RESEARCH ON DETERMINATION OF THE FINAL SIZE OF THE LANDING OF THE BASES OF HYDROTECHNICAL STRUCTURES

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Annotation

The article presents the results of studies on the establishment of design combinations of the degree of moisture and stress values in determining the final value of subsidence of the bases of hydraulic structures of irrigation systems.
Keywords: subsidence, loess soils, deformation of soils, stresses, humidity, moistening, foundation, hydraulic structures.

Introduction

The processes of deformation and moistening of subsidence soils are closely related to each other. On the one hand, subsidence soil deformations depend on the degree of its moisture, and on the other hand, they seriously affect the patterns of massif wetting. In this regard, the improvement of methods for calculating deformations of loess foundations of hydraulic structures requires a thorough study of the process of moistening the massif and the impact on this process of the specific effects and irrigation facilities on the ground.

The nature of the moistening of the loess bases of the hydraulic structures depends both on the ground conditions of the site, and on the type of structure, its size in plan, the pressure transmitted by the structure to the ground, the width of the water mirror and its pressure, etc. Two types of structures can be distinguished by the nature of the moistening of their bases.

Literature review

An analysis of the works [1; 2; 3; 6; 7; 10] shows that the maximum stresses arise in the process of moistening the base at the boundary of the wetted and moistened layers at a humidity corresponding to critical. With further advancement of the humidification front, soil moisture at this horizon increases, but stresses stabilize at a lower level. It should be noted that the combination of σ and ω, which depends on the properties of a particular soil, has a decisive influence on the final value of subsidence deformation in the soil layer. This position is confirmed by the different nature of soil deformation in the areas of the 4-X and 3-X distributors under identical experimental conditions [5; 8; 9].

Materials and metods

In connection with the foregoing, it seems appropriate to identify a combination of factors (σ and ω,) that determine the final value of the deformation of the subsidence of the loess bases of hydraulic structures.

Let V denote the ratio of the relative subsidence deformations of critical moisture samples at maximum stress and steady-state soil at a stabilized stress in the layer under consideration.

$$V = \frac{\varepsilon_{sl1}}{\varepsilon_{sl2}}$$

Where: is the relative deformation of the subsidence of the layer under conditions corresponding to the moment of stress concentration on the horizon, and is the relative deformation of the subsidence of the layer under conditions of appropriate stabilization of stresses and humidity.

If the values are V> 1, then this means that subsidence deformations at maximum stresses arising under conditions of soil under moistening are greater than those that could occur under conditions of stabilization of stresses and final humidity. For V <1, the picture will be the opposite.

For loess soils, the value of vertical stresses at the base of the structure can be determined using the table compiled from the results of the experiments described in [3]. The stress values given in the table are average on a particular horizon in the bearing column of soil. The table shows both the maximum occurring at specific horizons and taking place after stabilization of the stress-strain state of the stress array in the ground

Stresses at horizons lying at a considerable depth at the base of the foundation both under the edge and under its middle have close values.

In the soil layer located under the structure at a depth of up to 0.5 R or 0.25 V of the foundation, stresses are concentrated either under the edges of the stamp or in the middle of it, which complicates the calculation of deformations in this soil soy. Such a transformation of stresses is caused by the redistribution of moisture in the base when it is soaked, as mentioned [2; 3; 7].

At the same time, since the experimental dies are a rigid system, the values of soil deformations under the edges and the center of the dies are almost equal.

Based on this, it can be written that for the contact layer under study with a power of H1 = 0.5 R or H1 = 0.25 V, the magnitude of the vertical deformation is

$$\sigma_y \frac{H_1}{E_y} = \frac{\sigma_{кр} H_1}{E_{кр}}$$

It follows that

$$\frac{E_{кр}}{E_y} = \frac{\sigma_{кр}}{\sigma_y}$$

Those in the contact layer of the soil there is a direct proportion between the deformation modulus and stress.

Results

This, with a degree of accuracy sufficient for practice, allows us to take the stress deformations into account for the bases of a rigid foundation with a power of H1 in the layer of the bearing column of soil under consideration.

Thus, stresses in the layer H <0.5 R or H <0.25 V under the bottom of the foundation, based on the physical meaning and taking into account the low thickness of the layer, it is advisable to take deformations equal to the average pressure at the contact of the foundation and the base [11].

To study the deformability of loess soil in the zone of the distributor of the 4-x array of Turkmenistan, depending on its moisture content and stresses in it, we conducted a series of compression tests at various moisture samples. The experimental results are given in table 1.

Based on the previously presented data, we will further assume that the maximum subsidence of the foundation (stamp) stresses corresponds to the relative subsidence ε sl1 at critical humidity. The values of the relative subsidence of the soil ε sl 2 are determined at ω = 26% and the stabilized voltage.

Then, using the above tables, we can determine the values of ε sl 1 and ε sl 2, and therefore the coefficient V for any selected horizon.

Table 1. The relative drawdown at various humidity and voltage values.

Humidity / Voltage, MPa	10	14	18	22	26
	ε_{sl}, %				
0,025	0,1	0,2	0,3	0,45	0,6
0,05	0,15	0,3	0,6	1,3	3,2
0,10	0,2	0,7	1,2	3,6	6,1
0,15	0,3	0,9	2,4	5,5	8,8

So, 36 hours after the start of the soaking of the base of the round stamp, which transfers the pressure to the soil of 0.1 MPa, the instruments recorded a maximum stress of σz = 0.077 MPa at a depth of 1.3 m. Humidity ω on the horizon under consideration at this point in time was 18%. The relative subsidence of the soil corresponding to these values of σz and ω is ε sl 1 = 0.92%.

Sometime after the passage of the humidification front through a given horizon, the stresses in the soil σz stabilized and amounted to 0.066 MPa.

Using the above tables, we determine the value of the relative subsidence of the value ε sl 2 = 4.1%. Then

$$V = \frac{\varepsilon_{sl1}}{\varepsilon_{sl2}} = \frac{0,92}{4,1} = 0,22 < 1$$

For comparison, Fig. 1 shows an averaged graph of the deformation of the considered soil layer (125-150 cm) obtained during stamp tests of soils in the zone of the distributor 4 - X of the array of Turkmenistan (curve S sl 1).
The subsidence deformations in the soil layer appeared during the stress concentration period on the horizon. As the voltage drops, the subsidence also attenuates. However, with increasing soil moisture, deformations begin to increase again.
Coefficient V does not always matter less than unity. Its value depends on many factors: the size of the foundation, the load transmitted by the foundation to the soil, the depth of the horizon under consideration, the intensity of water infiltration into the soil, soil characteristics, etc.
So, curve S2 of Fig. 1 is similar to curve S1, but it was built according to the results of stamp tests of slightly subsidence soils (3-zone distributor of the Samarkand massif). As can be seen from Figure 1, the deformation of the subsidence of the layer completely stopped with a decrease in stress on the horizon. This corresponds to the fact that under specific conditions the coefficient V is greater than unity.
It should be noted that the coefficient V is advisable to determine in cases where the moistened soil perceives the pressure of the structure. If loading of a pre-moistened loess soil occurs, then the stress concentration associated with the movement of the moistening front is absent. In this case, V <1 should always be considered.

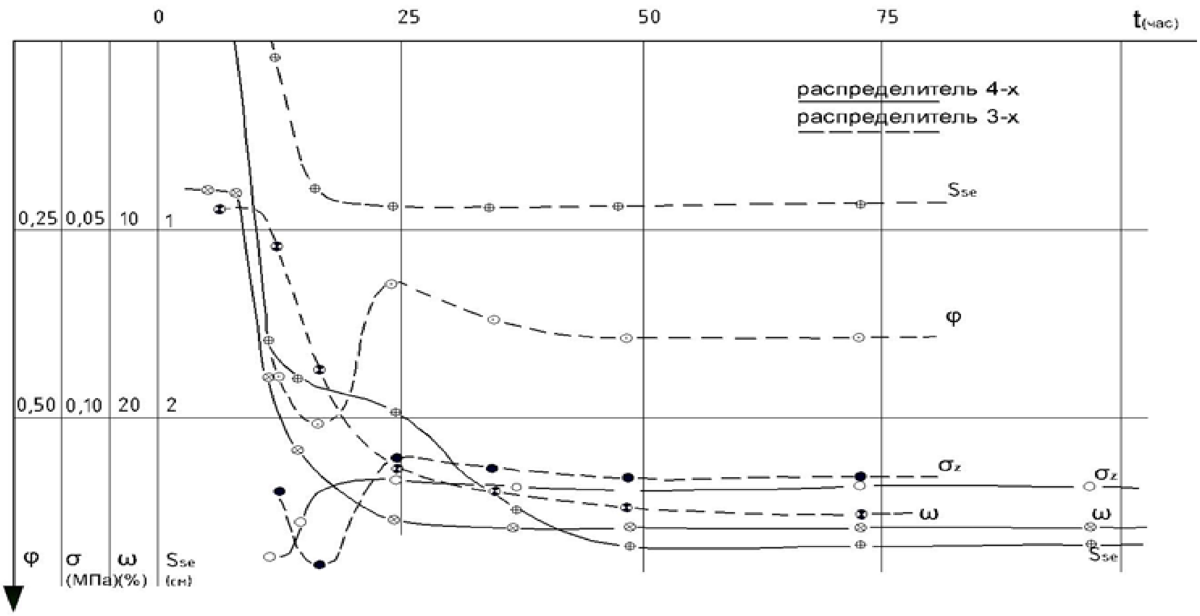

Fig. 1. Curves of subsidence deformations, vertical stresses, and lateral pressure coefficient in a soil layer located at a depth of 75-100 cm at the base of a stamp of 1 m 2 transmitting pressure to the soil P = 0.15 MPa

Conclusion

1. Deformations of subsidence bases of hydraulic structures must be calculated both for conditions corresponding to the period of stress concentration in the process of moistening the soil, and for conditions of stabilization of stress and humidity. In this case, a larger value of ε sl in the layer should be taken as the calculated one.
2. To establish a combination of factors determining the maximum value of ε sl, the coefficient V can be used, the magnitude and nature of which changes along the depth of the base are individual for a particular soil.
3. Based on the physical meaning of the interaction between the foundation and the foundation, stresses in the soil layer H <0.5R (H <0.25V) can be considered uniformly distributed and equal to the average pressure at the contact of the soil and the foundation.

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