CALCULATION CONDITIONS AND METHODS OF FILTRATION TIME

Quvatov Ulug'bek Jalolovich
teacher
Rakhimov Majid Orif o'g'li
student
Musurmonov Akhliddin Alimardon o'g'li
student
Karshi State Technical University

Annotation: *In natural conditions, encountering various soil layers that are located interactively within the structure's foundation, and performing filtration calculations to solve the following problems.*

Keywords: *filtration time, stratification of soils, water weir structures, filtration falculation, porous medium.*

In natural conditions, various soil layers can be encountered in the foundation of structures. When uniform soils are found under small structures, the foundation of large structures is often composed of various types of soils. The theory of filtration does not provide the ability to perform filtration calculations for all conditions. Therefore, areas with stratified soils are brought to the state of calculation schemes, which are ready solutions for determining the filtration flow parameters.

In water weir structures, water levels change over time; however, filtration calculations are only performed for the case where the difference between them remains constant. For this purpose, the calculation schemes are accepted based on the maximum value of the acting pressure. In this case, the water level is assumed to be regulated and filtration must be stable. For water levels in the byfs, the level reached at a given time in each byf is accepted. Normally, for calculation purposes, the normal water level in the upper byf and the minimum water level in the lower byf are assumed. If the difference in levels between the byfs is large in terms of duration, this difference is considered as a calculation condition.

The pressure of the filtration flow at an arbitrary point in the filtration area refers to potential energy, which is expressed as the sum of two components: geodetic and piezometric values.

$$h_x = \pm Z_x + \left(\frac{P}{\gamma}\right)_x$$

Here, h_x is the pressure at the point in the filtration area relative to the reference plane (datum); Z_x is the distance from the reference plane to the point in question, where h is positive if the point is above the reference plane and negative if it is below it; $(P/\gamma)_x$ is the piezometric head at the point.

Pressure determination scheme in water weir structures. In the filtration calculations for water weir structures, an arbitrary horizontal plane can be accepted as the reference plane. The pressure is calculated relative to this plane using formula (3.2). For convenience in calculations, the reference plane is usually taken at the water level of the lower byf or, if there is no water, at the bottom of the lower byf. In this case, the pressure is equal to the difference in levels between the byfs (the acting pressure).

In practical conditions, it is not possible to account for all the factors encountered during the filtration flow movement using calculation formulas. This necessitates several simplifications and the introduction of assumptions.

In filtration calculations, the main assumptions include the following:

- The filtration flow is considered as two-dimensional movement.
- The soil under the structure is assumed to be homogeneous and isotropic (in the case of homogeneous anisotropic soils, the filtration scheme is reduced to an equivalent homogeneous isotropic soil, with changes made to the dimensions of the flyutbet).
- The pressure acting on the structure does not change over time, meaning steady-state filtration is assumed.
- The filtration coefficient is considered constant.
- The water temperature and soil porosity are assumed to remain unchanged.
- The length of the structure is assumed to be infinite.
- The vertical elements of the underground contour are assumed to be impermeable to water.

Filtration calculation methods. Filtration calculations are performed to solve the following problems: determining the filtration pressure acting on the horizontal elements of the underground contour of the hydraulic structure; checking the soil's resistance to filtration; determining the water loss due to seepage from the ground.

The possible variants of the underground contour are compared, and the one that is most beneficial (preferable) from a technical and economic standpoint is selected. Such an underground contour is considered rational.

Filtration calculations in a porous medium are carried out based on Darcy's law:

$\vartheta = K_{\phi} \cdot J$,·

The flow rate of the filtration flow is calculated as follows:

$Q = K_{\phi} \cdot \omega \cdot J$ or $Q = K_{\phi}\omega(h_1 - h_2)/l$

Here, ϑ – filtration velocity; K_{ϕ} – filtration coefficient; J – pressure gradient (the pressure drop along the filtration flow path per unit length). ω – the cross-sectional area along with the soil particles and porosity.

Darcy's law represents the filtration flow in a laminar regime, and in this regime, the velocity variation is observed on a large scale. This law is applicable to all soils except gravel soils.

The methods for practical filtration calculations can be divided into three main groups.

The first group is the hydromechanical method, where the filtration flow movement is based on mathematical physics problems. Calculations using this method show that pressure varies along the underground contour's length in a curved path. In this case, the curvature of the curve is directed outward at the beginning of the section and inward at the end.

The second group is the experimental methods. Among them, the most commonly used is the Electro-Hydrodynamic Similarity (EHDS) method. This method allows observing the hydrodynamic type of any underground contour of the flow. The experimental method is also used in the study of filtration in models of hydraulic engineering structures located inside soil layers.

The third group is the hydraulic method, which is based on approximate solutions to the problem. This is the most commonly used method in practical calculations. In hydraulic methods, the pressure variation between the fractured points of the flow is considered linear, meaning that pressure is low at the end of the flow and high at the beginning. This approximation does not lead to significant errors when determining the pressure at certain sections of the flow. The thickness of the flow at the end is taken as a constructively (without calculations) assumed value.

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