Hydraulic calculation of a water discharge system for protecting construction pits and foundations from flooding

Marina Losaberidze, Badri Churcelauri, Giorgi Samushia
Technical University of Georgia, Tbilisi, Kostava 77, 016
DOI: https://doi.org/10.52340/building.2025.71.09

Abstract The groundwater level above the design pit bottom mark, together with surface runoff, create many negative conditions both during construction and operation. The article discusses the mechanism for protecting construction pits and foundations from flooding using irrigation systems. It is noted that when performing hydraulic calculations of irrigation systems, it is necessary to take into account the fact that surface runoff water carries a mass of solid particles. The calculation method takes into account the mass of these solid particles only from the point of view of abrasiveness. The work calculates the external pumping network and operating parameters of the hydrotransport system taking into account the characteristics of the selected pump based on data from regulatory, reference, advisory and scientific sources. (Q, H, N, η) Calculation formulas when working with hydraulic mixture.

Key words: construction pit, flooding, drainage system.

1. Introduction

Protection of pits and foundations from flooding (by surface and ground water) is one of the important factors in the organization of work, ensuring safe and uninterrupted working conditions during construction and positively influencing the subsequent operation of the facility. The groundwater level, located above the design mark of the pit bottom, together with surface runoff, create many negative conditions, both during construction and during operation. In particular, this complicates excavation work and can lead to flooding of construction equipment. Changes in the hydrological regime in urban areas often lead to the activation of such processes as deformation of the earth's surface, landslides, collapse of quarry slopes, flooding, etc. (Fig. 1). A rise in the groundwater level causes hydrostatic compaction of sand and softening of clay rocks. Penetration of capillary moisture into clay rocks leads to a decrease in their adhesion and strength. Foundations of buildings, represented by loams, clays and sands, as a result of dehydration change their physical and mechanical properties, lose strength, reduce the ability to resist movements and compression, are subject to swelling, significant deformations occur - uneven settlement of buildings and structures. Excessive moisture creates favorable conditions for the development of pathogenic microorganisms and other pests, which negatively affects the strength and durability of building materials.

Picture. 1

The protection of the construction cave from the crop is performed by four main methods [1-2]:

1. Superficial drain water flows to the mountain canal;

2. Open water;

3. Allowing (water);

4., Organizing an anti -filter curtain.

We will touch the protection of caves and foundations using water systems.

Please note that in the hydraulic calculation of waterproof systems, it is necessary to remember that the surface drop in water is introduced into the mass of solid particles from the water column, partial (relatively large particles) are removed in the sea bottom gallery, partly in this area. Currently, the content of solid particles is provided by the reporting methodology, only from the point of view of abrasiveness and the choice of low bases. As for the calculation of the external network of the pump, the content of solid particles in dried water is not provided.

Based on the data of regulatory, reference, recommendations and scientific sources, we will try to calculate the waterproof system when the contents of the solid mass in the dried - wound are accepted.

The movement of hydration losses calculated by the formula [2, 9].

$$\Im_{h.m.} = \lambda \frac{1}{D_{m.sh.}} \cdot \frac{V^2}{2g} \cdot \frac{\rho_{hn}}{\rho_w} \qquad (1)$$

Where: λ - Is a hydraulic coefficient of friction of the pipeline,V - The average flow rate in the pipeline (m/cm); g - The force of gravity is accelerated (m/s²), $D_{I.d}$ - Inner diameter of the pipe.

$$\rho_{hn} = \rho_w + S(\rho_{sm} - \rho_w) \qquad (2)$$

The density of hydraulic mixture (kg/m³), ρ_{sm} - The density of the sent solid material (kg/m³), ρ_w - Water density (kg/m³), While S - True volumetric consistency of hydraulic power.

The crisis speed of the hydromixture in the pipeline is calculated by the formula [7]:

$$V_{cs} = 8,3\sqrt[3]{D_{msh}} \cdot \sqrt[6]{S\psi_m} \qquad (3)$$

Where ψ_m - It is a coefficient of solid material (see table 1).

General pressure losses on hydrotarev are calculated by the formula [2, 4]

$$H_{tplh.} = (\mathcal{J}_{hn.1}L_1 + \mathcal{J}_{hn.2}L_2) + H_{tplh.+H_g.} \qquad (4)$$

Where K is the coefficient that takes into account the loss of pressure in the correct areas of the connection, $\mathcal{J}_{hn.1}$ are losers of the absorbing pipeline; $\mathcal{J}_{hn.2}$ losing pressure in the pipeline, L_1 - the length of the right area of the pipeline in this drainage unit (M); L_2 - the total length of the pipeline (m); $H_{tplh.}$ - total Loss of Pressure, on Hidromixture in local barriers

$$H_g = \Delta Z \frac{\rho_{hn.}}{\rho_w} \qquad (5)$$

This is pressure to overcome the geodetic height. Here ΔZ There is a difference between the minimum water level in the adjustable tank and geodetic characteristics of the axis in the field of hydration in the region.

The individual characteristics of ground pumps are determined by the plant using special exams on water and are given in the relevant catalogs and other reference literature.

Schedule 1

According to the fractions of materials Ψ Value of the coefficient

Material fraction, mm	0,05-0,10	0,10-0,25	0,25-0,5	0,5-1,0	1,0-2,0	2,0-3,0	3,0-5,0	5,0-10,0
ψ	0,02	0,20	0,40	0,80	1,5	1,8	1,9	2

When working with a hydraulic mixture, the characteristics change depending on the consistency and granulometric composition of the solid material being transported.

The pump characteristics also change due to intensive wear of the impeller and other parts.

The pressure created by a new pump when working with a hydraulic mixture can be calculated using the formula [5, 7]:

$$H_{tplh.n} = KH_{w.n}\left[1 + \frac{S}{\sqrt{\psi_m}}\right] \qquad (6)$$

And when working with a hydraulic mixture, the pressure developed by a partially or completely worn-out soil pump has the form [7]:

$$H_{hnwtg} = KH_{wtn}(1 - a_1^3 q^5)\left[1 + \frac{S}{\sqrt{\psi}}\right] \quad (7)$$

In images (6) and (7) is the consistency of the hydraulic mixture,k A dimensionless coefficient close to unity, a_1 - the experimental coefficient

q - The mass of solid transported by the pump, which must be determined directly on site based on statistical data.

To calculate the flow rate of the hydraulic mixture, we have the following expressions [3-7]:

$$\begin{cases} Q_{hnt.(max)n.} = Q_{wt.(max)\,n.}(1 - 1{,}65S)\frac{m^3}{min} \\ Q_{hnt.(max)n} = Q_{wt.(max)n}(1 - -a_1^3 q^5)\frac{m^3}{min} \end{cases}$$
(8)

The calculation of the soil pump MCC for a hydraulic mixture of consistency S is performed using the formula:

$$\eta_{hn.w.} = \eta_{w.n}(1 - 0{,}33S) \quad (9)$$

Where: η_{wn} - the efficiency factor of the ground pump when working on water, taken from the relevant catalogs. It is accepted that the MCC for worn pumps is taken in the same way as for new pumps. The conversion of power on the pump shaft from water to hydraulic mixture is carried out according to the formula [3-7]:

$$N_{hn.t.n} = N_{wtn}\frac{H_{wtn}}{H_{hntn}} \cdot \frac{\eta_{wn}}{\eta_{hn.n}} \quad (10)$$

The operating parameters (Q, H, N, η) of the hydrotransport system when working on a hydraulic mixture are determined based on the characteristics of the external network and the selected pump. The corresponding reserve size is calculated based on the number of selected simultaneously operating pumps, namely, if more than one pump is operating simultaneously, then a 50% reserve is taken, and in the case of one pump operating - 100% [8-9].

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