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INFLUENCE OF INFILTRATION MOISTENING OF SOILS FROM CANALS ON THE STRESS-STRAIN STATE OF HYDRAULIC STRUCTURES

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Annotation. The article deals with the features of the infiltration moistening of soils from canals and structures on them. Based on the analysis of previous studies performed, the specificity of infiltration in loess soils is considered as a serious factor affecting the stress-deformed state of hydraulic structures and their foundations.
Key words: subsidence of soil, infiltration, degree of humidity, calculation of deformations, hydraulic structures, loess grounds, the process of moistening, terms of preliminary soaking.

Introduction

The processes of deformation and moistening of subsiding soils are closely related to each other. On the one hand, deformations of collapsing soil depend on the degree of its moisture content, and on the other hand, they seriously affect the regularities of the process of moistening the massif. In this regard, the improvement of methods for calculating the deformations of loess bases of hydraulic structures requires a thorough study of the process of moistening the massif and the influence on this process of the specifics of the impact and irrigation facilities on the soil.

The nature of the moistening of the loess foundations of the GTS depends both on the soil conditions of the site and on the type of structure, its dimensions 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 according to the nature of the moistening of their bases [7; 14; 20]:

Type I - structures, during the period of operation of which their foundations are constantly moistened or for a long period. Such structures include drops, currents and other structures on the canals, as well as the canals themselves. During the operation of such structures, a significant amount of moisture enters their foundations;

Type II - structures from which water enters the ground only by accident, for a short time as a result of damage to their structures. These are pipes, trays, channels in impervious clothing, etc., as well as other water sources that have a very small area of the water mirror and work periodically.

In the foundations of type I structures, the subsidence stratum is wetted intensively and, as a rule, completely. In case of accidents of type II structures, the soil massif is not moistened to full water saturation and usually a suspended moistening loop is formed.

Within the moisture contour, soil moisture varies from natural (at the border of the wetted zone) to close to full water saturation in the immediate vicinity of the water source.

Literature review

The process of filtration moistening of soils, including subsidence soils, has been studied by many authors [1; 2; 5; 8; 9; 10; 13]. In particular, it is noted that for sources of moisture of any shape in terms of having approximately equal depth of filling, the rate of soil wetting is proportional to their transverse dimensions. At the same time, when the soil is soaked from sources of moisture that have approximately the same width and depth of filling, but a different shape in plan (in one case, a compact, imitating construction pits, and in the other elongated, representing sections of a structure with a base, the stress state of the hydraulic structures changes reducing their reliability.

Normative documents [6] recommend using the method of electrodynamic analogies (EGDA) for filtration calculations of the foundations of GTS of I and II classes. However, this method necessitates the use of analog computers or complex calculations requiring an exact solution of the equations of hydrodynamics.

In other cases, it is allowed to use simpler methods based on the principles of the generalized Darcy's law - methods of resistance coefficients, fragments, etc. When carrying out calculations using these methods, the structure of the porous soil medium is considered ordered, which does not correspond to reality. In addition, it is difficult to take into account the fact of changes in the filtration characteristics of the loess soil in the process of its subsidence and changes in the degree of water saturation of the massif [3; 15; 16; 17; 18; 19].

Materials and metods

In this regard, a number of scientists have made an attempt to determine the patterns of moisture movement in the soil by a statistical method. The disadvantage of statistical models of the soil moistening process is that due to the wide variety of soil properties, such models are not universal, which makes it difficult to use such solutions for practical purposes. Thus, A.A. Mustafaev [11; 20], relying on the results of studies of the dynamics of the process of moistening loess soils, indicates its complex nature, which he associates with the mutual influence of moistening and deformation of subsiding soils. Based on the analysis of various methods for calculating the moisture and deformation of loess soils [14], the author points out the need to develop reliable and not too labor-intensive methods for mopping up these processes.

Dzektser E. S. and Pevzner L. M. [14] a mathematical model of moisture movement in saturated soils with and without subsidence properties is presented. At the same time, in a moving stream of moisture, three zones are distinguished, separated by movable boundaries:

1. Zone of full (maximum) saturation, the movement of water in which occurs under the influence of gravitational forces.
2. Zone of capillary saturation - the movement of water is carried out under the action of capillary and partially gravitational forces.
3. Zone of film saturation, where the movement of liquid occurs under the action of sorption forces.

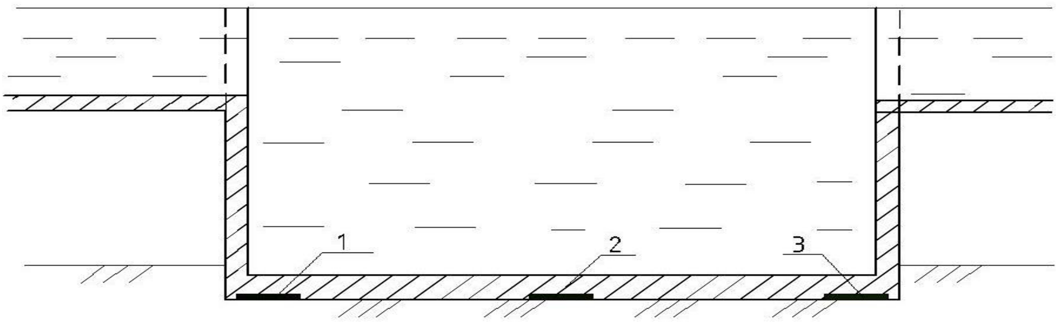
The theory of moisture transfer with incomplete soil saturation is based on the calculation of moisture zones in loess collapsible soils, proposed in the work of IG Rabinovich [4; 12]. One of the advantages of this technique is the use of elements of graphic modeling, which greatly simplifies the practical use of this calculation method.

However, these methods for modeling the process of moisture movement in loess soils also cannot be considered universal. This is due to the peculiarities and wide variety of properties of subsiding soils (porosity, subsidence, natural importance, layering, discontinuity, etc.).

Results

Taking into account the above, the normative document [6] recommends determining the filtration and other characteristics of the loess soils of the construction area by their field soaking. With such a study of the properties of the soil massif, it is possible to most fully determine its filtration subsidence and other characteristics. However, the experienced soaking of a large number of pits requires a significant investment of labor and time.

Of undoubted interest is the proposed in the work of AA Kirillov [11], the method for determining the required timing of the preliminary soaking of loess soils, the required amount of water, based on the results of field experiments. In the course of field work, the author [8; 9; 21; 22] studied the process of moistening the loess soil through the pits



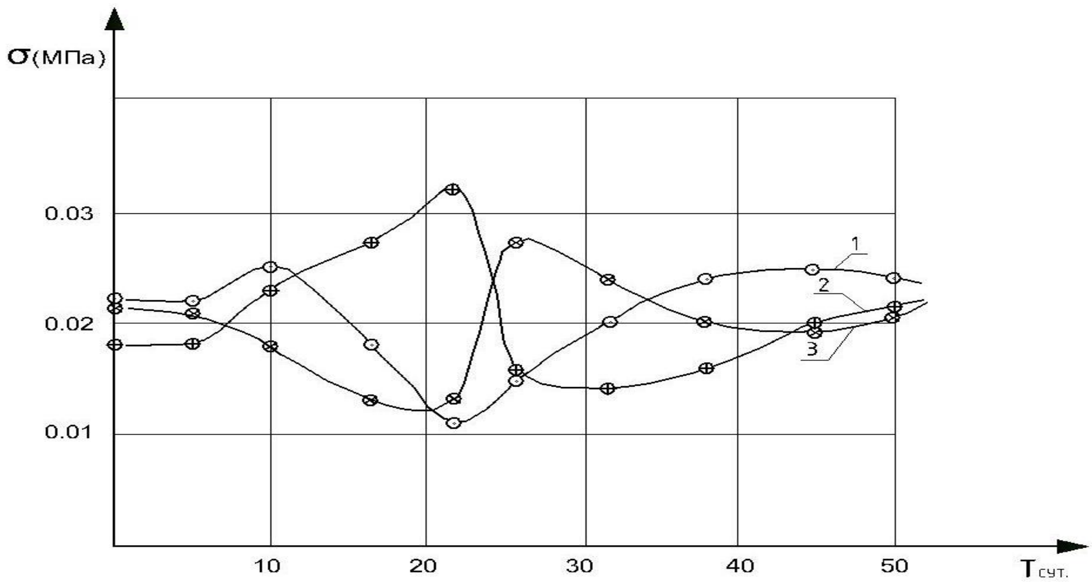


Fig. 1. Stress transformation at the contact of the water divider with the loess base

Different sizes, on the basis of which a method for determining the timing of the preliminary soaking of loess soils has been developed. This technique compares favorably with its comparative simplicity, but requires further refinement due to the fact that the experimental data used by the author were obtained only in one region.

It should be noted that the nature of subsidence soil moistening in the foundations of network structures on canals largely depends on the design of the underground circuit of the GTS and the conditions of interaction between the structure and the foundation [2; 14; 20]. In the process of subsidence, tear-off cavities can form between the floor bet and the loess base, contributing to the accelerated penetration of water into the soil and increasing the likelihood of contact erosion of the base.

Conclusion

In connection with the above, the following conclusions can be drawn:

- forecasting the time of soaking and the nature of moistening of the loess bases of the GTS is a complex task and requires taking into account a large number of different factors for its solution. This complicates the development of simple and reliable methods for calculating the parameters of the process of moistening a soil mass.
- The existing methods for calculating the process of moisture infiltration into the soil mass, as a rule, are cumbersome and complex. In this regard, it is of interest to develop other techniques and methods for predicting the process of soil moistening, which, with sufficient accuracy for practice, could replace the existing mathematical models.
- Despite the large number of studies carried out on this topic by many specialists, there are still a number of unresolved issues. Loess soils, as the foundations of hydraulic structures, require further experimental and theoretical study in order to identify the features of moisture infiltration in them, which seriously affect the stress-strain state of structures and their foundations.

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