The American Journal of Engineering and Technology
ISSN 2689-0984 Volume 08 - 2026

Determination Of The Pressure Gradient In The Basis Of Concrete Hydraulic Structures Using The Regression Model In Complex Conditions

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Received: 24th Dec 2025 | Received Revised Version: 10th Jan 2026 | Accepted: 25th Jan 2026 | Published: 11th Feb 2026

Volume 08 Issue 02 2026 | Crossref DOI: 10.37547/tajet/Volume08Issue02-07

Abstract

In the absence of control and measuring devices, it is important to investigate filtration processes at the base of hydraulic structures located in complex conditions and to improve calculation methods that take into account changes in soils during operation. The purpose of the research is to determine the pressure gradient in the foundations of concrete hydraulic structures located in complex conditions of the republic. The methodology includes the theory of similarity and dimensionality, which is widely used in various fields of science and technology, as well as the theory of experiment planning with the aim of minimizing the experiment. The results showed that as the length of the structure increases, the pressure gradient initially decreases, and then stabilizes at a low level. This corresponds to a slower increase in water pressure compared to the length under the chosen conditions. The dependence of the pressure gradient on the length, taking into account the physical and mechanical properties of the soils of the structure's base, made it possible to ensure the safety of the structure in the absence of control and measuring devices for practice.

Keywords: Hydraulic structures, model, safety, reliability, base, gradient, filtration, deformation, pressure.

Cite This Article: Aysanem M. Ablatova, & Daniyar T. Paluanov. (2026). Determination Of The Pressure Gradient In The Basis Of Concrete Hydraulic Structures Using The Regression Model In Complex Conditions. The American Journal of Engineering and Technology, 8(2), 96–98. https://doi.org/10.37547/tajet/Volume08Issue02-07

1. Introduction

Most hydraulic structures are located in densely populated areas, industrial zones, and areas with developed infrastructure, or develop near hydraulic structures that they operate over time. Hydraulic structures are a potentially hazardous object for the population and the environment, as accidents can lead to severe consequences, such as the death of people, the destruction of residential buildings, the destruction of economic facilities, the degradation of ecosystems, and the complete or partial loss of hydraulic structures as objects of economic activity. In this regard, an important task is to assess the condition of hydraulic structures after long-term operation and to analyze the possible consequences of accidents.

One of the biggest problems in hydraulic structures currently in use is the study of filtration processes in the foundations of III-IV class structures. Because in these

structures, verification of changes using control and measurement devices and data processing are minimized. In this regard, special attention is paid to the issue of finding a technical solution to the problem in this direction [1,2].

The passage of the filtration flow through the foundation of hydraulic structures has a clearly expressed spatial character, therefore, the application of conventional solutions to filtration problems in the plane leads to significant changes. In recent years, approximate methods for solving filtration problems have been applied in practice, leading to even greater deviations from real conditions.

Theoretically, the problem of filtration under hydraulic structures is solved by the linear velocity law and the Laplace equation. Precise analytical solutions of this equation were obtained for a number of simple contours and applied by the fragment method to more complex schematized contours under the conditions of a planar problem. In practice, various and complex underground contours with different boundaries of waterproof and water-permeable bases are more common, and analytical solutions for these cases are insufficient. Such problems can be solved graphically in plane conditions, but these solutions are inaccurate and require a lot of time. The spatial solution of the problem can be implemented only on the basis of the electrohydrodynamic similarity method proposed by Academician N.N. Pavlovsky. This method is also widely used in solving planar problems.

The purpose of this work is to determine the pressure gradient in the foundation of concrete hydraulic structures located in difficult conditions, provided there is no design documentation.

The object of the research is hydraulic structures of the IV class with complex conditions. The subject of the research is the analysis of the structure of the object of research, as well as the methods and means of its implementation.

To achieve the goal, it is necessary to complete the following tasks:

1) improvement of calculation methods that take into account the physical and mechanical properties of the soils of the foundation of hydraulic structures,

2) determination of the dependence of the pressure gradient on the length,

3) determination of complex filtration characteristics in the foundation of a concrete structure based on the theory of experiment planning.

2. Method

The theory of similarity and dimensionality has recently become widespread in various fields of science and technology. The general conclusion of dimensional theory is known as the π-theory. The main rule to follow when using this theory is that factors should not be interconnected, that is, independent, but this is permissible if their interconnection is nonlinear.

The methods of similarity and dimensional theory are often used in underground hydraulics and hydromechanics, particularly in solving problems of stable filtration, which are also useful for deriving the fundamental law of filtration.

3. Results

Since periodic checks of the concrete structure's condition are recommended, the observation results can be used to construct regression models for changes in parameters characterizing the structure's reliability. Additionally, it is proposed to use these regression models to create predictions of the structure's condition over a certain time interval, which allows calculating the failure-free operation time and planning repair work on the structure in advance [3,4].

4. Conclusion

Taking into account the physical and mechanical properties of the soils of the structure's foundation, the dependence of the pressure gradient on the length was obtained, and the possibility of ensuring the safety of the structure in the absence of control and measuring instruments for practice was created. To minimize the number of experiments, based on the theory of experiment planning, the dependencies for determining the complex filtration characteristics of the concrete structure foundation were derived.

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