special bolt (arre-tirom) was tightened from the top of the shaft in the compression device. Only then was a sample of lyoss suglinok soil moistened. Arretir resists the vertical displacement of the stamp and ensures that the value of its initial porosity coefficient remains unchanged after the suglinok soil sample is wetted. Control experiments conducted without arrhythmias showed that the value of lyoss suglinok soil swelling was up to 6% in some cases.

3. The final part. Based on the results of research conducted in the laboratory, the following relationship was identified

$$\mathrm{E}_W = \mathrm{E}_{W_0}(1 - S_W)^n \quad (3)$$

$$S_W = \frac{W - W_0}{W_{sat} - W_0} \quad (3a)$$

where E_{W_0} is the total modulus deformation of lyoss soil at natural W_0 humidity; n -level pointer.

Analysis of the results of compression studies of lyoss soils of different humidity showed that the total modulus of deformation of the soil at a given moisture is related to the amount of total modulus of deformation in the natural moisture of this soil and the moisture index as follows:

$$\frac{\sigma}{\varepsilon - \varepsilon_0} \cong E_{комп} = E_0(1 - S_W)^n, \quad (4)$$

where - ε_0 - instantaneous deformation in compression, equal to the natural pressure under the action of the load at the next stage given to the sample of lyoss soils;

the deformation in ε- -compression compression is equal to the natural pressure under the action of the load in the next step given to the sample of lyoss soils;

E_o is the stabilized compression modulus deformation of lyoss soils in natural moisture;

S_w is the moisture content of lyoss soils;

n - degree indicator.

The results of the study show that the test points around the straight line are located satisfactorily enough. The mathematical equation of this straight line can be written as follows:

$$\ell n\left(\frac{\sigma}{\varepsilon - \varepsilon_0}\right) = \ell n A_t + n\ell n(1 - S_W). \quad (5)$$

From this equation (5) it is possible to find the values of the exponent n degrees. This allows us to find its modulus deformation at any depth when the lyoss soils are moistened from above using formula (5).

(3a) - From the formula, it can be seen that the moisture content of the soil varies from 0 when W = Wo to 1 when W = Wsat.

$$\ell n E_W = \ell n E_{W_0} + n \ell n (1 - S_W) \qquad (6)$$

In order to determine the exact values of E_o and n, it is necessary to carry out the processing of experimental data in the least squares method. An analysis of the research conducted on the scientific experiment shows that the sedimentation of lyoss suglink occurs gradually over a period of 14 to 20 days, without occurring overnight.

Deformation of lyoss gruns, which occurs gradually over time, A.A. Following in the footsteps of Mustafaev, it can be written as follows:

$$\varepsilon_t = \varphi(\sigma, W) f(t, W). \qquad (7)$$

The voltage function $\varphi(\sigma, W)$, can be written as follows based on the above expressions:

$$\varphi(\sigma, W) = \frac{\sigma}{E_{W_0}(1 - S_W)^n} \qquad (8)$$

The polzuchest function f (t, W) can be obtained by analyzing the time dependence of the deformation of lyoss soils at different humidity. It should be noted that at loads under consideration in a certain limit range, the polzuchest deformation has an extinction character, when the polzuchest function tends to $t \to \infty$ at f (t, W), its value is equal to one, i. $\ell im_{t \to \infty} f(t, W) \to 1$. In this case, the stabilized deformation of lyoss soils (when $t \to \infty$ is sought) can be written as follows:

$$\varepsilon_{cm} = \frac{\sigma}{E_{W_0}(1 - S_W)^n} \qquad (9)$$

The deformation equation obtained on the basis of solution (2.8) for the calculation of the deformation of the foundation laid on it when the Lyoss soil foundations are wetted can be written as follows:

$$\varepsilon_t = \frac{\sigma}{E_{W_0}\left(\frac{y}{a\sqrt{\pi \cdot t}}\right)^{\alpha}}. \qquad (10)$$

where $\bar{y} = \frac{y}{a\sqrt{\pi \cdot t}}$ is the dimensionless coordinate of the lyoss soil layer;

α is the exponent, equal to $\alpha = m \cdot n$.

The law of deformation can be written as:

$$\varepsilon_t = \frac{\sigma}{\bar{E}(\bar{y})}, \qquad (11)$$

where $\bar{E}(\bar{y})$ - is the base module, variable according to the degree law of depth:

$$\overline{E} = E_{W_0} \cdot (\overline{y})^{\alpha}. \qquad (12)$$

4. Conclusion. Based on laboratory studies to determine the deformation of lyoss soils at different humidity using a compression tool, it was found that there is a degree correlation between the modulus of deformation of lyoss soils and the moisture index ($R_W = \frac{W - W_0}{W_{sat} - W_0}$):

$$\mathrm{E}_W = \mathrm{E}_{W_0}(1 - R_W)^n \qquad (3)$$

Based on the analysis of the results of studies on the compression of lyoss soils of different humidity, it was developed that the total modulus of deformation of the soil at a given humidity is related to the amount of total modulus of deformation and moisture content of the soil at natural humidity as follows:

$$\frac{\sigma}{\varepsilon - \varepsilon_0} \cong E_{комп} = E_0 (1 - S_W)^n, \qquad (4)$$

At loads of a certain boundary range under consideration, the polzuchest deformation has an extinction character, when the polzuchest function f (t, W) is equal to its value when $t \to \infty$ is sought, i.e. when $\ell im_{t\to\infty} f(t,W) \to 1$. It was developed that the stabilized deformation of Lyoss soils (when t $\to \infty$ is sought) can be written as follows:

$$\varepsilon_{cm} = \frac{\sigma}{E_{W_0}(1 - S_W)^n} \qquad (9)$$

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