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RECOMMENDATIONS ON EMERGENCY AND RESTORATION WORKS OF WATER SPRING STRUCTURE 1 ON THE CHORNY TASHLYK RIVER IN THE CITY OF NOVOUKRAINKA

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The article provides recommendations for emergency restoration work on the spillway structure on the Chorny Tashlyk River in the city of Novoukrainka. The problem statement and survey facts that affect the operation of the spillway structure are presented in detail. The characteristics of the hydraulic structure and the Chorny Tashlyk River are given. A list of defects is presented and the category of the technical condition of the structure is determined. The technical condition of the supports is determined and the category of their technical condition is determined. Two options for restoring the hydraulic structure to its working capacity are presented. Consider in detail both options for restoring the hydraulic structure and present the sequential execution of the work. Detailed information about the Chorny Tashlyk River is provided, its main characteristics are given. The type of water regime of the river is given, a multi-year schedule of average annual flows at the Tarasivka post is presented. Flow indicators by year are given (the largest, average and smallest). A graphical characteristic of the maximum flow rate of spring floods of the Chorny Tashlyk River is presented. Hydraulic calculations of the Novoukrainske reservoir hydraulic structure are presented in 4 variants of the reconstruction of the structures. Each of the variants is described in detail, the third variant is determined and adopted in further calculations. A calculation table of the results of hydraulic indicators of all 4 options is presented. Specific design solutions for the overhaul of hydraulic structure No. 1 are presented:

– dismantling of defective reinforced concrete beams;
– dismantling of metal segment gate;
– dismantling of metal gates of the sandor type;
– dismantling of beam slabs;

– repair of the protective layer of concrete of stands and intermediate supports;
– repair of the protective layer of concrete of the beam ribs;
– installation of a new beam plate;
– installation of new metal gates of the sandor type;
– arrangement of a technological platform in the vicinity of the parking lot.

Repair work on the hydraulic structure is planned to be carried out with a phased closure of half of the channel of the Chorny Tashlyk River by installing a gabion bridge from the intermediate support to the bank at an acute angle to the hydraulic structure.

Key words: *spillway structure, justification, repair gate, technical condition, operability.*

Волошин М. М. Рекомендації з аварійно-відновлювальних робіт водовипускної споруди № 1 на річці Чорний Ташлик у місті Новоукраїнка

У статті наведено рекомендації з аварійно-відновлювальних робіт водоспускної споруди на річці Чорний Ташлик у місті Новоукраїнка. Розгорнуто представлено постановка проблеми та факти обстеження які впливають на роботу водоспускної споруди. Наведено характеристика гідроспоруди та річки Чорний Ташлик. Представлено перелік дефектів та визначено категорія технічного стану споруди. Визначено технічний стан опор та визначено категорію їх технічного стану. Наведено два варіанти відновлення працездатності гідроспоруди. Розглянути детально обидва варіанти відновлення гідроспоруди та представлено послідовно виконання робіт. Наведено розвернута інформація про річку Чорний Ташлик, наведено її головні характеристики. Наведено тип водно режиму річки, представлено багаторічний графік середніх річних витрат в створі поста Тарасівка. Наведено показники витрат по роках (найбільша, середня і найменша). Представлена графічна характеристика максимальної витрати весняних повеней р. Чорний Ташлик. Представлені гідравлічні розрахунки гідроспоруди водосховища Новоукраїнське в 4-х варіантах реконструкції споруд. Детально розписано кожен із варіантів, визначено та прийнятий третій варіант в подальших розрахунках. Наведено розрахункова таблиця результатів гідравлічних показників усіх 4-х варіанті. Наведено конкретні проектні рішення по капітальному ремонту гідроспоруди № 1:
– демонтаж дефектних залізобетонних балок;
– демонтаж металевого сегментного затвору;
– демонтаж металевих затворів шандорного типу;
– демонтаж плити балок;
– ремонт захисного шару бетону стоянів та проміжних опор;
– ремонт захисного шару бетону ребер балок;
– влаштування нової плити балок;
– установка нових металевих затворів шандорного типу;
– влаштування технологічного майданчика в околі стояна.

Виконання ремонтних робіт на гідроспоруді передбачається виконати із поетапним перекриттям половини русла річки Чорний Ташлик шляхом влаштування перемички із габіонних конструкцій від проміжної опори до берега під гострим кутом до гідроспоруди.

Ключові слова: *водоспускна споруда, обґрунтування, ремонтний затвор, технічний стан, працездатність.*

Problem statement. Hydraulic structure No. 1 is located at Svitly Lane in the city of Novoukrainka, Kirovohrad region and crosses the Chorny Tashlyk River. It is an open non-pressure coastal spillway with gates. A segment type gate is used as a working gate. The repair gate is of the Sandor type [1].

The hydraulic structure crosses the Chorny Tashlyk River at a right angle. The river flows from left to right according to the number of supports. The river flow is smooth. The depth of the river on the upstream side of the hydraulic structure is 1.4…2.0 m, on the downstream side – 0.4…0.66 m.

When examining the main load-bearing structures of hydraulic structure No. 1 for a set of defects, it was found that the technical condition of most building structures, such as reinforced concrete beams and metal gates [2,3], according to clause 5.2 of DSTU-N B V.1.2-18:2016 "Guidelines for the inspection of buildings and structures to determine and assess their technical condition" refers to category "4" – emergency.

In this regard, according to clause 5.2.4 of DSTU-N B V.1.2-18:2016, it is necessary to immediately exclude people from the area of possible collapse and/or take measures to prevent such collapse until the structures are repaired, strengthened or replaced or the facility is liquidated.

Analysis of the state of the problem. According to the totality of defects and categories of technical conditions of individual building structures, the technical condition of the object as a whole, according to clause 5.3 of DSTU-N B V.1.2-18:2016, belongs to category "4" – emergency. In this regard, according to clause 5.3.4 of DSTU-N B V.1.2-18:2016, the operation of the facility must be stopped until its operational suitability is restored or liquidated.

The technical condition of the foundations of the hydraulic structure supports due to the absence of direct signs of subsidence, destruction or washing out according to Table B.1.1 of DSTU-N B V.1.2-18:2016 belongs to the category of technical condition "2" – satisfactory [4]. In this regard, according to clause 5.2.2 of DSTU-N B V.1.2-18:2016, measures to protect the structure and compliance with the established requirements for its use are required.

Status of the study of the problem. There are two possible options for restoring the operability of hydraulic structure No. 1 in the city of Novoukrainka, Kirovograd region:

Option 1. Major repair (reconstruction) of the existing spillway with gates, the throughput of which is regulated by special gate mechanisms.

Option 2. Reconstruction of the existing spillway with the installation of an automatic spillway, the throughput of which is not regulated and depends only on the water level in the river. The discharge of water through this type of structure begins automatically when the water level exceeds the spillway mouth.

When using Option 1, it is recommended to perform the following main works:

Perform major repairs to the hydraulic structure supports.

Replace the reinforced concrete beams that cover the spans of the hydraulic structure on the floor.

Replace emergency repair valves of the sandor type in run 2-3.

Repair or replace the operating valve of the segment type in run 1-2.

To restore the use of the hydraulic structure for its functional purpose, install a segment-type working gate in run 2-3 and a sandor-type emergency repair gate in run 1-2.

Provide for the installation of operating mechanisms for raising and lowering emergency and repair gates of the sandor type and opening operating gates of the segment type in runs 1-2 and 2-3.

When using Option 2, it is recommended to perform the following main works:

Carry out major repairs to the supports of the hydraulic structure.

The openings of the spans shall be covered with reinforced concrete or metal wall structures to a height determined by calculation, which will allow the water to be raised in the upper reaches of the river without harm to the environment and automatically lowered when the calculated height is reached.

Provide special holes in wall structures for additional or emergency water drainage.

Research results. According to the physical and geographical zoning, the basin of the Chorny Tashlyk River is located in the South-West of the East European Plain, on the border of the Forest-Steppe and Steppe zones. The border between the zones runs through the center of the basin (along the river bed). The northwestern part of the basin is located in the Dniester-Dnieper forest-steppe province, in the South-Pridnieper upland region. The southeastern part is in the Dniester-Dnieper northern steppe province, in the South-Pridnieper slope-upland region.

Major repairs of the hydraulic engineering structure of the Novoukrainske-1 reservoir are planned on the Chorny Tashlyk River (left tributary of the Synyukha River, Southern Bug River basin) in the city of Novoukrainka, Kirovograd region, at a distance of 103 km from the river mouth.

The left tributary of the Synyukha River, the Chorny Tashlyk River (Southern Bug River basin), originates in the steppe area at a distance of 0.7 km northwest of the village of Kvitka, Novoukrainsky District, Kirovograd Region, at an altitude of 200 m above sea level. The coordinates of the source are 48º 27' 28" N and 31º 49' 17" E. The river flows through the territory of Novoukrainsky district of Kirovohrad region, 17.9 km of the riverbed is located on the border of Kirovohrad and Mykolaiv regions. The Chorny Tashlyk river flows into the Synyukha river from the left side at a distance of 21 km from its mouth, near village of Kalmazov, Novoukrainskyi district, Kirovograd region, at an altitude of 77.7 m. The coordinates of the mouth are 48º 12' 49" N and 30º 10' 21" E. The length of the river is 144 km, the basin area is 2383 km2. The drop of the channel is 122.3 m, the average slope is 0.85 ‰, the weighted average is 0.69 ‰.

The head of the Novoukrainsk Reservoir hydroelectric facility is located 103 km from the river mouth, the basin area above the head of the hydroelectric facility is 852 km2, and the length of the watercourse above the head is 40.6 km.

In the upper reaches of the Chorny Tashlyk River, on modern maps there are three rivers that have the same name – Chorny Tashlyk. They all merge into one river. On old maps (1860), the left tributary is called Tashlyk, and the right one is called Chorny Tashlyk.

The longest riverbed of the Chorny Tashlyk River is from the source of its left tributary, the Tashlyk River, and is 160 km long. This headwaters also have the greatest height above sea level – 248 m. For hydrological calculations, the main source of the river is the source of the Tashlyk River, its coordinates are 48º 08' 03" N and 31º 41' 00" E. The drop of the channel from this source is 170.3 m, the average slope of the watercourse is 1.06 ‰, the weighted average is 0.69 ‰.

The type of water regime of the river is Eastern European, characterized by spring floods with a rapid rise in water levels and summer-autumn-winter low water, which is interrupted by water rises from rainfall. The river is fed by surface water runoff from rain and snowmelt and spring feeding.

The multi-year schedule of average annual costs at the Tarasivka military post is shown in Figure 1.

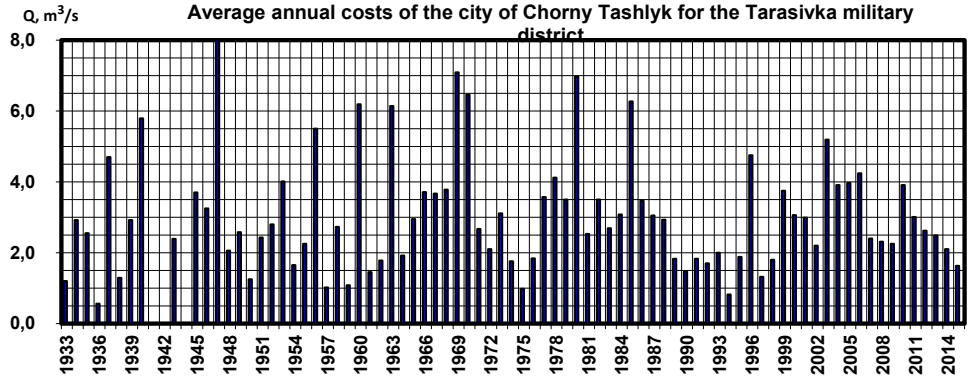

Fig. 1. Average annual costs of the Chorny Tashlyk River on the Tarasivka military district

The river flow is uneven over the years. The average long-term flow in the section of the Tarasivka military post on the Chorny Tashlyk River is 3.18 m^3/s, in the section of the Novoukrainsk reservoir hydroelectric facility – 1.20 m^3/s. The highest average annual water flow was observed in 1947 – an average of 8.42 m^3/s at the water meter station and 3.17 m^3/s at the hydroelectric facility on the Chorny Tashlyk River.

Characteristics of spring floods at the Tarasivka post-analogue are shown in the multi-year schedule of maximum spring flood flows – in Figure 2.

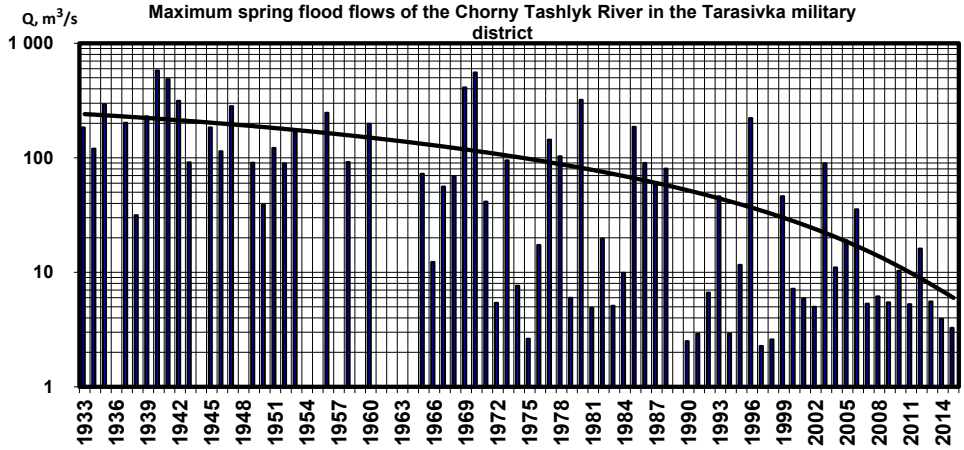

Fig. 2. Maximum discharges of spring floods of the Chorny Tashlyk River in the Tarasivka military district

The highest discharge during the peak spring flood period was observed in 1969 (578 m^3/s), large floods (more than 300 m^3/s) were also in 1940; 41; 42; 70 and 1980. The last significant flood of 222 m^3/s was observed in 1996.

Ways to solve the problem. As a result of hydraulic calculations of the riverbed, it turned out that both Novoukrainske-2 and Novoukrainske-1 hydraulic structures are not flooded from the downstream side (maximum water levels in the downstream are below the spillway thresholds).

Hydraulic calculations of the Novoukrainske-1 reservoir hydraulic structure were performed in 4 variants of the reconstruction of the structures: Variant 1 – installation of a blind concrete bridge in both culverts of the hydraulic structure with a crest mark of 129.50 m (NPR of the reservoir);

Option 2 – installation of a blind concrete lintel with a crest mark of 129.50 m in the right opening of the hydraulic structure and a removable sandor gate in the left opening of the hydraulic structure with a spillway threshold mark at 127.04 m;

Option 3 – replacement of segmental gates in both culverts with sandor type gates while maintaining the conditions for passing maximum flows in accordance with the existing ones according to the original design.

Option 4 – installation of a blind concrete lintel with a crest mark of 129.44 m in the right opening of the hydraulic structure (height 2.4 m) and a removable sandor gate in the left opening of the hydraulic structure with a spillway threshold mark at 127.44 m (height 0.4 m);

In all 4 cases, the forced water level was limited to not flooding the span structures of the road bridge and the beams of the lifting mechanisms of the gates by more than 132.50 m (the bottom mark of the span structure is 132.77 m). The results of hydraulic calculations are presented in Table 1.

Table 1

Results of hydraulic calculations of the Chorny Tashlyk riverbed and the hydraulic structure of the Novoukrainske-1 reservoir

Calculation option	Option description	Marks			Throughput, m^3/s
		spillway threshold	NPR	FPR	
Option 1	Blank concrete lintel in both openings	127,74	127,74	130,84	169
Option 2	Blank concrete lintel in the right opening; sandor shutter in the left opening	125,74	127,74	130,84	263
Option 3	Shandorn shutters in both openings	125,74	129,50	130,84	357

For further design, it is recommended to adopt option 3 of the calculation with sandor gates in both openings with an overflow threshold of 129.50 m in both openings.

Design solutions. According to the design solutions developed on the basis of the design task and on the basis of a field survey, this working project for the overhaul of hydraulic structure No. 1 on the Chorny Tashlyk River in the city of Novoukrainka, Kirovograd region, envisages the implementation of:

– dismantling of defective reinforced concrete beams B1 and B2 in span 0-1 and beams B1 in spans 1-2 and 2-3;

– dismantling of metal segment gate in span 1-2;

– dismantling of metal gates of the sandor type in spans 1-2 and 2-3;

– dismantling of the slab of beams B2 and B3 in spans 1-2 and 2-3;

– repair of the protective layer of concrete of stands No. 1 and 3 and intermediate support No. 2;

– repair of the protective layer of concrete of the edges of beams B2 and B3 in runs 1-2 and 2-3;

– installation of a new slab of beams B2 and B3 in runs 1-2 and 2-3;

– installation of new metal gates of the sandor type in runs 1-2 and 2-3;

– installation of a technological site in the vicinity of the stand No. 1 for servicing hydraulic structure No. 1.

To drain water from the technological site, it is arranged with a slope of i=5‰ towards the side of the hydraulic structure's stand No. 1. The site is framed by a curbstone to direct water that will fall onto the site towards the slope. The slope of the site embankment is arranged with a slope of 1:1.5.

Repair work on the hydraulic structure is planned to be carried out with a phased closure of half of the channel of the Chorny Tashlyk River by installing a gabion bridge from the intermediate support to the bank at an acute angle to the hydraulic structure. The organizational and technological sequence of overpass repair is given in the section "Construction Organization".

When performing the work, building materials and products that have positive conclusions from the state sanitary and epidemiological examination are used. When performing repair work, building materials are used for which there are documents confirming their radiation safety, and final radiation control is carried out after the completion of the work under a contract with an accredited laboratory.

According to DBN V.1.2-14:2018, clause 5.2, the supports of the hydraulic structure correspond to the structural responsibility category A. The metal gates of the sandor type and the reinforced concrete beams of the service bridge correspond to the structural responsibility category B.

Based on clause 4 of article 89 of the Water Code of Ukraine, economic activities related to the overhaul of hydraulic structure No. 1 in the coastal protection zone of the Chorny Tashlyk River are permitted.

The overhaul project excludes negative interference with the aquatic environment both during the construction and operation of hydraulic structure No. 1.

Conclusions and suggestions.

1. Hydraulic structure No. 1 is located at Svitly Lane in the city of Novoukrainka, Kirovograd region and crosses the Chorny Tashlyk River. It is an open non-pressure coastal spillway with gates. A segment type gate was used as a working gate. The repair gate is of the Sandor type.

2. After research, for further design, it is recommended to adopt option 3 of the calculation with sandor gates in both openings with an overflow threshold of 129.50 m – in both openings.

3. The overhaul of the object "Technical justification of emergency and restoration works of the existing water outlet structure No. 1 on the Chorny Tashlyk River in the city of Novoukrainka, Kirovohrad region" is being carried out according to the design task, without allocating queues and start-up complexes.

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