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Changes of Mechanical Properties in Humidification Saline Soil Based in Builds and Constructions

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Abstract. In the last few years, a number of saline soils in Uzbekistan have experienced the rise of groundwater and flooding of the territory. As a result, the state of Eurasia is noted in many buildings and structures due to a decrease in the consistency characteristics of foundation lattices. The main reason for the decrease in self-sufficiency characteristics is the result of prolonged leaching of light and hard-to-grind salts under the influence of water. This article presents the results of experiments on the study of legislation on changing their consistency during filtration washing of salt gratings on the basis of buildings and structures.

Keywords. Saline soils, the amount of initial gypsum, salinity, alkalinity of salts, strength indicators.

27 June 2023 16:31:04

INTRODUCTION

Construction of buildings and structures in our country is often carried out in complex engineering-geological conditions, especially in areas with saline soils. These soils cover numerous regions of Uzbekistan such as Bukhara, Jizzakh, Syrdarya, Fergana, Khorezm and large areas of the Republic of Karakalpakstan.

In Uzbekistan, saline soils, which can be used as a basis for the construction of buildings and structures, consist of saline, saline, saline and bald soils, differing in the composition and amount of slightly soluble salts. They are often formed in the depressions of the relief: mountain slopes, lowlands, saline lake shores, cliffs, desert zones formed as a result of suffocation, mineralized waters close to the surface (1 - 3 m).

The main factor in the formation of saline soils is the mineralized groundwater and saline rocks that lie close to the surface. The main condition for salinization is the impossibility of water flow in places and the fact that the amount of evaporation is greater than the amount of precipitation.

Analysis of the existing literature on saline soils and experience in the design and construction of buildings and structures in different regions of the country, as well as special studies on saline soils show that changes in the composition, structure and physical and mechanical properties of substances during wetting and alkaline leaching. and this phenomenon needs to be taken into account in design work.

As a result of flooding and wetting of areas composed of saline soils, a number of major affects can occur in buildings and structures.

As mentioned above, the analysis of the emergency situation of some facilities in Uzbekistan shows that the forecast of changes in the mechanical properties of the foundations of buildings and structures should take into account the impact of factors affecting the decrease of mechanical properties (eg: long water infiltration, salinity, etc.).

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Existing guidelines and normative literature provide recommendations for determining the mechanical properties for saline soils with easy and moderately soluble salts, but the amount of difficult-to-dissolve salts is not taken into account. Studies suggest that in order to ensure the safe operation of buildings and structures built on saline soils, it is necessary to study the process of leaching of insoluble salts, especially when the mechanical properties of the soil are exposed to long-standing water.

An experimental study of the laws of change of mechanical properties of water from saline soils over a long period of time. This is because the issues of assessing the change in the mechanical properties of saline soils in the long-term exposure to water to insoluble salts have not been fully studied.

The saline loamy and loamy soils in the territory of Uzbekistan, in particular in Pakhtakor district of Jizzakh region, where capital, industrial and civil construction is currently booming, are taken as the object of research and its mechanical characteristics in the article. The purpose of this article is to develop a methodology for studying the mechanical properties of saline and sedimentary soils when used with water and solutions and long-term leakage, in order to use the parameters of soils in the calculation of the foundation of structures.

The main feature of saline soils is the change in their mechanical properties during the washing of salts, there are two main types of washing of salts:

- filter washing, in which the washing of the salt in the soil is carried out by the filtration flow of the liquid under the pressure gradient and is of practical importance for soils with high permeability;
- diffusion washing, in which the washing of the salt in the soil occurs as a result of the movement of ions due to the difference in the concentration of salts in solution. This is typical for low absorbent soils.

The laws of changing in salinity level and mechanical characteristics when saline soils are exposed to water for a long time under laboratory conditions were studied and expressions were proposed to predict them.

METHOD OF RESEARCH

Loam and sandy loam samples (Tables 1 and 2) from Pakhtakor district of Jizzakh region were used to study and predict the laws of change in salinity levels and mechanical characteristics of saline soils during prolonged exposure to water.

TABLE 1. Normative and calculated characteristics of soils

Names of descriptions	Units of measurement	Normative values		Estimated values, α=	
		Loam	Sandy loam	0,85	0,95
Ground density	t/m^3	1,73	1,76	1,74	1,73
Density of soil in the dry state	t/m^3	1,44	1,43		
Density of soil particle	t/m^3	2,69	2,66		
Porosity	%	46,5	46,3		
Porosity coefficient	dimensionless	0,869	0,863		
Natural humidity	One point	0,175	0,234		
Humidity level	dimensionless	0,54	0,72		
Humidity at the level of fluidity	One point	0,261	0,261		
Humidity at the germination boundary	One point	0,180	0,212		
Quantityof plasticity	One point	0,081	0,049		
Fluidity indicator	dimensionless	<0	0,46		
Comparable adhesion strength	kPa	13	9,0	5,0	3,0
Internal thrust angle	degree	26	27	25	24
Deformation modules: in the natural humidity condition	MPa	5,0	5,0		
In wet condition	MPa	4,0	4,0		
Relative deposition:					
P=0,1 Mpa	dimensionless	0,007	0,009		
P=0,2 MPa		0,013	0,015		
P=0,3 MPa		0,017	0,020		
Initial deposition pressure	MPa	0,15	0,12		

27 June 2023 16:31:04

TABLE 2. Chemical analysis of grills using water titers

Soil name	Dry residuem g/kg	Ion content mg/kg						pH
		HCO'_3	CI'	SO_4''	Ca··	Mg··	Na·+K·	
Loam	13480	210	640	8800	3250	480	60	7,8
Sandy loam	14380	160	910	9090	3150	390	640	7,8

Based on the task set and the results of previous research, the methodological part of the experiment was based on the following laws:

- In the process of interaction of ground distilled water with water, its structure changes as the amount of soluble salts in the water decreases.
- Changes in soil structure during alkali washing lead to a decrease in strength and an increase in deformation (additional suffocation subsidence).
- Changes in the composition and volume of salts in the soil can affect the water-physical properties of soils, in particular, the composition of the microaggregate, plasticity parameters, viscosity, etc.

Therefore, the experiment is carried out as follows: first, for the first naturally formed primer, the parameters given in Tables 1 and 2 are determined: density (ρ, ρ_d, ρ_c), humidity (w), abrasion and plastic strength (C, φ, ρ_m). The composition was also studied: granulometric, microaggregate, chemical (easily soluble salts, gypsum, calcium content) and mineral composition. In addition, the microstructure of the soils was further investigated.

After the initial grunt was thoroughly examined, the diffuser or filter lye was rinsed.

Changes in the composition, structure, and mechanical properties of (C, φ) solutions were evaluated due to the fact that solutions leave a certain amount of salts from the solution in a diffuse manner after prolonged exposure to distilled water (alkaline washing rate-β).

Filtration of salts in the soil is carried out according to the lifting current scheme in the FIM device. A pre-tested sample of the natural structure was placed on the device according to the same scheme. B on the side surfaces of the sample for loss of filtration on стенке.P.It it was processed in accordance with the methodology proposed by Petrukhin [1]. The sample was scraped off with a diameter smaller than the ring of the F-IM tool (D=50 cm2), plastic glue on its side surfaces is rubbed into the groove, and wax is poured into the gap between the ring and the sample. This treatment allows us to calculate that the liquid moves only through the volume of the soil.

Filtration washing with alkaline was carried out under pressure, often without squeezing the soil, that is, the soil was in conditions of constant volume during the experiment.

Water filtration was carried out under the influence of high pressure gradients (up to J = 100), which formed a column of water. The limit value was determined by a jump (J=10, 30, 60, 100), slowly, not in one piece. During the experiment, the filtrate was selected to determine the amount of washed salts, its volume and minerals were recorded.

To determine the consistency characteristics of the studied grinds, instruments developed by the "Gidroproekt" system are used, registering a uniformly cut surface[2]. Depending on the physical condition of the soil, methods of rapid cutting of samples are used.

Grinding machines, the structure and humidity of which are a natural method of rapid cutting, are tested without prior condensation. The amount of moderate pressure at which cutting is performed is selected taking into account the thickness of the soil and the weight of the structure. After a moderate load is set, experimental work is carried out no later than 5 minutes after the start of the pulse load generator.

Locker rooms were given with splashes.Their volume was determined by the value of moderate pressure and was 5% of its volume.Each stage was carried out until the deformation was conditionally stabilized (0.01 mm/min). The test was completed when the dimensional deformations reached 5 mm or when the sample was cut [3-5].

27 June 2023 16:31:04

Based on the results of the tests, the graphs Δλ=f(τ) and τ=f(δ) were constructed and the consistency parameters C and φ were determined.

After the filtration process was completed, the amount of salt was determined in the "Solemer" device of the PNIIIS design.

RESEARCH RESULTS

After a long period of water exposure to the soil sample and the completion of the filtration process, the consistency characteristics (s, φ) and the degree of salinity (Dsol) for the suglinocli and supesli soils were summed up, respectively, with respect to the initial amount of soluble salt - gypsum and the degree of alkalinity (β) [6].

TABLE 3. Average values and degree of mineralization of individual characteristics of gypsum supersids in primary gypsum and varying degrees of alkalinity

Preliminary plasticity, %	Indicators	Degree of friction β, %							
		0	10	20	30	40	50	60	70
10	$D_{sol,}$ %	10	9,1	8,1	7,2	6,2	5,3	4,3	3,4
	C, kPa	3	2,5	2,1	1,74	1,4	1,2	1,1	1
	φ, degree	28	28,4	28,86	29,29	29,7	30,15	30,58	31,01
20	$D_{sol,}$ %	20	18,1	16,2	14,4	12,5	10,6	8,7	6,8
	C, kPa	7	6,3	5,7	5,2	4,8	4,5	4,3	4,1
	φ, degree	30	30,02	30,77	31,32	31,2	32,28	32,46	33,42
30	$D_{sol,}$ %	30	27,2	24,3	21,5	18,7	15,9	13,1	10,3
	C, kPa	11	10,1	9,4	8,7	8,2	7,8	7,4	7,2
	φ, degree	32	32,8	32,21	33,29	33,48	34,07	34,33	35,1
40	$D_{sol,}$ %	40	36,2	32,5	28,7	25	21,2	17,5	13,7
	C, kPa	15	13,9	13,1	12,3	11,6	11,1	10,6	10,3
	φ, degree	34	34,43	34,54	35,79	36,1	36,43	36,64	37,83
50	$D_{sol,}$ %	50	45,3	40,6	35,9	31,2	26,5	21,8	17,1
	C, kPa	20	17,8	16,7	15,8	15,1	14,3	13,8	13,4
	φ, degree	36	36,33	36,89	37,27	37,72	38,29	38,62	39,41

As a result of mathematical modeling of the insulation results presented in Tables 3 and 4, expressions were obtained relating to the initial levels of plasticity of gypsum and salinity values and (D_sol) for sandy loams and loam, and they are presented below.The cumulative values for loams are presented in Table 4.

A representation of 4 tables structured for loam soil describes the individual characteristics of the hyplinocular soil during initial gipslanation and various levels of alkalinization in the form of mejori values and the degree of salinity for loam soil, has also been developed in the form of a table and is presented in Table 4.

For loam:

$$D_{sol} = -0{,}04 \cdot (N+1)\beta + 4 \cdot (N+1) \quad (1)$$

$$C = 0{,}0004 \cdot \left(\frac{N}{4}+1\right)\beta^2 - 0{,}2 \cdot \left(\frac{N}{2}+1\right)\beta + 25N \quad (2)$$

$$\varphi = -0{,}04 \cdot \beta + 2 \cdot (N+13) \quad (3)$$

For sandy loam:

$$D_{sol} = -0{,}094 \cdot \beta \cdot N + 10 \cdot N \quad (4)$$

$$C = 0.0003 \cdot \left(\frac{N}{4}+1\right)\beta^2 - 0.036 \cdot \left(\frac{N}{2}+1\right)\beta + 4N - 1 \quad (5)$$

$$\varphi = 0.043 \cdot \beta + 2 \cdot (N+13), \quad (6)$$

Here: N – initial amount of gypsum, %;β – degree of friction, %

27 June 2023 16:31:04

TABLE 4. Values and salinity levels of individual characteristics of loam with gypsum in primary gipslan and different levels of alkalinity

Preliminary plasticity, %	Indicators	Degree of friction β, %										
		0	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**
8	$D_{sol,}$ %	8	7,2	6,4	5,6	4,8	4	3,2	2,4	1,6	0,8	0
	C, kPa	25	22	19,2	16,5	13,8	11,3	9	6,5	4,2	2	1,5
	φ, degree	28	27,6	27,2	26,8	26,4	26	25,6	25,2	24,8	24,4	24
12	$D_{sol,}$ %	12	10,8	9,6	8,4	7,2	6	4,8	3,6	2,4	1,2	0
	C, kPa	50	47,0	44,2	41,4	38,8	36,2	33,8	31,4	29,2	27	25
	φ, degree	30	29,7	29,3	28,6	28,2	28,1	27,3	27	26,4	26,1	26
16	$D_{sol,}$ %	16	14,4	12,8	11,2	9,6	8	6,4	4,8	3,2	1,6	0
	C, kPa	75	72,5	69,2	66,4	63,8	61,2	58,8	56,4	54,2	52,3	48
	φ, degree	32	31,8	31,4	30,8	30,4	30,2	29,5	29,2	28,8	28,2	28
20	$D_{sol,}$ %	20	18	16	14	12	10	8	6	4	2	0
	C, kPa	100	97,2	94,2	91,4	88,8	86,2	83,8	81,4	79,2	77,3	74
	φ, degree	34	33,6	33,2	32,8	32,3	32	31,6	31,4	30,4	30,1	29,8
24	$D_{sol,}$ %	24	22,6	19,2	16,8	14,4	12	9,6	7,2	4,8	2,4	0
	C, kPa	125	122	119	116	113,8	111,2	108,8	106	104,2	102	99
	φ, degree	36	35,4	35,1	34,6	34,4	34,2	33,6	33,1	32,7	32,4	32

Comments: Dsol - degree of salinity - the amount of salts dissolved in water in the ground.

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27 June 2023 16:31:04

CONCLUSIONS

A study conducted to study their salinity characteristics and the degree of salinity associated with the amount of initial plaster and the degree of salt leaching during prolonged exposure to water based on salt gratings of buildings and structures allows us to draw the following conclusion.

1. Salts of complex soil, in particular, when water enters the mush with which the plaster is salted for a long time, give them a description of the consistency and amount of salt in them, that is, the degree of salinity decreases, which in turn leads to a decrease in the stagnation of the foundation of buildings and structures and additional deposition.

2. Mathematical (1-6) expressions have been developed that allow predicting the degree of salinity and consistency with the processing of the results of experiments conducted to study the regularities of reducing the salinity of soil descriptions in the Pakhtakor district of the Jizzakh region, as can be seen in the example.

3. Before designing buildings and structures, it is necessary to determine the initial salinity and solubility of salt – the degree of alkalinity and, accordingly, the salinity characteristics, as well as the degree of salt leaching - the initial salinity of the salty soil of the area in depth.

4. Using the expressions proposed (1-6), it will be possible to predict the characteristics of the consistency and salinity values of water used in the design ofbuildings and structures when water has been exposed to salinity for a long time.

REFERENCES

1. V. P. Petrukhin, Construction of structures on saline soils. -M.: Stroyizdat, 1989. -264 p.
2. Maslov N. N. Fundamentals of engineering geology and soil mechanics. Textbook for high schools. –M.: Higher School, 1982.- 511 p.
3. Dmitriev V.V., Yarg L.A. Methods and quality of laboratory study of soils: textbook / V.V. Dmitriev, L.A. Yarg. –M.: KDU, 2008. - 502 p.
4. Trofimov V. T., Koroleva V. A. Laboratory work on soil science. –M.: KDU, University book, 2017. - 654 p.
5. Trofimov V. T. et al. Ground science. –M., Publishing House of Moscow State University, 2005. - 1024 p.
6. Muzaffarov A. A., Fanarev P. A. Engineering and geological support for the construction of highways, airfields and special structures. Tutorial. M.: MADI, 2016. -180 p.

27 June 2023 16:31:04