

# Supplying long-term workability of the old elements of the hydraulic facilities by using of cold compositions

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**Abstract.** The aim of the research is to improve the composition of the cold composition BNR (bitumen-nairite rubber) by improving the technical properties, the technology of anti-filtration and anti-corrosion materials using at repair of the hydraulic structures, as well as the development of a method for predicting the state of reliability of hydraulic structures with anti-corrosion and sealing protective coating.

## 1 Introduction

One of the most important issues in the world and domestic practice of using concrete in impervious structures of hydraulic structures GTS and especially in the underwater parts of the structures is the discrepancy between the actual durability of the material and the required design service life of structures, which necessitates the use of measures for anti-corrosion protection of structural elements in order to extend their viability. In this sphere developed countries such as the USA, Russia, France, Italy, Uzbekistan pay special attention to the processes of carbonization of concrete caused by the leaching of calcium silicates under the influence of the water in the GTS, which shows the impossibility of using traditional cement-containing materials in repairs. [1]

The world experience in repair and restoration works shows that a decrease in reliability and stability occurs after 10-12 years of operation of hydraulic structures (destruction of structural elements and the appearance of the first signs of metal corrosion). Within the framework of this dissertation work, the method was developed for sampling concrete in the early stages of detecting places of destruction (determination of concrete leaching, with indicators below 10 units - the appearance of carbonization) and waterproofing with the installation of impervious screens. The method has been developed for predicting the appearance of corrosion of structural elements and carrying out waterproofing and sealing on hydraulic structures at any time of the year.

At present, in Uzbekistan the measures are being carried out to improve the reliability in the operation of hydraulic structures, the correctness of determining and selecting the initial data of waterproofing and sealing materials, which provide savings in material costs and prevent accidents, which is one of the main tasks. In the Strategy of Water Resources Management and Development of the Irrigation Sector in the Republic of Uzbekistan for

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2021-2023. indicated "... on the further development of reclamation and irrigation facilities for the development of the national economy" In this direction, it is also required to improve and develop an innovative technology for the production of repair and restoration work on hydraulic structures, ensuring durability and preventing accidents<sup>1</sup>.

Nowadays the issue of the applicability of the developed compositions when carrying out repair and restoration work of hydraulic structures in a year-round mode has not been sufficiently studied, which negatively affects the operational reliability of water facilities. The improvement of methods for predicting and evaluating the durability of hydraulic structures, taking into account the use of waterproofing materials in the repair of concrete structures, has also been insufficiently studied.

## **2 Materials and methods**

The analysis and the evaluation of existing anti-filtration and anti-corrosion compositions for the installation of protective screens for defective concrete zones to increase the operational reliability of hydraulic structures. The initial components are justified for improve the selected analog and study method and comparison of improved and analog components is carried out. In the research process for the compositions of NBR (bitumen nairit rubber) improvement, to simplify the material production technology various options for technical solutions were tested. At the same time, the most effective option is when instead of the main plasticizing component - chlornairite rubber grade A with the optimal ratio of additives - accelerators, as well as vulcanizing, stabilizing and anti-aging components, synthetic rubber is used with the same ratio of ingredients prepared in the conditions of rubber products factories.

Thus, the composition of the cold composition has been improved to reduce the multicomponent content in the production of the material to improve the technology of work. Field researches were carried out at existing hydraulic engineering facilities in order to establish the physical, mechanical and operational and technical parameters of the improved composite material.

The object and the subject of the research are flume conduits of various sizes, concrete impervious linings of canals and dams, elements of impervious concrete coatings with varying degrees of durability of carbonized concrete due to the depth of peeling, as well as butt joints of expansion and shrinkage joints [6, 7].

In the process of research, generally accepted methods for conducting experimental, field observations and numerical calculation methods were used.

The general pattern of compositions necessary for waterproofing structural elements of hydraulic structures has been improved, taking into account the formation of the structure of bitumen-polymer compositions, the composition of the cold composition has been improved, taking into account the plasticizing components [2], as well the possibility of ensuring the stability and durability of structural elements of hydraulic structures is substantiated by the cold compositions using.

## **3 Results**

The tested analog and improved compositions' properties analyses showed that they have sufficient characteristics to ensure long-term operational reliability, which generally guarantees, even in the worst case, the extension of the viability of water facilities by at least 15 years [4]. The involvement of cold compositions in domestic practice is possible due to the year-round production of insulation works, where the type of material selection is

determined by the manufacturability of the production of compositions that improved BSR compositions possess.

The cold composition preparing technology from prepared materials can be both active and passive. At an active technology, the dissolution of the components is carried out by using of specific mixing devices. At a passive technology, the preparatory components are loaded into containers, where the solvent is injected and left until the solutions are naturally obtained.

Considering the high physical-mechanical and operational-technical characteristics, combined with the high plasto-elasticity of the cold composition material, in addition to their main purpose, can be used for sealing butt interfaces of elements:

- Improved composition, technology of preparation and use of waterproofing and anticorrosive material to improve the reliability of hydraulic structures GTS.
- On the basis of full-scale and theoretical studies of the process of mass transfer of reinforced concrete structures and an improved composition in an aggressive environment, an accident-free service life of hydraulic structures with a protective coating of at least 15 years was established [4].

The reliability of the research results is substantiated by the improvement of the composition of the composite material, the comparison of the results of field and laboratory studies, and the implementation of the research results into practice. The scientific significance of the research results lies in the development of an improved cold composition instead of hot alloys, with the provision of an effective technology for the production of insulation works.

## 4 Discussion

The most common methods for improving the composition of waterproofing, anticorrosive and sealing compositions are considered [5]. It has been proved that as a result of the anisotropy of elastic and thermoelastic properties in composite materials, when the temperature changes, thermal stresses arise, which are determined by the difference in thermal expansion coefficients. The anisotropy of the properties of composite materials is widely discussed, but not always consistently taken into account in design and testing. For composite materials, the strength in the direction of reinforcement and in the transverse direction can differ by several tens of times. If it is desirable to take into account anisotropy in metals under certain types of stress state, then in composites this phenomenon should be treated very carefully. Cases of unforeseen failures of structural elements made of composite materials due to underestimation of low interlaminar shear strength and, especially, tear strength are also considered. The analysis of the properties of hot alloys of compositions with modifying components in the form of synthetic rubbers based on ethylene-propylene, butyl and other types of materials is carried out, which provides not only low water absorption of hot compositions, for example, of the BITEP type (butyl ethylene-propylene).

The main disadvantage of the hot alloys is their applicability in hot form, which limits their use in the practice of water management construction in the form of a limited period of their operation, while accessibility for inspection and insulation work for most structures is provided only in the autumn-winter season after emptying storage facilities. It is difficult to ensure the quality of the resulting alloys due to the possibility of overburning of the composition and the protective screen being performed when the compositions are applied to cold and wet concrete.

Another type of materials for anti-filtration and anti-corrosion protection of structures is the cold composition of NBR (bitumen nairit rubber), the use of which not only provides

high durability of protective screens, but also guarantees economic and technological advantages compared to hot compositions due to the exclusion of thermal processes.

A serious obstacle, excluding the mass introduction of the NBR composition into the practice of domestic construction in the performance of repair and restoration work of hydraulic structures, is the multicomponent nature of the composition.

The considered options of the methods and the technologies for impervious and anticorrosive protection of hydraulic structures GTS dictated the need for research on improving the analog composition in terms of manufacturability, by reducing the components in the preparation of the material with the provision of equal or close properties characterizing the analogue with the confirmation of their comparative tests [3].

## 5 Conclusion

- The retrospective analysis of the works of domestic and world practice devoted to the scientific and technical problems of the durability of hydraulic structures GTS showed that the composition and existing technologies for the use of hot, cold and thermosetting anti-filtration and anti-corrosion materials at an insufficient level supply the operational reliability of concrete structure elements in the underwater and underground parts of hydraulic structures.
- Modern bitumen-polymer compositions based on hot bitumen-rubber alloys have the highest water resistance, which ensure long-term viability of the material with a low water absorption rate and preservation of the original properties of protective screens during prolonged exposure to water. The main disadvantage of such compositions is the preparation technology, which creates difficulties in supplying the quality of the material due to the possibility of overburning of the alloy and insufficient continuity of protective colors when applied to cold parts and insulated surfaces of structures.
- On the basis of experimental studies, the analogue - cold composition BNK (bitumen-nairite-rubber), with the highest technological, physical, mechanical and operational characteristics. The NBR composition is characterized by high operational and technical characteristics, which ensure long-term durability of the waterproofing material for protecting structures with the preservation of the original properties, while having a working capacity of 20 years, when exposed to fresh and mineralized waters. The NBR composition, which is taken as an analogue, consists of 11 components. The improvement provided for the use of raw rubbers of domestic production, where all vulcanizing and stabilizing agents and anti-aging agents are in the same proportions with respect to rubber, which ensured greater manufacturability and cost-effectiveness of its production at existing hydraulic engineering facilities.
- The experimental implementations of the improved composition at operating facilities have shown that the preparation of the material is possible in the field using both active and passive methods, whereas the using activators for mixing the compositions during dissolution or passively waiting for the dissolution of the components under the action of a solvent.
- In addition to the main purpose of the composition as an anticorrosive and waterproofing material, it can be used as a sealant to eliminate joint defects using the gluing method with the application of an adhesive sublayer to the surface of adjacent elements and the subsequent application of reinforcing strips and protecting the material with additional layers of color with a total consumption of the composition in the amount of 100- 200 gr. dry matter per 1 p.m.
- On the basis of the theoretical and the field research of the process of mass transfer of reinforced concrete structures and an improved composition in an aggressive

environment, an accident-free service life of HTS elements has been established at least 15 years.

- The use of an improved composition provides a reduction in labor costs by at least 37 .

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