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Water resource saving in irrigation networks through improving the efficiency of reinforced concrete coatings

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Abstract. This article examines the hydraulic conditions of the soils and their defects by analyzing the hydrogeological conditions of the land along their alignments to reduce the excessive water consumption in the irrigation networks and the rational use of the existing canals. The surveys were conducted on the example of the Dustlik channel in the Syrdarya region and the Khamdam channel in the Tashkent region. The technical condition of reinforced concrete coatings in these channels was analyzed and recommendations were given to increase the icing resistance and waterproofing of cement mixtures using the chemical additive Antihydron – 2D to fill the cracks and deformations also for repair, restoration, protection and waterproofing of structures and products from concrete, stone, brick.

1. Introduction

Problems with the destruction of structures made of concrete, brick, stone due to water penetration and provision of reliable waterproofing structures - problems that acute in all sectors of construction [1]. According to the Decree of the President of the Republic of Uzbekistan dated November 27, 2017 "On Measures for the Development of Irrigation and Amelioration of Irrigated Lands for 2018-2019" [2] 4487 km of irrigation systems, 5250 km of irrigation networks, 3636 Hydrotechnical constructions, 495 pumping station units, and 1500 vertical irrigation wells, as well as 7.500 km of collector-drainage stations, 13 reclamation pump stations and 185 steep pumps need to be repaired or reconstructed. To date, the water supply of 167.000 hectares of irrigated land throughout the country remains unsatisfactory; 1957.000 hectares of irrigated land is saline to varying degrees, of which 542.000 hectares are irrigated and about 99.000 hectares are heavily saline [3]. Taking into account the above, the issues of construction and reconstruction, repair, and reclamation facilities remain one of the most urgent tasks in the field of water management. Currently, the technical condition of the majority of farms and internal networking channels does not fully meet the current requirements and their efficiency is at a very low level. Farmers involved in irrigated agriculture face similar problems that are common to irrigation areas around the world: a shortage of water resources, poor management of water, outdated physical assets, high soil, and groundwater salinity, lack of effective institutional setup, and imbalance of financial revenues and expenditures [4]. To give recommendations for the introduction of innovative water-saving technologies in the construction and reconstruction of irrigation and land reclamation facilities in the Republic as well as in the maintenance of irrigation canals. It also guides the use of modern chemical additives to fill in the cracks and deformations in the reinforced concrete surfaces by analyzing the causes. Causes of defects in concrete and reinforced



concrete slabs in irrigation networks. Crop yield and reductions in irrigation water depend to increase Water productivity to meet these projections, irrigation systems will have to be modernized and optimized [5].

Research objectives:

- - the analysis of the water properties of the ground by studying the hydrogeological conditions of the lands along the route in the design of the canals;
- - to study defects in concrete and reinforced concrete slabs;
- - use of antihydron chemical additives for the repair of reinforced concrete slabs in canals;
- - analyzing the basic technical parameters of the antihydron chemical additive as a chemical additive to the cement mortar used to repair the seams and cracks in the reinforced concrete coatings [6].

2. Methods

The technical condition of reinforced concrete slabs at the beginning of the Khamdam channel in the Tashkent region and the central part of the Dustlik channel in the Syrdarya region was studied in the field [7]. Technical characteristics of the antihydron chemical additives and their effect on the properties of cement mixing were carried out following the current State Standards (GOST 5802-82, GOST 6246-82, GOST 10060-87 and GOST 8905-82) in the Building Materials Laboratory.

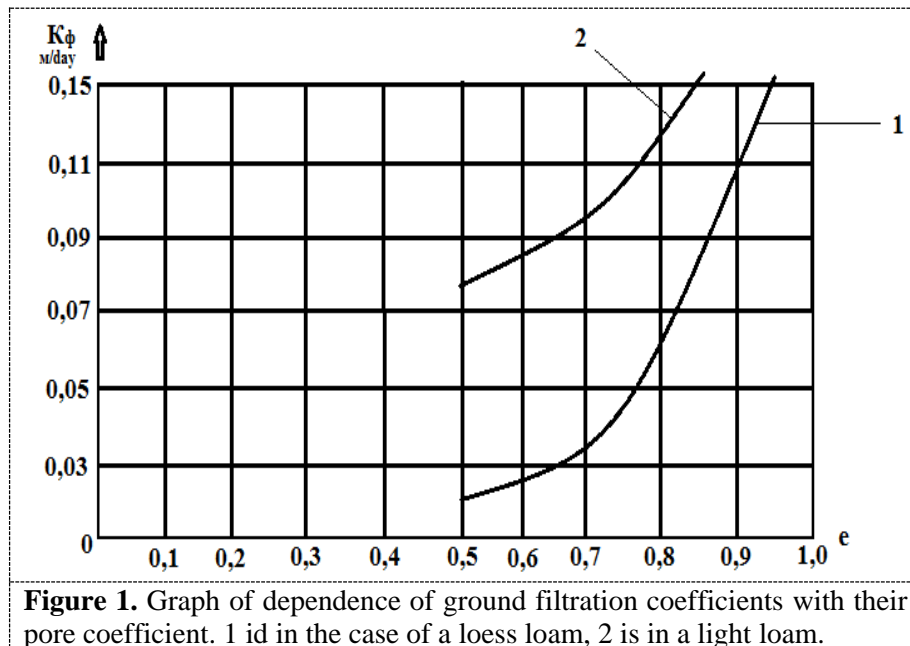
3. Results and Discussion

In the construction of canals in irrigation networks, they may be the first type of ground along the longitudinal axis [8]. In the laboratory conditions, the water permeability of various groundwater obtained on the basis of hydrogeological investigations was increased with increasing the size of the ground particles in the natural structure with the structure intact (Table 1).

Table 1. Coefficient of filtration on the tested soil

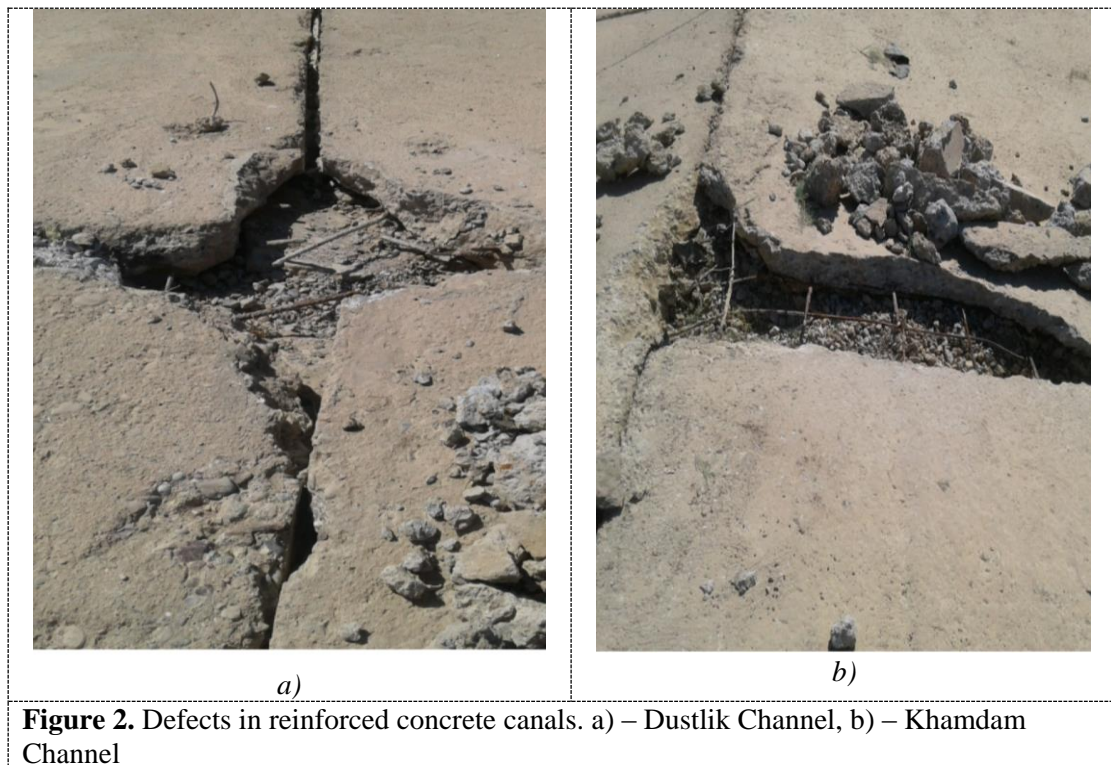
Name of the soil	Filtration, m/day
Sand and pebble	17 – 118
Sand	1.8 – 62
Sandy loam	0.12 – 2,3
Loam	0.11 – 0,001
Clay	0.001 and less

The underground filtration rate depends on many factors. For example, the pore coefficient of the soil depends on the shape and size of the soil particles, the mineralogical composition, and the active porosity [9]. Although the different pore coefficients are the same, their permeability may be different. Figure 1 below shows the correlation coefficient of filtration coefficients in the fluorescent sorrel and light sorrel ground.



From the graph above, it is fair noting that even though the soil pore coefficients are the same, their active porosity is relatively high for the relatively large number of sand particles in light hydrocarbons, hence the increase in their permeability. Soil permeability is the property of the soil to transmit water and air and is one of the most important qualities [10].

Based on the above, it is important to note that during the construction and operation of irrigation canals, it is desirable to cover sand and sandy sections of the canal along the longitudinal direction of the canal with the concrete slabs. The current technical condition of irrigation canals is not satisfactory. For the most part, the channel operating efficiency is 0.45 – 0.73. This is since the bulk of the water in the canals is absorbed by the damp perimeter of the open channel, while some of the water evaporates on hot days [11]. This situation, especially in machine channels, harms the rational use of water and other energy resources. One of the reasons is the technical condition of reinforced concrete slabs to reduce the water permeability of the canals. As an example, defects in reinforced concrete slabs of Khamdam and Dustlik channels were studied (fig.2).



When analyzing the defects in Figure 2 above, we found that cracks and debris of different sizes in reinforced concrete slabs were mainly observed in areas where the water level in the canal varies.

The main reason for this was the loss of freezing of concrete in the body of reinforced concrete and cement mortar at deformation lines. Because the groundwater levels in these canals are variable (1.7... 2.8 m), the mineralization is 0.6... 1.1 g/l. Fractures formed in reinforced concrete coatings are not waterproof if they have a size of 0.4 mm, but in cases where cracks are larger than 0.4 mm, reinforced concrete slabs lose water and freeze water in the pores and capillaries in the winter. The tension is caused by the breaking of concrete and reinforced concrete slabs. Research shows that cracks, cracks, and other breakdowns in concrete pavements can occur for a variety of reasons. Currently, the main causes of this include freezing of free water in concrete, low waterproofing, deformation of temperature and humidity, and finally corrosion of concrete and fittings in reinforced concrete [12,13].

The formation of relatively large cracks and breakdowns in reinforced concrete pavements causes double water filtration in the canals. First, under high hydrostatic pressure, primary filtration occurs when the water level in the canal is reduced, resulting in a decrease in the efficiency of the channel. However, when the water level in the canal decreases, the groundwater levels at the edges of the canal are relatively high and reverse filtration is initiated. As a result of this process, the intensity of mechanical and chemical reactions on the underside of the reinforced concrete coating increases. This may cause the base surfaces on the back of the reinforced concrete slab to become uneven over time. As a result, the reinforced concrete slab will move away from the slab and cause damage to it. In this case, the efficiency of the channels is significantly reduced. Deformation joints between reinforced concrete slabs must be securely closed to prevent this.

To solve this problem, depending on the size of the cracks, they are covered by special cement or fine-grained concrete mixes.

Basic specifications:

1. Achieved as a result of surface treatment, the waterproof grade of concrete, which has a grade of W2 before processing, at least W12 (1.2 MPa);

2. Achievement of frost resistance of concrete achieved as a result of surface treatment, which has grade F50 before processing, not less than F300;
3. Compressive strength, MPa, not less 30;
4. Adhesion with concrete, MPa, not less 1.2;
5. Setting time:
 - beginning, hour, not earlier 2;
 - end, hour, no later 5;
6. Average consumption, kg/m² 2 – 3.5.

Experiments have shown that it is desirable to fill cracks and sand (1: 3 ratio) with special waterproofing properties if the fractures are less than 30 mm. At the same time, a mixture of M400 waterproof extensible cement, quartz sand with a modulus $M_{cr} = 1.6$ and chemical Antigidron – 2D developed by Biskhimstroyaterialy LLC were used as a chemical additive [14]. At the same time, the preparation of cement-sand mixture was used with the addition of Antigidron – 2D 0.4% of cement mass. It is a powdery substance that increases the water-resistance of the cement-sand mixture from W2 to W8 and increased the frost resistance of the mixture from F50 to F250. When preparing the mixture, its excitation was taken at 7 – 8 sm. In laboratory conditions, the deformation and hardening parameters of the mixture were investigated: the start of the alloying time was 47 minutes, and the end of hardening time was 4 hours 17 minutes. The strength of the mixture was 30MP under natural conditions. The absence of chlorine in the chemical additive of Antigidron – 2D makes it possible to prevent corrosion from corrosion and to be used for repair and repair of reinforced concrete coatings. The additives with the chemical additive of Antigidron – 2D have sufficient adhesion properties and also interconnection with reinforced concrete slabs and the adhesion strength varies between 2.22 ... 2.43 MPa.

4. Conclusions

The following conclusions can be drawn from the results of the research on water saving in irrigation networks:

- When constructing canals in irrigation networks or performing reconstruction and repair of existing channels, the hydrogeological parameters of the land along the longitudinal axis of each canal should be thoroughly studied.
- It is desirable to use constructive and technological measures for the filtration of the channel through the sandy and sandy soils along the channel route.
- Deformation joints must be correctly laid when placing anti-filtering concrete and reinforced concrete slabs in the channels or placing reinforced concrete slabs.
- The composition of cement mortars or concrete mixtures should be properly selected based on their size when filling the deformation lines or closing the cracks.
- The use of the chemical additive Antigidron – 2D in cement mixing for cracks or cracks, 0.4% of cement mass, increases the frost resistance of cement mixture from F50 to F250 and waterproofing from W2 to W8. This reduces filtration by preventing groundwater leaching from the canal, thus increasing the service life of the concrete and reinforced concrete structures in the canals and saving water resources by 15 – 20%.

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