Field studies to determine the deformations of low-pressure hydraulic structures

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Abstract. The article deals with the issues of field studies of the deformation of low-pressure hydraulic structures in operation. Based on the results of the project, preliminary and repeated geodetic measurements, a longitudinal profile of sedimentation of the concrete structure body was built using the obtained leveling.

1 Introduction

An urgent problem is the development of effective methods for the design and construction of low-pressure hydraulic structures in regions with difficult engineering and geological conditions, the use of efficient and cost-effective technologies to increase their stability and ensure safety during their operation, and to strengthen soil dumps.

In recent years, a lot of attention has been paid to the design and construction of low-pressure hydrotechnical structures in the era of severe water resources shortage. The rational use of the existing structures is also very important. Low-pressure hydraulic structures built from concrete and soil material play an important role in managing the use of surface water not only for crop irrigation, but also in the socio-economic sphere of the country [1-4].

Many low-pressure hydraulic structures have been in operation for more than 50-60 years, which affects the deterioration of their technical condition and, accordingly, their reliability and safety. According to statistics [5-7], in recent years, more than 300 accidents have occurred in low-pressure hydrotechnical constructions. Due to the lack of proper control over the safety of low-pressure hydrotechnical constructions, the efficiency of working with facilities of this category remains inadequate or even low [8].

Some specific features depend on the methods of assessing the level and condition of the safety of low-pressure hydrotechnical constructions. Such work requires adequate performance, since in low-pressure hydrotechnical constructions, that is, in objects of class IV, as a rule, the installation of control-measuring instruments is not envisaged [9], therefore, specialists mainly focus attention on qualitative, partial-number diagnostic indicators, which are determined on the basis of nature or visual observations and the simplest measurements. So, one of the observations of nature is an important issue in determining the deformation (drowning, deviation, horizontal smoothing) of structures and their floors [10-12].

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2 Methods

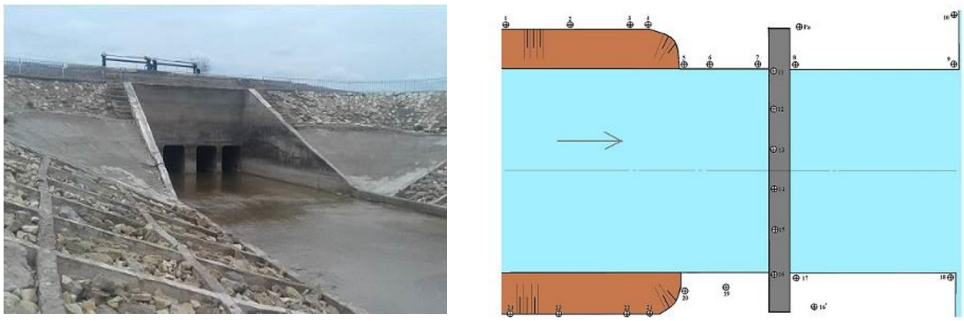
Nature observations should be conducted, which will give the opportunity to monitor the safety of each exploited concrete low-pressure hydrotechnical constructions. The composition and size of natureobservations are determined by design guidelines, normative documents, depending on the class of the building, the characteristics of the engineering-geological structure of the floor, the environmental situation, etc. The nature monitoring program, developed in the design of gidrotechnics facilities, as a rule, is adapted to the period of continuous exploitation [13-18].

Deviations from the technology of construction work, as well as violations of the rules of operation of hydrotechnical constructions, can lead to their deposition and silencing. In the practice of construction of hydrotechnics, geodesic methods of determining deformations are adopted: geometric and geostatic leveling – determination of silgears by height; angle and target measurements for determining smooth in the plan [19, 20]. Deformation of the structure by height is often manifested in the form of its deposition. In order to monitor the deposition by the method of geometric leveling, deposition stamps are placed in places characteristic of deformations in the lower parts of the structures. The height of the plunge marks is determined in relation to the foundation rappers.

3 Results and Discussion

Specific features of the use of foundation rappers in the construction of gidrotechnics include the location of their installation: at a distance of not more than 1 km; on the basis of groups – at such a distance from each other it is necessary to place 2-3 rappers, so that there is an opportunity to control them from one device to another. Among the foundation repers are conducted leveling way of grade II without the addition of all plunge stamps. In the period of use, the leveling period of deposition stamps is carried out every year, until the deposition is stabilized up to 1-2 mm in the annulus.

The conclusion on the permissibility of existing deformations is obtained by comparing the actual deformations with the project one. As an object of research, drowning stamps were established around the perimeter of the hydrosystems to conduct geodesic work on the example of the main water intake concrete structure of the Marinkin canal (Fig. 1).



a) View of the structure from the downstream b) Location of geodesic stamps in the plan

Fig. 1. Installation of immersion stamps around the perimeter of the hydrosystems

Class II leveling was carried out in hydrosystems to determine the deposition at the beginning of the water intake facility. It should be noted that the above rules correspond to the mandatory requirements of the filing for the design, construction and use of water intake facilities in rivers and canals. The study of the design documentation of some small

hydrosystems showed that from the moment of filing for use, materials for measuring the actual parameters of the state of the hydrotechnical constructions are not available. Therefore, it will be necessary to conduct the work of leveling in full. In leveling, the general scheme and sequence of works are carried out according to the generally accepted methodology. The results of the observations were recorded in the Journal in the prescribed form.

When conducting geodesic measurements, 2N-10L leveling was used, which was designed for leveling in the justification of topographic images, engineering-geodesic research [20]. Nature observations of geodesic methods were conducted to observe the deformation processes and deposition of hydrosystems. The object was held leveling of class II and III. Completed with leveling 2N-10L leveling and HP-4 leveling rail. Prior to the implementation of the work, the study and inspection of the equipment were carried out in accordance with the normative documents.

Before leveling, points were marked to measure the absolute signs on the hydrosystems. All the characters received due to the absence of rappers in the hydrosystems area are tied to the high mark of the Pa_1(Fig. 1).

To determine the deposition and deformation in the territory of the hydrosystems, 10 points were obtained on the left bank of the hydrosystems and 9 points on the right bank (Fig. 1, b). The main water intake facility of the Marinkin canal was launched in 1994 year, the first geodesic works were carried out, and after a year the next geodesic measurement works were carried out. In 2014-2015, geodesic research work was carried out in cooperation with specialists of the Scientific research institute of irrigation and water problems. The signs and absolute values of the points are presented in Table 1.

Table 1. Results of geodesic measurements

Number of points	Project		Initial		Repeatedly	
	Increase, Δh_{kr}	Sign	Increase, Δh_{kr}	Sign	Increase, Δh_{kr}	Sign
1		0.2125		0.2125		0.2125
2	0.000	0.210	0.000	0.531	0.000	0.473
3	0.170	0.040	0.241	0.290	0.212	0.261
4	0.010	0.030	0.133	0.157	0.132	0.129
5	-0.099	0.127	-0.012	0.169	0.016	0.113
6	-0.141	0.2685	-0.135	0.304	-0.162	0.275
7	0.014	0.255	0.016	0.288	0.015	0.260
8	0.186	0.065	0.025	0.263	0.055	0.205
9	-0.005	0.0775	-0.016	0.279	-0.045	0.250
10	0.035	0.040	0.136	0.143	0.135	0.115
Pa_1	0.040	0.00	0.143	0.00	0.115	0.00
11	1.702	1.706	1.702	1.686	1.702	1.628
12	-0.014	1.692	-0.048	1.638	-0.05	1.609
13	0.024	1.7205	-0.063	1.575	-0.062	1.547
14	0.027	1.7465	0.022	1.597	0.022	1.541
15	-0.005	1.7415	-0.085	1.512	-0.086	1.483
16	-0.028	1.7165	0.076	1.588	0.077	1.560
16	-1.720	-	-1.75	-0.165	-1.73	-0.109
17	0.222	0.0085	0.144	-0.021	0.132	-0.241
18	0.04	0.2110	0.041	0.020	0.042	-0.01
19	0.043	0.248	0.010	0.030	0.017	0.020
20	0.005	0.2895	0.018	0.048	0.015	0.051
21	-0.163	0.2945	-0.075	-0.027	-0.05	0.001
22	0.027	0.1330	0.134	0.107	-0.083	0.084
23	0.168	0.1590	0.024	0.131	0.009	0.075
24	0.038	0.3270	-0.015	0.116	-0.014	0.089
		0.3645				

Based on the results of the conducted geodesic studies, a longitudinal profile of the body deposition of concrete structures was constructed (Fig. 2)

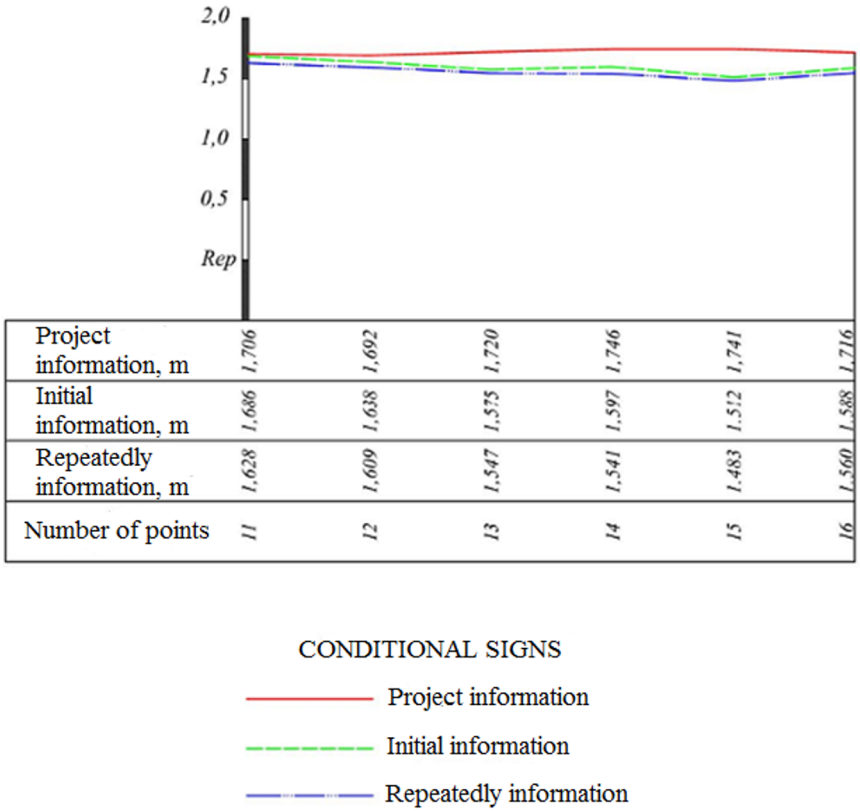


Fig. 2. Longitudinal profile of concrete structure body deposition

According to the results of the obtained geodesic measurements, the sedimentation of the body of the concrete structure was on average 0,21 m. According to the results of the study, it was noted that the allowable immersion depth of the foundation of the projected and constructed structures in the area under consideration should not exceed 0.5 m. Therefore, we can see that the state in which the total immersion of the construction Foundation does not exceed the allowed limit value is ensured the safety and reliability of the construction.

4 Conclusions

Field studies were carried out, which made it possible to control the safety of the floor of the concrete structure of the main water intake of the Marinkin canal. In the first year of its launch into construction, preliminary and repeated geodetic survey work was carried out to determine the slope of the project, and then the floor. Based on the results of geodetic measurements, a longitudinal profile of the body of the concrete structure was constructed.

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