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Constructive-technological decisions in regulating the flow of atmospheric precipitation

Конструктивно-технологические решения при регулировании стока атмосферных осадков

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Key words: flow regulation; above-ground reservoir; underground reservoir; bearing capacity

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Abstract. Practically all sources of fresh water suitable for agriculture, water supply to the population and vacationists, as well as for industrial development on the Black Sea coast of the Caucasus either have completely exhausted themselves or are on the verge of their possibilities. Further development of the region is directly related to the resolution of this problem. The solution of the problem is possible when the system for regulating precipitation flow is implemented. The proposed system includes small reservoirs located in canyons of mountain gorges. Moreover, it is proposed to create in the gorge both above-ground and underground reservoirs for accumulation of surface and underground flow. Complex hydro-geological conditions of construction, seismicity of the zone, suggest the construction of lightweight buttress dams in the structure of hydrosystems, when the pile foundation directly perceives horizontal shear forces. Complex formulation of the issue required the use of mathematical modeling of the situation on the basis of 3D production, with the analysis of the stress-strain state of the "foundation-dam" system. Dynamic analysis (calculation of eigenvalues) and analysis of seismic impact on the dam are carried out. The carrying capacity of the buttress dam was estimated and the degree of reinforcement was determined, as a result of which it was established that the proposed construction complies with regulatory requirements. Design solutions for the system of regulation of precipitation flow were introduced in production in 2016 in the suburbs of the resort town of Gelendzhik. Successful operation of the system confirms the correctness of theoretical and technological prerequisites and opens up new opportunities in the intensive development of the Black Sea coast of the Caucasus. The proposed system for regulating atmospheric runoff can find application in other regions of the mountain-foothill zone, for example, in the countries of Central Asia.

Аннотация. Практически все источники пресной воды, пригодной для целей сельского хозяйства, водоснабжения населения и отдыхающих, а также для развития промышленности на Черноморском побережье Кавказа или полностью исчерпали себя или находятся на грани своих возможностей. Дальнейшее развитие региона напрямую связано с разрешением этой проблемы. Решение проблемы возможно при реализации системы регулирования стока атмосферных осадков. Предлагаемая система включает в себя небольшие водохранилища, расположенные в каньонах горных ущелий. Причем, предлагается создание в ущелье как надземных, так и подземных водохранилищ для аккумуляции поверхностного и подземного стока. Сложные гидрогеологические условия строительства, сейсмичность зоны, предполагают возведение в составе гидроузлов облегченных контрфорсных плотин, когда свайное основание напрямую воспринимает

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горизонтальные сдвигающие силы. Комплексная постановка вопроса потребовала обращения к математическому моделированию ситуации на основе 3D постановки, с анализом напряженно-деформированного состояния системы "основание-плотина". Осуществлен динамический анализ (расчет собственных значений) и анализ сейсмического воздействия на плотину. Оценена несущая способность контрфорсной плотины и определена степень армирования, в результате чего установлено, что предложенная конструкция соответствует нормативным требованиям Проектные решения по системе регулирования стока атмосферных осадков были внедрены в производство в 2016 году в пригороде города-курорта Геленджик. Успешная эксплуатация системы подтверждает правильность теоретических и технологических предпосылок и открывает новые возможности в интенсивном развитии Черноморского побережья Кавказа. Предлагаемая система регулирования атмосферного стока может найти применение в других регионах горно-предгорной зоны, например, в странах Центральной Азии.

1. Introduction

Features of the rivers and streams of the Black Sea coast are that they, in their majority, are of insignificant length. At the same time, the mountainous terrain provides significant catchment areas and, as a consequence, the high water content of these streams. However, in view of their various food, mostly rain and underground, and in the southern part, it is also snow and glacial, the water regime of the Black Sea watercourses is quite diverse. The snow cover in the basins of these rivers is unstable and when it melts, a pronounced flood is not observed. The total annual flow of fresh water to the Black Sea here is 7.5 km^3, it is a huge renewable and hitherto poorly used resource for economic development [1, 2].

At present, the various types of above-ground reservoirs that accumulate only the surface flow of atmospheric precipitation have some distribution without using underground flow, although it is quite comparable to the above-ground [3]. So, the Krasnodar reservoir with a volume of 2.8 billion m^3, the Varnavinsky reservoir with a volume of 140 million m^3, the Kryukovsky reservoir with a volume of 210 million m^3 and others operate in the Krasnodar region. The total volume of renewable accumulated water annually in the region is about 3.2 billion m^3. At the same time, it should be noted that the vast majority of reservoirs are located in valleys, exposing fertile agricultural lands to flooding, bringing them out of circulation [4]. The negative environmental effect is very significant, which in most cases is reflected in the significant change of hydrological regimes affecting large areas affected by reservoirs. Reservoirs with large mirrors of the water surface affect the microclimate of the surrounding areas essentially and often negatively [5, 6]. Thus, we have a clearly expressed structure of unidirectional use of natural resources, which does not take into account the features of the natural and landscape state of the Black Sea coast.

Given the lack of freshwater in the summer-autumn period in cities and settlements of the Black Sea coast of the Krasnodar region, the accumulation and supply of fresh water in this territory can not be carried out by traditional methods and means with the arrangement of classical reservoirs arranged on the flat land surfaces, or the extraction of water from aquifer through wells. So, the experience of the construction of underground and above-ground reservoirs on the territory of Russia was studied, when by means of the dam construction surface and groundwater accumulated in reservoirs.

Despite the large number of existing reservoirs, the problem of providing water to mountain territories and areas with increased seismic activity, to which the Black Sea coast of the Krasnodar Territory belongs, remains urgent.

The presence of modern software products, as well as building materials allows to simulate and implement in kind safe hydraulic structures for the accumulation of fresh water in the mountainous areas and sites with increased seismic activity.

The object of the study is the system for regulating the flow of atmospheric precipitation (SRFAP) on the Black Sea coast of Krasnodar region. However, the possibility of applying the proposed system of flow regulation in other mountainous regions of the planet is being considered.

Statement of the problem - the provision of fresh water to cities and settlements of the Black Sea coast of the Krasnodar region involves the creation of systems for regulating the flow of atmospheric precipitation (SRFAP), intended for the accumulation of surface and underground flow, which will be adapted to the conditions of the mountainous terrain and high seismicity of construction sites, as well as the justification of the proposed structures with the study of the stress-strain state (SSS) of the "foundation-dam" system, taking into account the different level of filling the seasonal regulation basin and influence of seismic load on the structure.

The purpose of the research is a constructive and technological justification for the proposed "foundation-dam" system designs.

Research objectives:

1. To develop a system for regulating the flow of atmospheric precipitation (SRFAP), including underground and above-ground reservoirs.

2. To carry out mathematical modeling of the stress-strain state of the "foundation-dam" system, taking into account the different level of filling of the seasonal regulation basin and the influence of the seismic load on the structure for analyzing the joint work of the dam and base construction.

3. Assess the bearing capacity of SRFAP dam structures and determine the degree of reinforcement.

4. To develop a working draft of SRFAP.

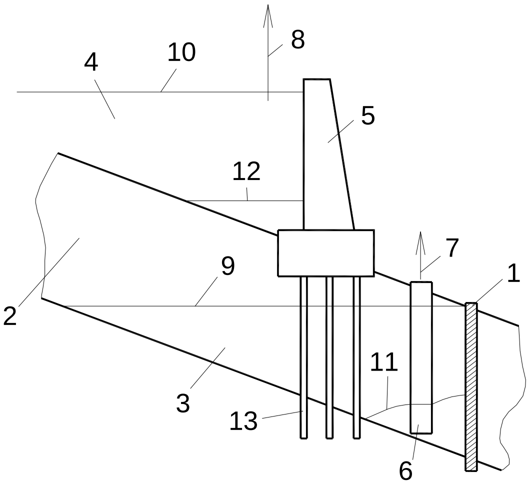
5. Implement the developed SRFAP.

2. Methods

One of the first water storage systems was built in the 6th century AD – the Basilica cistern located in the European part of the city of Istanbul (Turkey) on the promontory between the Golden Horn Bay, the Sea of Marmara and the Bosphorus Strait in the Sultanahmet area. The present twenty-first century - the century of water scarcity, according to the UN in 2018, more than 36 countries in the world suffer from a shortage of fresh water. Scientists of many countries are looking for ways of large-scale regulation of water resources. In some countries, for example in India, there is experience in managing the supply of groundwater. The use of groundwater through the construction of 19 million wells and small wells, and subsequently deep wells, has increased the irrigated areas of India from 6.5 million hectares in 1950 to 58.5 million hectares in 2015 [7, 8]. The increase in the use of groundwater has led to the satisfaction of basic needs in irrigation and drinking water for rural populations of up to 700 million people [9]. At the same time, uncontrolled use of groundwater, as the experience of India, as well as the deserts of Kazakhstan, leads to uneven distribution and depletion of water resources, and as a consequence to the deficit. The regulatory systems developed by us SRFAP implement a different principle, they use only atmospheric precipitation and geologically unrelated water SRFAP, located in mountain gorges, have minimal impact on the environment, namely: do not lead to a change in the groundwater table; do not deplete groundwater reserves; do not lead to salinization or waterlogging of soils; the area of agricultural purpose is not withdrawn from circulation.

The above analysis of the current state of the issue of the use of atmospheric precipitation flow caused the need for a new concept for the use of renewable water resources. It is necessary to avoid unidirectional use of natural resources, when only surface flow water is used, and to switch to a complex system involving the accumulation of groundwater flow, in addition to the accumulation of surface flow water, [2, 10]. In this case, underground and above-ground reservoirs, as a whole should represent the system providing possibility of regulation, at the expense of reserves of each other, volumes and, as a result, levels in them. It is necessary to dispose system complexes, including both underground and above-ground reservoirs, in the mountainous terrain, where the negative moments from the creation of large volumes of water are many times smaller, due to the reduced involvement of the surrounding volumes and areas in the zone of influence [11]. And whether giant structures are so advisable, if in most cases, as calculations show, the smaller volume of the reservoir located in the right place is ultimately more effective. This approach to the accumulation of water surface flow is dictated by the Black Sea coast, where the rivers are large slopes, fast current, and the valleys of many rivers, especially in the upper current, have the shape of canyons. In summer, when there is heavy precipitation, the water in the rivers can rise by 3–5 m. This is the key to the successful implementation of the concept of the integrated use of renewable water resources, for the implementation of which new technologies and their technical means are proposed [12–15].

In this paper, we consider one of the mentioned technological schemes, implemented in practice, and having good technical and economic indicators (Figure 1).



1 – waterproof barrage;
2 – aquifer of the gorge;
3 – underground reservoir;
4 – above-ground reservoir;
5 – above-ground dam;
6 – mine well;
7 – pipeline of an underground reservoir;
8 – the pipeline of the above-ground reservoir;
9 – the maximum level of the underground reservoir;
10 – the maximum level of the above-ground reservoir;
11 – the minimum level of the depression curve;
12 – minimum above-ground water level;
13 – piles

Figure 1. Technological scheme of regulation of atmospheric precipitation flow

The technological scheme (one of the proposed ones) implemented by a set of devices for regulating freshwater resources includes: a waterproof barrage 1, created, for example, by the "wall in the ground" method in the cross-section of the river valley in aquifer 2, completely overlapping in thickness and width aquifer 2. This ensures the prevention of underground flow beyond the limits of the barrage 1, the support of groundwater and favorable conditions for their accumulation in the aquifer 2 above the alignment of this barrage with the formation of an underground reservoir. Above the underground reservoir 3 is located the volume of the above-ground reservoir 4 formed by the above-ground dam 5. At the same time, the barrage 1 is located downstream of the above-ground dam 5 at a distance sufficient for the installation between the water intake well or well 6, communicated by the pipeline 7 with the volume of the above-ground reservoir 4 or with the consumer of water, for the purposes of water supply of populated areas. In turn, the volume of the above-ground reservoir 4 is communicated by the pipeline 8 with water users for irrigation purposes or with the volume of the underground reservoir 3, to regulate the water volumes in both reservoirs.

Regulation of freshwater resources by this set of devices is implemented as follows: in the high water period, inflows of underground and surface water are accumulated in the underground reservoir 3 and in the above-ground reservoir 4 due to infiltration of atmospheric precipitation and flood waters flooding part of the valley in the catchment areas of both reservoirs. Thus, provided that the inflow of groundwater exceeds the other components of the balance, in particular over the drainage from the well 6 through the pipeline 7, groundwater accumulates in the underground reservoir 3. Under the condition that overhead drainage prevails over the water intake through pipeline 8 from the above-ground reservoir 4 there is an accumulation of an above-ground flow in the above-ground reservoir 4.

In the high-water period of the year, as a result of the accumulation of fresh water in the underground reservoir 3 and above-ground reservoir 4, their level rises and corresponds to the maximum water levels: 10 in the above-ground reservoir and 9 in the underground reservoir 3.

In the initial period of low water level during the drying of the surface watercourse of the river, in the underground reservoir 3, the groundwater surface, respectively, occupies position 9, since excess water is poured through the barrage 1 and then flows along the river, and in the above-ground reservoir, the water level 4 corresponds to position 10, since excess water is discharged through a catastrophic spillway in a dam 5.

When the inflow of water into the underground reservoir 3 due to the infiltration of atmospheric precipitation decreases, a situation arises that water abstraction for drinking water supply from a well 6, through pipeline 7, exceeds the external inflow of water. In this case, the groundwater level gradually decreases and can reach the minimum marks represented by the depression curve in position 11. However, at the same time, in the initial low water period, the volume of water in the above-ground reservoir 4 remains unchanged and corresponds to its maximum values, at a water level at 10. To prevent the depression curve from falling to the minimum values of position 11, in the underground reservoir the water level is regulated by additional let-down from the above-ground reservoir 4 through the pipeline 8. The water supply from the underground source of the well 6 is oriented to the purposes of drinking water supply, through the pipeline system 7.

In the orientation of the water consumption system for irrigation, when it is necessary to have more heat, it is more rational to serve from an above-ground reservoir 4, through pipeline 8, when the inflow of water through the flow of surface waters decreases, there is a situation that the level of elevated waters gradually falls and can reach the minimum marks represented by the level "dead" volume of reservoir 12. However, at the same time, during the initial period of low water availability, the volume of water in the underground reservoir 3 located under the above-ground reservoir 4 remains unchanged and corresponds to its maximum values. In order to prevent a drop in the water level in the above-ground reservoir 4 to a "dead" volume corresponding to the level 12, an outlet of water from the underground reservoir 3 through the pipeline system 7 through a well 6 is carried out to the above-ground reservoir 4.

SRFAP provides seasonal work, which consists in the accumulation of precipitation on the Black Sea coast in the underground and aboveground reservoirs in the high water periods of the year (winter, spring) before the low-water period (summer). In the high water period, atmospheric precipitation, as well as geologically unconnected groundwater, will accumulate in the underground and above-ground reservoirs. Specific climatic conditions with the presence of a temperature difference and high humidity contribute to the accumulation of water in the atmosphere and the formation of particles of water vapor even in the summer warm period. At the onset of a low-water period (summer) and the orientation of the system for the purposes of drinking water supply, water is piped to the consumer from the underground reservoir. When orienting the water consumption system for irrigation, when warmer water is needed, water is supplied from the above-ground reservoir. When the demand for water for drinking water supply purposes or in irrigation water increases, it is possible to redistribute volumes between underground and above-ground reservoirs.

The volume of reservoirs is calculated on the basis of the need for water and, if possible, the gorge to place reservoirs. SRFAP can be a cascade of reservoirs located one above the other or one after another. It is planned to build reservoirs with a capacity of about 200000 m^3, while it should be noted that this resource will be periodically replenished. The average demand of the Gelendzhik during the holiday period is 1647000 m^3 of fresh water. Thus, it is necessary to install 8 similar reservoirs capable of providing the city in a shallow period.

From the presented set of devices implementing the described technology, in this work for a more detailed analysis, an above-ground dam was chosen [16]. The above-ground dam in the plan has a complex broken form, which is explained by the need to fit into the relief conditions of the real gorge.

2.1. Mathematical modeling of the "foundation-dam" system

To analyze the joint work of the dam and the foundation, mathematical modeling of the stress-strain state of the foundation-dam system takes into account the different level of filling of the seasonal regulation basin and the effect of the seismic load on the structure described in [17–19].

Classical approaches to the calculation of hydraulic structures on rock bases are reduced to calculating the dam in the transverse direction - 1 m. wide. The main loads for the dam are:

- own weight of the dam;
- load from the water pressure;
- load from seismic action.

The calculation is carried out for the worst stage of operation of the hydraulic structure, which corresponds to the operation of the structure with the maximum water level from the upstream side. The carrying capacity is reduced to the fulfillment of the condition:

$$\gamma_n \gamma_{fc} \sigma \leq \gamma_c R, \tag{1}$$

where σ – stress in concrete,

R – design resistance of concrete.

The stability of the dam against shear is based on the condition:

$$\gamma_n \gamma_{fc} F \leq \gamma_c Q, \tag{2}$$

where F – the sum of the shifting (horizontal forces);

Q – shear load capacity.

$\gamma_n, \gamma_{fc}, \gamma_c$ – coefficients of reliability, combinations of loads and operating conditions.

However, this calculation does not fully take into account the geometry of the body of the dam during construction in difficult construction conditions. In this regard, for a more accurate analysis of the operation of structures such SRFAP (systems for regulating the flow of atmospheric precipitation) located in the mountainous conditions of construction, it is necessary to model the work of the structure in a 3D setting [20].

In the SRFAP facilities, in contrast to the classical hydraulic structures in which the pile field is used as a reinforcement of the foundation, the pile foundation SRFAP directly participates in the perception of shearing horizontal forces, thereby increasing the economic efficiency of construction [21, 22].

An integral feature of the SRFAP is the tightness of the bowl, which excludes filtration effects that are unavoidable under certain engineering and geological conditions, such as the foothill and mountainous areas of the Black Sea coast of the Krasnodar region, represented by eluvial soils of the fissured zone - marls and clay marls with layers of clay limestone, or similar soils.

In the example below, consider the mathematical 3D modeling of structures with the analysis of the stress-strain state (SSS) of the “foundation-dam” system.

The calculation is carried out for the worst stage of the work of the SRFAP, which corresponds to the operation of facilities with the maximum water level from the upstream dam of the above-ground dam.

Modeling of the design work in 3D setting [20] is carried out in the following sequence.

Source data:

- estimated seismicity of the construction site – 8 points;
- soil category in accordance with (Russian Set of Rules SP14.13330.2014) - II;
- building responsibility level – CS-2 (Russian State Standard GOST 27751-2014).

Constructive decisions

- the construction is designed in the form of a monolithic reinforced concrete structure 0.5 m thick with reinforcement in the form of buttresses 0.3 m thick.
- the foundation is designed by a pile, united by a grillage. The cross-section of reinforced concrete grate b*h = 4.1*0.8m, made of concrete of class in strength B25.

Collecting loads:

- the own weight of the structures is included in a separate load with a reliability factor for the load $\gamma_f = 1.1$, and is calculated automatically.
- with the horizontal direction of seismic action, the attached weight of water per unit area of the wall is determined by the formula:

$$m_w = \rho_w h \mu \psi, \tag{3}$$

where ρ_w – density of water;

h – water depth at the structure;

μ – dimensionless coefficient of the added mass of water, determined according to Table 14 of CP 14.13330.2014;

ψ – coefficient that takes into account the limited length of the reservoir and is assumed to be $l/h \geq 3$ equal to 1, and for $l/h < 3$ – according to Table 15 CP 14.13330.2014;

l – distance between the structure and the opposite shore of the reservoir at a depth of 2/3 h from the free surface of the water.

The collection of loads for the construction is summarized in Table 1.

Table 1. Collecting loads on the structure

Type of load	Normativeload	Coefficient reliability	Designload, kN/m^2
Own weight	2.5 kN/m^3	1.1	2.75
Hydrostatic	100 kN/m^2	1.0	100
Hydrodynamic	25.0kN/m	1.0	25.0

The hydrodynamic load is also determined in accordance with Russian Set of Rules SP 14.13330.2014

The present calculation was carried out using a multifunctional software package for calculating, researching and designing structures for various purposes "StarkES", version 2018. The calculation model describes in detail the structural design of the facility, taking into account ground conditions. The purpose of the calculation is to obtain data for the construction of all the main structural support elements.

The design model of the structure in the form of reinforced concrete overhead dam with buttresses is shown in Figure 2.

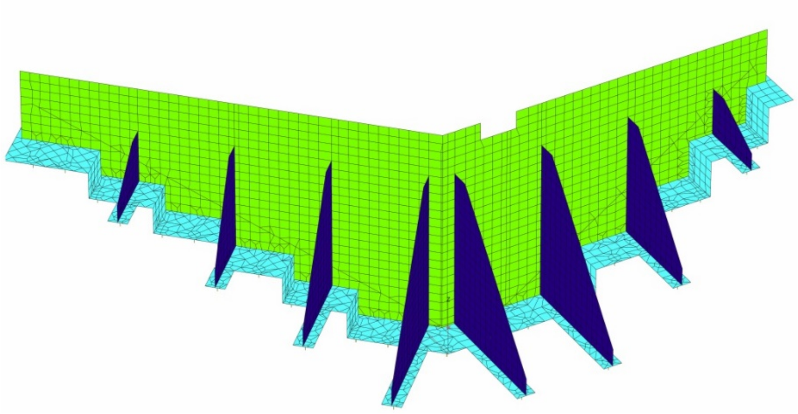


Figure 2. The settlement model of the structure

2.2. Dynamic analysis (calculation of eigenvalues)

Calculation of natural oscillations was carried out for a monolithic reinforced concrete structure of an overground reservoir. For calculation and analysis of the system, a study of 100 eigenvalues is given, the results are presented in tables and in the figures below [23].

The results of calculation for natural oscillations are summarized in Tables 2 and 3. Table 2 presents a dangerous direction of seismic action for translational action, found by the results of solving the optimization problem. Table 3 selectively presents the direction cosines (orientation) of the forms for translational action [24].

Table 2. Dangerous direction of seismic action

Numberofownforms	Anglewith OX axis	Anglewith XOY plane
23	60.264	0.000

Table 3. Orientation of forms for progressive impact

Direction	Form	OX	OY	OZ
1	1	0.038	0.999	0.000
2	2	-0.965	0.264	0.000
3	3	0.811	0.586	0.000
10	10	-0.061	-0.994	-0.093
11	11	0.998	-0.066	0.016
12	12	0.999	-0.024	-0.019
21	21	0.999	0.003	-0.002
22	22	-0.003	0.999	0.002
23	23	0.000	-0.001	0.999
worst-casedirection		0.496	0.868	0.000

Figures 3, 4 and 5 show the first three, the most characteristic and essential for analysis, forms of natural oscillations.

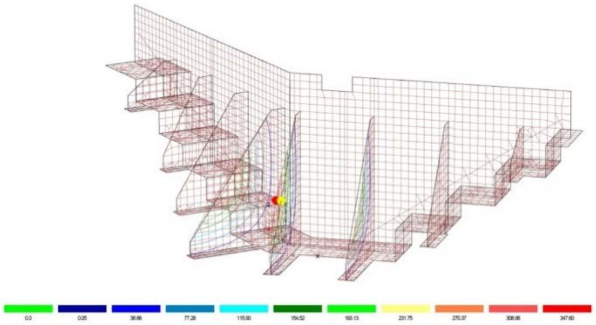


Figure 3. The first form ofnatural oscillations

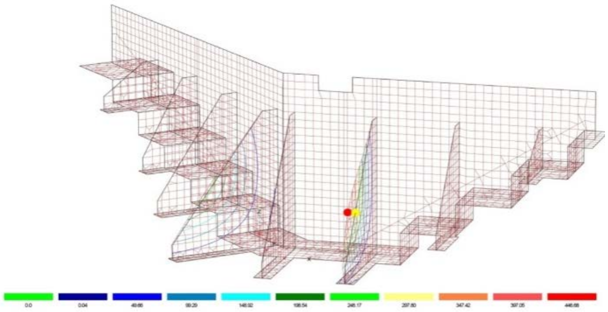


Figure 4. The second form of natural oscillations

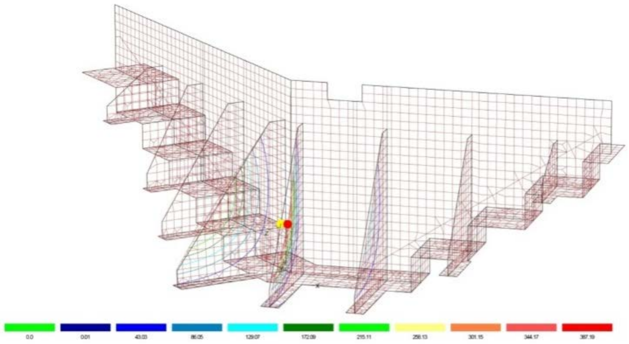


Figure 5. Third form of natural oscillations

Analysis of the information presented in Figures 3, 4 and 5 allows us to state that practically all maximum displacements in the body of the structure are concentrated in buttresses and in those of them located at the point of fracture of the axis of the dam [25].

2.3. Static analysis

In the static calculation, the following loads are involved:

1 – constant design load;

2 – hydrostatic pressure;

3 – hydrodynamic pressure;

4–12 – seismic action in the 1-st direction;

13–20 – seismic action in the 2-nd direction;

21–30 – seismic action in the worst direction.

While making calculations for the selection of armatures in the program "StarkES" the following algorithm is used. First, calculation combinations of forces (CCF) are calculated in the nodes of the finite element grid, then the calculated values of the CCF are used for armatures selection**.** Coefficients of combinations for each loading the program determines automatically, depending on what load corresponds to this loading (constant, long, short, special) and by what combination of forces this CCF (the main or special combination) is calculated. The selection of the required theoretical armature is made in the constructing system of reinforced concrete structures.

Table 4 shows the protocol of the preset parameters of the CCF for the calculation of reinforced concrete elements.

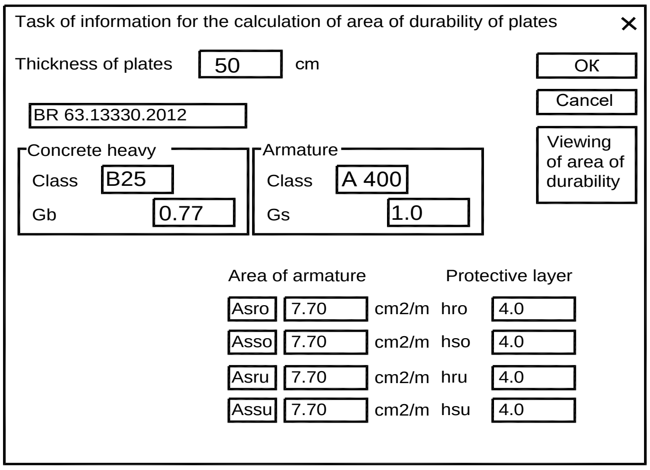
Table 4. The protocol of the given parameters of the calculated combinations of forces

impact	Load-ings	Impacttype		K_N	K_D	+/-	Seismic	Wind	Groupsof incompatible	Groupsofat tendant
1	1	Permanent	v	1.1	-					
		Permanent	v	1	-					
		Particularlystrong	v	1	0					1–3
		Particularlyseismic	v	1	0	v	4;9;1;0		1	1
		Particularlyseismic	v	1	0	v	13;8;1;0		1	2
		Particularlyseismic	v	1	0	v	21;10;1;0		1	3

3. Results and Discussion

3.1. Assessment of load-bearing capacity

We will perform a preliminary analysis of the structure by means of calculating the load-bearing capacity [25]. The parameters of the initial data for the calculation of vertical structures are shown in Figure 6.



Task of information for the calculation of area of durability of plates

Thickness of plates 50 cm

BR 63.13330.2012

Concrete heavy
Class B25
Gb 0.77

Armature
Class A 400
Gs 1.0

Area of armature / Protective layer
Asro 7.70 cm2/m hro 4.0
Asso 7.70 cm2/m hso 4.0
Asru 7.70 cm2/m hru 4.0
Assu 7.70 cm2/m hsu 4.0

BR – build rules

Figure 6. The data set for calculation

The calculation results for estimating the bearing capacity of the vertical pressure part of the structure are shown in Figure 7. The results of the calculation of the load capacity of the buttresses of the structure are shown in Figure 8.

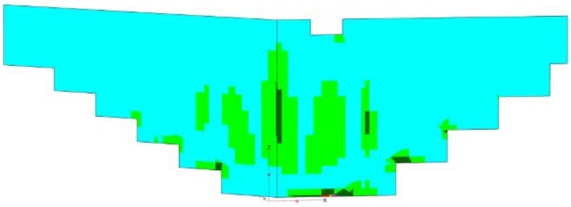


Figure 7. Evaluation of the bearing capacity of the vertical head

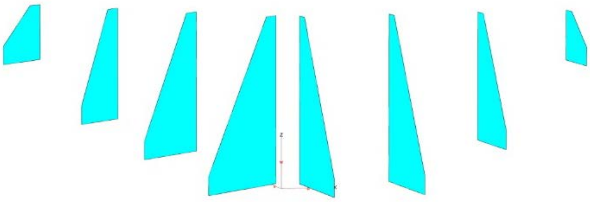
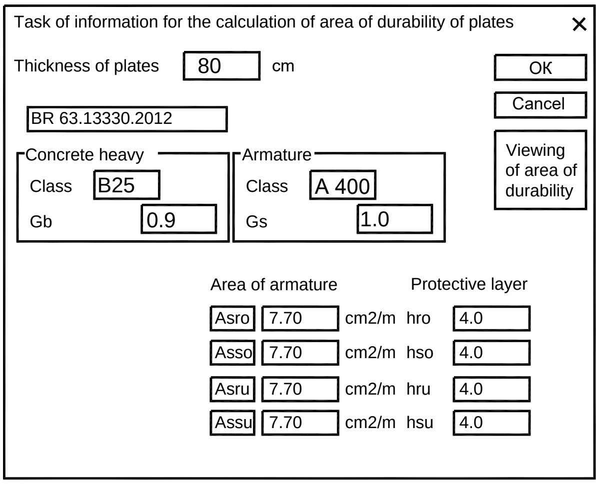


Figure 8. Assessment of buttresses carrying capacity

The parameters of the original data to calculate the horizontal structures of a building are shown in Figure 9.



Task of information for the calculation of area of durability of plates

Thickness of plates 80 cm

BR 63.13330.2012

Concrete heavy
Class B25
Gb 0.9

Armature
Class A 400
Gs 1.0

Area of armature / Protective layer
Asro 7.70 cm2/m hro 4.0
Asso 7.70 cm2/m hso 4.0
Asru 7.70 cm2/m hru 4.0
Assu 7.70 cm2/m hsu 4.0

BR – build rules

Figure 9. The data set for calculation

The results of the calculation of the load-bearing capacity of the grillage of a monolithic structure are shown in Figure 10.

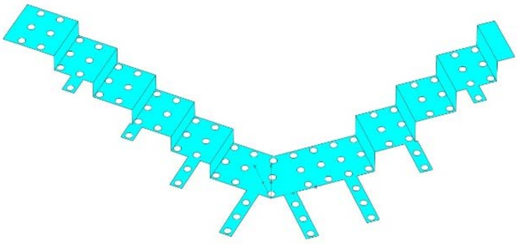
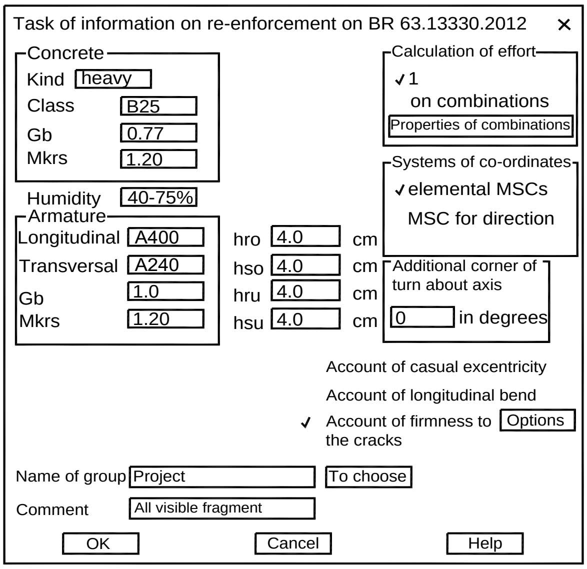


Figure 10. Estimation of bearing capacity of grillage of a structure

3.2. Determination of the degree of reinforcement

The calculation to determine the degree of reinforcement of flat reinforced concrete elements of the structure is made in accordance with the requirements of Russian Set of Rules SP 63.13330.2012. The parameters of the initial data for reinforcing the flat vertical elements of the structure are shown in Figure 11.



Task of information on re-enforcement on BR 63.13330.2012 ×

Concrete
Kind heavy
Class B25
Gb 0.77
Mkrs 1.20
Humidity 40-75%

Armature
Longitudinal A400
Transversal A240
Gb 1.0
Mkrs 1.20

hro 4.0 cm
hso 4.0 cm
hru 4.0 cm
hsu 4.0 cm

Calculation of effort
✓ 1
on combinations
Properties of combinations

Systems of co-ordinates
✓ elemental MSCs
MSC for direction

Additional corner of turn about axis
0 in degrees

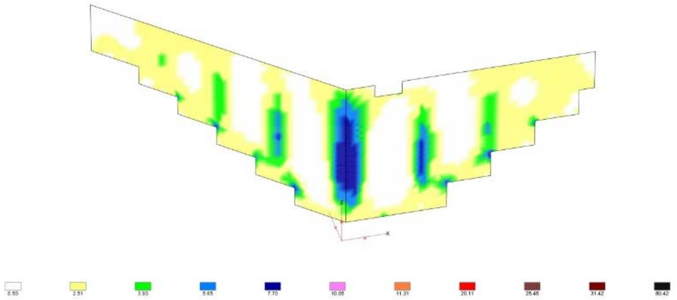
Account of casual excentricity
Account of longitudinal bend
✓ Account of firmness to the cracks Options

Name of group Project To choose
Comment All visible fragment

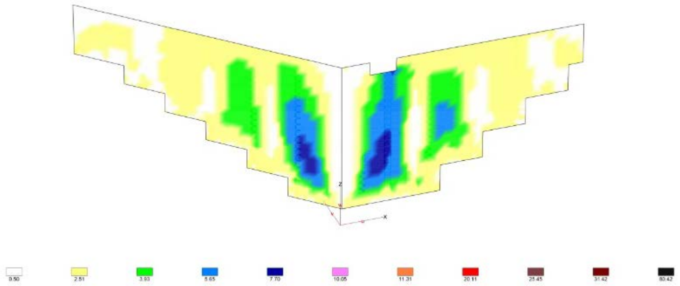
OK Cancel Help

1 – by a calculation combination of efforts
BR – build rules
Figure 11. The data set for calculation

The results of calculating the reinforcement of the vertical pressure part of the structure are selectively presented in Figures 12 and 13. Calculations show that, on the whole, the design of the vertical discharge part of the structure has been chosen correctly, since virtually the same reinforcement is required throughout the calculation. Although, of course, the fracture along the axis of the dam could not but affect the distribution of stresses in the televertical pressure section of the structure and, as a consequence, in the additional reinforcement of the parts of the structure immediately adjacent to the fracture of the axis of the dam.



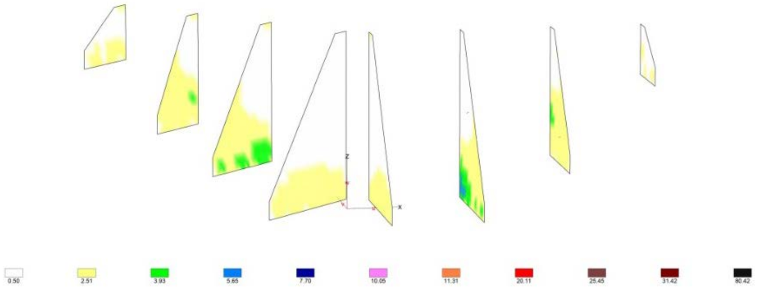
Calculation by DCS – the minimum reinforcement area of the upper zone in the direction of the "r" axis Asro = 0 cm^2/m, the maximum reinforcement area of the upper zone in the direction of the "r" axis Asro = 8.91145 cm^2/m
Figure 12. Upper reinforcement along



Calculation by DCS – minimum reinforcement area of the lower zone in the direction of the "r" axis Asru = 0 cm^2/m, maximum reinforcement area of the lower zone in the direction of the "r" axis Asru = 6.95308 cm^2/m

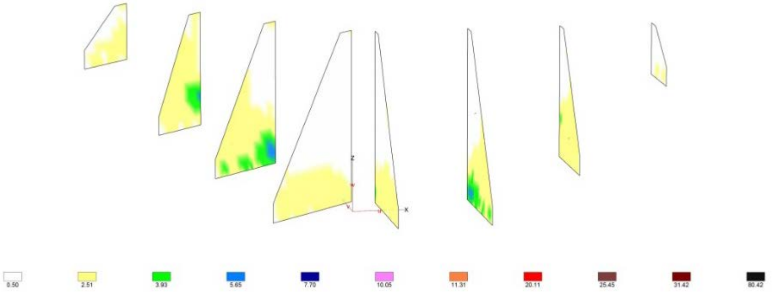
Figure 13. Lower reinforcement along the "r" axis

The results of calculating the reinforcement of the buttresses of the structure are selectively presented in Figures 14 and 15.



Calculation by DCS – the minimum reinforcement area of the upper zone in the direction of the "r" axis Asro = 0 cm^2/m, the maximum reinforcement area of the upper zone in the direction of the "r" axis Asro = 5.88102 cm^2/m

Figure 14. The upper reinforcement along the "r"

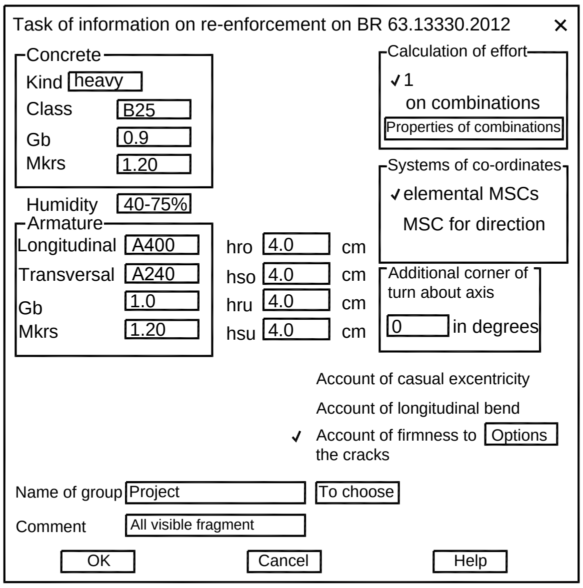


Calculation by DCS – minimum reinforcement area of the lower zone in the direction of the "r" axis Asru = 0 cm^2/m, maximum reinforcement area of the lower zone in the direction of the "r" axis Asru = 6.92081 cm^2/m

Figure 15. Lower reinforcement along the "r" axis

Calculations show that on the whole the designs of the buttresses of the above-ground dam are chosen and distributed correctly throughout the body, since they require practically the same reinforcement everywhere. Although, of course, the fracture along the axis of the dam and the base of the buttresses, which take practically the main load, could not but affect the distribution of stresses in these elements of the structures and their parts. As a consequence, additional reinforcement of the parts of the structure immediately adjacent to the fracture of the dam axis and at the base of the buttresses is required.

The parameters of the initial data for calculating the reinforcement of flat horizontal elements are shown in Figure 16.



Task of information on re-enforcement on BR 63.13330.2012

Concrete
Kind: heavy
Class: B25
Gb: 0.9
Mkrs: 1.20

Humidity: 40-75%

Armature
Longitudinal: A400
Transversal: A240
Gb: 1.0
Mkrs: 1.20

hro: 4.0 cm
hso: 4.0 cm
hru: 4.0 cm
hsu: 4.0 cm

Calculation of effort
✓ 1
on combinations

Systems of co-ordinates
✓ elemental MSCs
MSC for direction

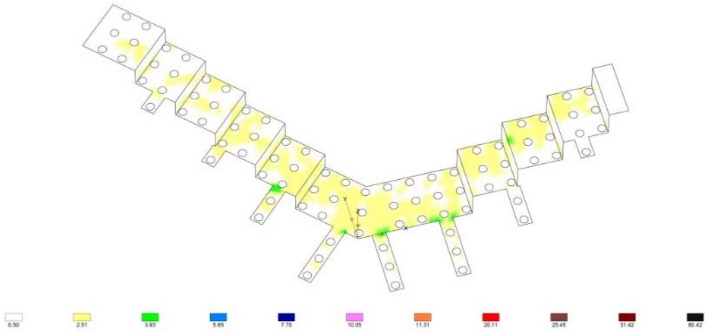
Additional corner of turn about axis: 0 in degrees

Account of casual excentricity
Account of longitudinal bend
✓ Account of firmness to the cracks

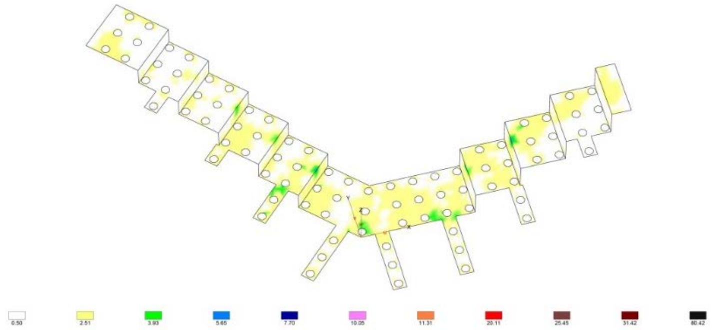
Name of group: Project
Comment: All visible fragment

1 – by a calculation combination of efforts
BR – buildrules
Figure 16. The data set for calculation

The results of calculating the reinforcement of the grillage of the structure are selectively presented in Figures 17 and 18.



Calculation by DCS – the minimum reinforcement area of the upper zone in the direction of the "r" axis.Asro = 0 cm^2/m, the maximum reinforcement area of the upper zone in the "r" axis direction Asro = 3.46899 cm^2/m
Figure 17. The upper reinforcement



Calculation by DCS – minimum reinforcement area of the lower zone in the direction of the "r" axis Asru = 0 cm^2/m, maximum reinforcement area of the lower zone in the "r" axis direction Asru = 6.0713 cm^2/m
Figure 18. Lower reinforcement along the "r" axis

Calculations show that, as a whole, the design of the grillage of the structure was chosen correctly, since it requires the calculation of practically the same reinforcement.

3.3. Calculation of movements

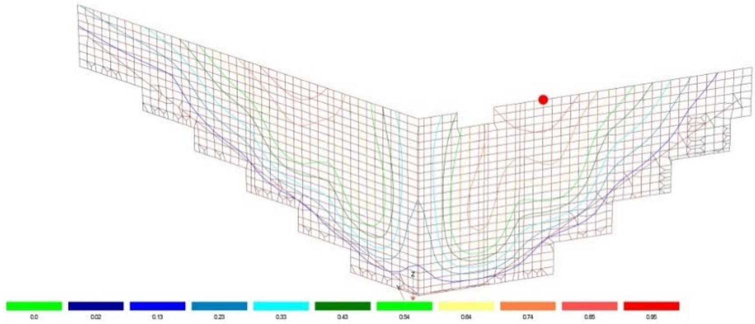
Figure 19 shows the complete displacement of the Utot vertical discharge part of the structure, according to the first combination of loads, defined by the formula:

$$\mathrm{Utot} = \sqrt{Ux^2 + Uy^2 + Uz^2}, \qquad (4)$$

where: Ux – movement along the axis OX;

Uy – movement along the axis OY;

Uz – movementalong the OZ axis.

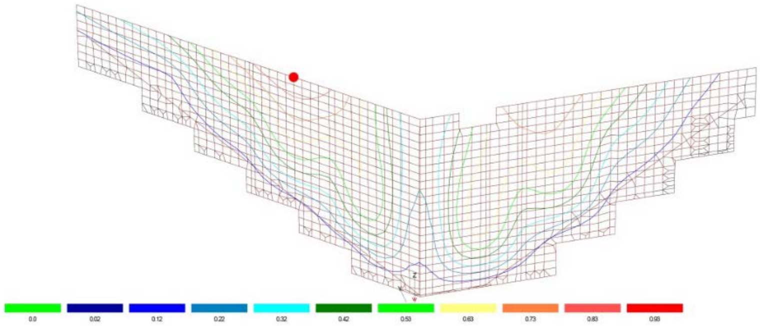


Combination 1 – maximum movement is 0.99 mm at node 1449

Figure 19. Maximum movement of the structure with the main combination of loads

Analysis of the maximum movement of the vertical head of the structure with the main combination of loads is 0.99 mm at node 1449, which fully meets the regulatory requirements.

Figure 20 shows the complete movement of the vertical head of the structure, according to the third combination of loads, which corresponds to the maximum total displacement with a special combination of loads.



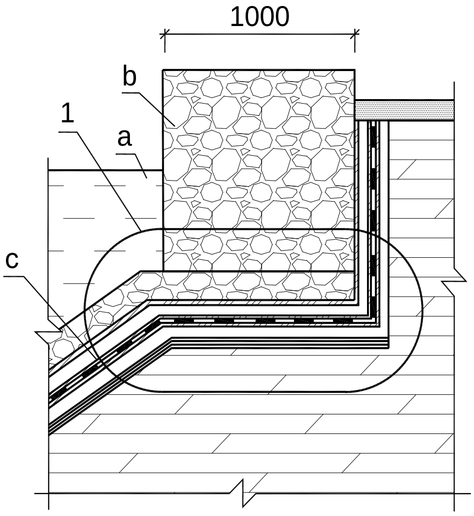
Combination 3 – maximum displacement is 1.42 mm at node 1882

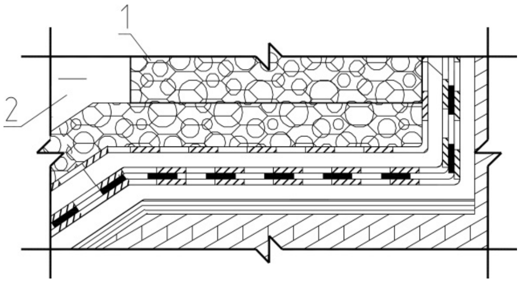
Figure 20. The maximum movement of the structure with a special combination of loads

Analysis of the maximum movement of the vertical head of the structure with a special combination of loads is 1.42 mm at the site of 1882, which fully meets the regulatory requirements.

The absence of an obvious alternative to the proposed method of accumulation of atmospheric precipitation on the Black Sea coast of the Caucasus, and also considering that the constructive and technological solution for the creation of above- and underground dams is pioneering, we took every project step as thoroughly as possible. The volume setting of the calculation program in 3D allowed us to establish that the results obtained are in good agreement with the results of calculations of similar or close to them problems [17, 23–26]

Based on the calculations carried out, a working project was developed. In the design of control systems for the flow of atmospheric precipitation, in order to exclude the filtration of accumulated water [27, 28], advanced technical solutions in the field of construction chemistry, namely anti-filtration membranes, such manufacturers as Techno Nicole, Sika, BASF were used. On the basis of the expected positive effects, Sika materials are used on the site. We also developed specific structural schemes and nodes for waterproofing, as shown in Figure 21.





Structure of the design from the top down: mattress Renault - 170 mm; canvas made of geotextile; sand - 100 mm; canvas made of geotextile; TPO membrane - 1.8 mm; canvas made of geotextile; sand - 100 mm; clay - 50 mm

1 - water; 2 - gabion 1*1*1.5; 3 - membrane

1. Gabion 1*1*1.5*2. Water

Figure 21. Nodes of waterproofing above-ground reservoir

The project provides for laying technology with mechanical fastening or with ballast, in accordance with the technological regulations for laying waterproofing membranes, recommendations for welding lap seams with the help of electric welding equipment, hot air welding machines and manual welding machines, using rolling rollers, with the possibility regulation of air temperature not less than +600 °C.

Figures 22 and 23 show fragments of the final stage of construction of a system for regulating the flow of atmospheric precipitation on the Black Sea coast of the Krasnodar region.


a)
b)

Figure 22. View of the above-ground reservoir from the downstream side at completion of construction

Figure 23. A view of the above-ground reservoir from the upstream side while performing the works of waterproofing

Developed and introduced in the production of control systems for the flow of atmospheric precipitation with their wide distribution will allow to provide accumulated water resources in the droughty period of the year, the population and tourists, enterprises of the industrial and agricultural industries, which in turn will increase the influx of tourists, the volume and quality of the products and, as a result, will lead to the economic growth of the Krasnodar region [29].

4. Conclusions

1. A system for regulating the flow of atmospheric precipitation (SRFAP) has been developed, which includes underground and above-ground reservoirs arranged in the mountainous terrain, providing the possibility of regulating the volumes and, as a consequence, the water levels due to each other reserves.

2. For the analysis of the joint work of the dam construct and base, mathematical modeling of the stress-strain state of the "foundation-dam" system was carried out, taking into account the different level of filling of the seasonal regulation basin and the effect of the seismic load on the structure. Simulation of the design work is done in a 3D setting. Dynamic analysis (calculation of eigenvalues) and analysis of seismic action are carried out.

3. The load bearing capacity of the SRFAP dam structures is estimated and the degree of reinforcement is determined, as a result of which it is established that the proposed construction meets the regulatory requirements.

4. Based on the calculations, a working draft of SRFAP was developed.

5. The developed SRFAP designs are put into production on the Black Sea coast of the Krasnodar region and allow the accumulation of fresh water and use it in the summer-autumn period. The proposed system for regulating atmospheric runoff can find application in other regions of the mountain-foothill zone, for example, in the countries of Central Asia.

References

1. Belyakova, P.A., Borshch, S.V., Khristoforov, A.V., Yumina, N.M. Veroyatnostnoye prognozirovaniye maksimalnykh raskhodov i urovney vody i kriticheskikh osadkov na rekakh Chernomorskogo poberezhya Kavkaza [Probabilistic forecasting of maximum flow rates and water levels and critical precipitation on the rivers of the Black Sea coast of the Caucasus]. Trudy Gidromettsentra Rossii. 2013. No. 349. Pp. 104–121. (rus)
2. Begich, Y.E., Sherstobitova, P.A., Morina, E.A., Makarov, A.I Methods of management of environmental sources in Europe and the possibility of their application in the city of St. Petersburg. Construction of Unique Buildings and Structures. 2018. No. 2(65). Pp. 59–76. (rus)
3. Murgulet, D., Murgulet, V., Spalt, N., Douglas, A., Hay, R.G. Impact of hydrological alterations on river-groundwater exchange and water quality in a semi-arid area: Nueces River, Texas, Science of the Total Environment. 2016. Vol. 572. Pp. 595–607.
4. Vatin, N., Lavrov, N., Shipilov, A. The water intake facility for diversion HPPs in winter operation conditions in an urban area. Procedia Engineering. 2015. Vol. 117(1). Pp. 374–380.
5. Vatin, N., Lavrov, N., Loginov, G., Processes at Water Intake from Mountain Rivers into Hydropower and Irrigation System. MATEC Web of Conferences. 2016. Vol. 73. art. no. 01006. DOI: 10.1051/matecconf/20167301006
6. Gaborit, E., Anctil, F., Pelletier, G, Vanrolleghem, P. Exploring forecast-based management strategies for stormwater detention ponds. Urban Water Journal. 2016. Vol. 13. Pp. 841–851.
7. Sakthivadivel, R. The groundwater recharge movement in India. The agricultural groundwater revolution: Opportunities and threats for development, Wallingford, UK: CABI. Pp. 196–210.
8. Sharma, K.D. Groundwater management for food security. Current Science. 2009. Vol. 96(11).
9. Tuinhof, A., Olsthoom, T., Heederik, S.P., De Vries, J. Management of aquifer recharge and subsurface storage.

Литература

1. Белякова П.А., Борщ С.В., Христофоров А.В., Юмина Н.М. Вероятностное прогнозирование максимальных расходов и уровней воды и критических осадков на реках Черноморского побережья Кавказа // Труды Гидрометцентра России. 2013. № 349. С. 104–121.
2. Бегич Я.Э., Шерстобитова П.А., Морина Е.А., Макаров А.И. Методы управления источниками поверхностного стока в странах Европы и возможность их применения в Санкт-Петербурге // Строительство уникальных зданий и сооружений. 2018. № 2(65). С. 59–70.
3. Murgulet D., Murgulet V., Spalt N., Douglas A., Hay R. G. Impact of hydrological alterations on river-groundwater exchange and water quality in a semi-arid area: Nueces River, Texas // Science of the Total Environment. 2016. Vol. 572. Pp. 595–607.
4. Vatin N., Lavrov N., Shipilov A. The water intake facility for diversion HPPs in winter operation conditions in an urban area // Procedia Engineering. 2015. Vol. 117(1). Pp. 374–380.
5. Vatin N., Lavrov N., Loginov G., Processes at Water Intake from Mountain Rivers into Hydropower and Irrigation System // MATEC Web of Conferences. 2016. Vol. 73. art. no. 01006. DOI: 10.1051/matecconf/20167301006
6. Gaborit E., Anctil F., Pelletier G, Vanrolleghem P. Exploring forecast-based management strategies for stormwater detention ponds // Urban Water Journal. 2016. 13, 2016. Pp. 841–851.
7. Sakthivadivel R. The groundwater recharge movement in India // The agricultural groundwater revolution: Opportunities and threats for development, Wallingford, UK: CABI. Pp. 196–210.
8. Sharma K. D. Groundwater management for food security // Current Science 96 (11). 2009
9. Tuinhof A., Olsthoom T., Heederik S.P., De Vries J. Management of aquifer recharge and subsurface storage. A promising option to cope with increasing storage needs // Management of aquifer recharge and subsurface storage. 2002

A promising option to cope with increasing storage needs. Management of aquifer recharge and subsurface storage. 2002.

10. Caughey, S.J., Kitchen, M., Leighton, J.R. Turbulence Structure in Convective Boundary Layers and Implications for Diffusion. Boundary-Layer Meteor. 1983. Vol. 25. No. 4. Pp. 345–352.
11. Jeng, D.-S., Seymour, B.R., Barry, D.A., Li, L., Parlange, J.-Y. New approximation for free surface flow of groundwater: capillarity correction. Advance in water recourses. 2005. Vol. 28. Pp. 1032–1039.
12. Degtyareva, O.G., Degtyarev, G.V. Ustroystvo dlya regulirovaniya zapasov podzemnykh vod [The method of regulation of groundwater accumulation]. Patent Russia no. 2569004, 2015. (rus)
13. Degtyareva, O.G., Degtyarev, G.V. Sposob regulirovaniya zapasov podzemnykh vod [The method of groundwater reserves]. Patent Russia no. 2569035, 2015. (rus)
14. Degtyareva, O.G. Sposob regulirovaniya nakopleniy podzemnykh vod [The method of regulation of groundwater accumulation]. Patent Russia no. 2618336, 2017. (rus)
15. Degtyareva, O.G., Degtyarev, V.G. Ustroystvo dlya regulirovaniya zapasov presnykh vod [Device for regulating freshwater]. Patent Russia no. 2621258, 2017. (rus)
16. Moss, B., Johnes, P., Phillips, G. The monitoring of ecological quality and the classification of standing waters in temperate regions. Biol. Rev. 1996. Vol. 71. No. 2. Pp. 301–339.
17. Degtyareva, O., Degtyarev, G., Togo, I., Terleev, V., Nikonorov, A., Volkova, Yu. Analysis of stress-strain state rainfall runoff control system-buttress dam. Procedia Engineering. 2016. Vol. 165. Pp. 1619–1628.
18. Reidar N., Olsen B. Numerical modelling and hydraulics, Department of Hydraulic and Environmental Engineering the Norwegian University of Science and Technology. 2012. No. 3. 157 p.
19. Zolezzi, G, Seminara, G. Downstream and upstream influence in river meandering. General theory and application to over depening. Part 1. J. Fluid Mech. 2001. Pp. 183–211.
20. Yuan, W. Simulation der Saugrohr-Unterwasser-Wechselwirkung, Düsseldorf: VDI Verl, Cop. XII. 2000. 119 p.
21. He, S., Gotts, J.A. Calculation of Friction Coefficients for Noncircular Channels. J. Fluids Eng. 2004. Vol. 126. Pp. 986–992.
22. Shimizu, Y., Futaki, Y., Martin, C.S. Secondary Flow and Hydraulic Losses Within Sinuous Conduits of Rectangular Cross Section. J. Fluids Eng. 1992. Vol. 114. Pp. 426–434.
23. Degtyareva, O.G., Datso, D.A., Degtyarev, G.V., Gumbarov, A.D. Modelirovaniye v SAE sisteme osadki plitnogo fundamenta nizkonapornoy plotiny [Modeling in the CAE system for the sludge foundation of a low-pressure dam foundation]. Trudy Kubanskogo gosudarstvennogo agrarnogo universiteta. 2017. No. 1(64). Pp. 221–227. (rus)
24. Degtyareva, O.G. Matematicheskiy analiz kontrforsnoy plotiny pri termicheskikh vozdeystviyakh kak chasti sistemy regulirovaniya stoka atmosfernykh osadkov [Mathematical analysis of the buttress dam during thermal effects as part of the system for regulating the flow of precipitation]. Trudy Kubanskogo gosudarstvennogo agrarnogo universiteta. 2016. No. 5(62). Pp. 165–171. (rus)
25. Degtyareva, O.G. Issledovaniye zhestkostnykh kharakteristik gravitatsionnoy i kontrforsnoy plotin posredstvom analiza sobstvennykh kolebaniy [Investigation of stiffness characteristics of gravity and counterforce dams by means of analysis of natural oscillations]. Trudy Kubanskogo gosudarstvennogo agrarnogo universiteta. 2016. No. 6(63). Pp. 138–144. (rus)
26. Sainov, M.P. Analysis of normal operation of a rockfill dam with combination of seepage-control elements: reinforced

10. Caughey S.J., Kitchen M., Leighton J.R. Turbulence Structure in Convective Boundary Layers and Implications for Diffusion // Boundary-Layer Meteor. 1983. Vol. 25. № 4. Pp. 345–352.
11. Jeng D.-S., Seymour B.R., Barry D.A., Li L., Parlange J.-Y. New approximation for free surface flow of groundwater: capillarity correction // Advance in water recourses. 2005. Vol. 28. Pp. 1032–1039.
12. Пат. 2569004 Российская Федерация, МПК E03B 3/32, E03B 3/06. Устройство для регулирования запасов подземных вод / Дегтярева О.Г., Дегтярев Г.В.; заявитель и патентообладатель Кубанский государственный аграрный университет (RU). N 2014134653/13; заявл. 25.08.2014; опубл. 20.11.2015, Бюл. N 32. 5 с.
13. Пат. 2569035 Российская Федерация, МПК E03B 3/32, E03B 3/06. Способ регулирования запасов подземных вод / Дегтярева О.Г., Дегтярев Г.В.; заявитель и патентообладатель Кубанский государственный аграрный университет (RU). N 2014134991/13; заявл. 26.08.2014; опубл. 20.11. 2015, Бюл. N 32. 5 с.
14. Пат. 2618336 Российская Федерация, МПК E03B 3/32, E03B 3/06. Способ регулирования накоплений подземных вод / Дегтярева О. Г.; заявитель и патентообладатель Кубанский государственный аграрный университет (RU). N 2016124555; заявл. 20.06.2016; опубл. 03.05.2017, Бюл. N 13. – 5 с.
15. Пат. 2621258 Российская Федерация, МПК E03B 3/32, E03B 3/06. Устройство для регулирования запасов пресных вод / Дегтярева О. Г., Дегтярев В. Г.; заявитель и патентообладатель Кубанский государственный аграрный университет (RU). N 2016124446; заявл. 20.06.2016; опубл. 01.06.2017, Бюл. N 16. 5 с.
16. Moss B., Johnes P., Phillips G. The monitoring of ecological quality and the classification of standing waters in temperate regions // Biol. Rev. 1996. Vol. 71. № 2. Pp. 301–339.
17. Degtyareva O., Degtyarev G., Togo I., TerleevV., Nikonorov A., Volkova Yu. Analysis of stress-strain state rainfall runoff control system-buttress dam // Procedia Engineering. 2016. Vol. 165. Pp. 1619–1628.
18. Reidar N, Olsen B. Numerical modelling and hydraulics. Department of Hydraulic and Environmental Engineering the Norwegian University of Science and Technology. No 3. 2012. 157 p.
19. Zolezzi G, Seminara G. Downstream and upstream influence in river meandering. General theory and application to over depening. Part 1 // J. Fluid Mech. 2001. Pp. 183–211.
20. Yuan W. Simulation der Saugrohr-Unterwasser-Wechselwirkung, Düsseldorf: VDI Verl, Cop. XII. 2000. 119 p.
21. He S., Gotts J.A. Calculation of Friction Coefficients for Noncircular Channels // J. Fluids Eng. 126, 2004. Pp.986–992.
22. Shimizu Y., Futaki Y., Martin C. S. Secondary Flow and Hydraulic Losses Within Sinuous Conduits of Rectangular Cross Section // J. Fluids Eng. 1992. Vol. 114. Pp. 426–434.
23. Дегтярева О.Г., Дацьо Д.А., Дегтярев Г.В., Гумбаров А.Д. Моделирование в CAE системе осадки плитного фундамента низконапорной плотины // Труды Кубанского государственного аграрного университета. 2017. № 1(64). С. 221–227.
24. Дегтярева О.Г. Математический анализ контрфорсной плотины при термических воздействиях как части системы регулирования стока атмосферных осадков // Труды Кубанского государственного аграрного университета. 2016. № 5(62). С. 165–171.
25. Дегтярева О.Г. Исследование жесткостных характеристик гравитационной и контрфорсной плотин посредством анализа собственных колебаний // Труды

concrete face and a clay-cement-concrete wall. Magazine of Civil Engineering. 2016. No. 4. Pp. 3–9. doi: 10.5862/MCE.64.1

27. Foster, T.D. The hierarchy of convection. Colloques Internationaux du CNRS. N 215. Processus de Formation Des Eaux Oceaniques Profondes. 1974. Pp. 235–241.
28. Terleev, V.V., Nikonorov, A.O., Ginevsky, R.S., Lazarev, V.A., Togo, I., Topaj, A.G., Moiseev, K.G., Pavlova, V.A., Layshev, K.A., Arkhipov, M.V., Melnichuk, A.Yu., Dunaieva, I.A., Mirschel, W. Hysteresis of the soil water-retention capacity: estimating the scanning branches. Magazine of Civil Engineering. 2018. No. 1. Pp. 141–148. doi: 10.18720/MCE.77.13.
29. Motta, R.S., Thomas, A., Hazin, L.S., Ferer, J.G., Nauges, C., Hazin, A.S. Economic Instruments for Water Management. The Case of France, Mexico and Brazil. Bodmin: Cornwall, MPG Books Ltd, 2004. 151 p.

Кубанского государственного аграрного университета. 2016. № 6(63). С. 138–144.

26. Саинов М.П. Анализ работоспособности каменной плотины с комбинацией противофильтрационных элементов – железобетонного экрана и глиноцементобетонной стены // Инженерно-строительный журнал. 2016. № 4(64). С. 3–9.
27. Foster T.D. The hierarchy of convection // Colloques Internationaux du CNRS. № 215. Processus de Formation Des Eaux Oceaniques Profondes. 1974. Pp. 235–241.
28. Терлеев В.В., Никоноров А.О., Гиневский Р.С., Лазарев В.А., Того И., Топаж А.Г., Моисеев К.Г., Павлова В.А., Лайшев К.А., Архипов М.В., Мельничук А.Ю., Дунаева Е.А., Миршель В. Гистерезис водоудерживающей способности почвы // Инженерно-строительный журнал. 2018. № 1(77). С. 141–148.
29. Motta R.S., Thomas A., Hazin L.S., Ferer J.G., Nauges C., Hazin A.S. Economic Instruments for Water Management. The Case of France, Mexico and Brazil. Bodmin: Cornwall, MPG Books Ltd, 2004. 151 p.

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