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THE POSSIBILITY OF REPAIRING WASHOUTS IN DAMS USING POLYMER-MINERAL MATERIAL (A CASE STUDY OF TSAKHKASHEN RESERVOIR DAM)

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Abstract

A new technology was proposed to mitigate leakage in the Tsaghkashen reservoir dam and prevent filtration losses. This technology involves using a "PMM"- modified polymer mineral material. To eliminate leakage in the Tsaghkashen dam, this material should be installed at a ratio of 4 kg/m^2.

***Keywords*:** water, soil, filtration, polymer-mineral material, sand clay

Introduction

In many hydraulic structures, including reservoir bowls, it is not possible to effectively mitigate the problem of filtration. Although a number of effective technological solutions for implementing anti-filtration measures have been developed in this direction in recent years, their mass application implies long-term experimental research and the issue is unlikely to be solved in the near future [1, 2].

In Armenia, in 2019, a pool was built in the form of an upturned truncated cone with a top circle diameter of about 12 m. At the bottom of the tamped pool, 5-6 cm thick sand was first laid and tamped again. Then, a layer of gravel, 5 cm thick, was poured on top, which was sprinkled with material «Natlen» at a ratio of 30 kilograms per 1 m^2 and all rammed again. The gravel was covered by a 5 cm thick sand layer. On top of the layer was put a 10 cm thick layer of soil from a dug-out pit and the layer was tamped down to protect it from mechanical processes (as a waterproofing layer a mixture of gravel and sand with «Natlen» material at a ratio 1:1 was used).

Water was gradually poured into the formed basin, which did not pass through the waterproofing layer of «Natlen» and sand with gravel. This new technique is meant for creating a waterproofing mixture from innovative materials «Natlen» and «PMM» for reservoirs and irrigation canals, as well as their repairs [2].

G.L. Hayriyan

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The «PMM» material is developed at the Institute of Mechanics of Moscow State University after Lomonosov, by employees of the laboratory of natural processes under the direction of A.A. Shakhnazarov. Over the past four years, scientists from the Moscow State University and the Shushi Technological University have been conducting research on the use of the PMM material in order to develop technologies for its use in urban planning, water management, waste disposal, agriculture and other sectors of the economy [3-5].

The modified PMM material undergoes multiple cycles of swelling and drying, and It does not decompose under soil, biological and atmospheric influences and is environmentally friendly and safe. Depending on its concentration, it can maintain a water pressure of tens of atmospheres along with clay.

PMM created by polymer-mineral materials based on natural components of b-powder less than 1 mm in size with specialized polymer-mineral additives of organic origin. The created mixture is environmentally friendly, stable, retains its properties for ten years, is frost-resistant and withstands temperatures up to 90°C. Polymer additives have a long molecular structure, dissolved in water, significantly increases the viscosity of the liquid, which makes it possible to accumulate in the soil additionally from 10-30% and significantly reduces the filtration coefficient [1].

The PMM materials were utilized to construct experimental reservoirs to demonstrate the waterproofing abilities of the PMM material. These experimental reservoirs were built on a pond in the courtyard of the Research Institute of Mechanics of Moscow State University, a reservoir in the Republic of Armenia, and a reservoir in the Republic of Kazakhstan. Freshwater in the Republic of Armenia is considered being of strategic importance. Therefore, the construction of new reservoirs and the repair of old ones using a waterproofing layer with a modified polymer-mineral material (PMM) will greatly reduce the cost of anti-filtering work. The innovative material «PMM» was developed by researchers at the Institute of Mechanics of Moscow State University after M.V. Lomonosov.

Below are presented options for waterproofing mixtures with and without modified PMM, for laboratory tests on the equipment, which are recommended for full-scale tests:

1. Rammed soil, 7 cm thick, with a 7 cm layer of clay (sand or soil) laid on top of a nearby quarry without PMM, modified to control measurements of various options for waterproofing mixtures.

2. Rammed soil, 7 cm layer, laid with a film, and then a 5-7 cm layer of clay (sand or soil) from a nearby quarry.

3. Rammed soil, 7 cm thick, with a 2-3 cm layer of clay (sand or soil) placed on top, followed by a 0.6 cm layer. In addition, there should be a modified PMM and a rammed layer of clay (sand or soil) 5-7 cm thick at the bottom of a cylindrical container.

4. Rammed soil, 7 cm thick, with a 2-3 cm layer of clay (sand or soil) was poured on top, followed by a 0.7 cm layer. On top of this, a modified PMM, and then a rammed layer of clay (sand or soil) 5-7 cm thick at the bottom of a cylindrical container.

5. Multilayer stacking: a layer of tamped soil from the bottom of the reservoir with a layer 7 cm thick is placed on the bottom of the reservoir, with a layer of clay (sand or soil) 2-3 cm thick, laid on top to level the surface, and then a tamped waterproofing layer of 7 cm on

top with 450 grams of PMM modified for 1 kg of soil, and on top there is a tamped layer of clay (sand or soil) 5-7 cm thick.

6. Multilayer stacking: A layer of tamped soil from the bottom of the reservoir with a layer thickness of 7 cm was placed on the bottom of the reservoir, with a layer of clay (sand or soil) 2-3 cm thick, laid on top to level the surface, a tamped waterproofing layer of 7 cm on top with 550 g PMM modified for 1 kg soil, and a tamped layer of clay (sand or soil) 5-7 cm thick. Note that the thickness of the clay (sand) used and placed on the bottom depends on the undulations of the tamped bottom of the reservoir. A new technology is proposed to create and apply a waterproofing layer on the bottom and walls of the reservoir, capable of withstanding a liquid pressure of at least 10 m in the water column.

The waterproofing layer model consisted of three layers:

- the bottom layer should consist tamped soil (clay) from the bottom of the repaired reservoir. It should be rolled with a roller at least 10 cm in thickness. It is recommended that the surface be as flat as possible;
- the middle layer consisted of an innovative PMM material modified with a mixture of local soil. It should be placed on top of the lower layer of the compacted soil;
- the top layer should consist of a compacted layer of soil that is at least 10 cm thick and laid on top of the layer of the modified PMM material.

Conflict Setting

The problem is to develop technology to eliminate leakages and prevent filtration losses in the Tsakhkashen reservoir dam.

Research Results

The Tsakhkashen reservoir, with a volume of 330 m^3, is situated in the Aragatsotn region of the Republic of Armenia. It is designed for the irrigation of 350-400 hectares of land (Fig. 1, 2).

Fig. 1 Tsakhkashen reservoir dam

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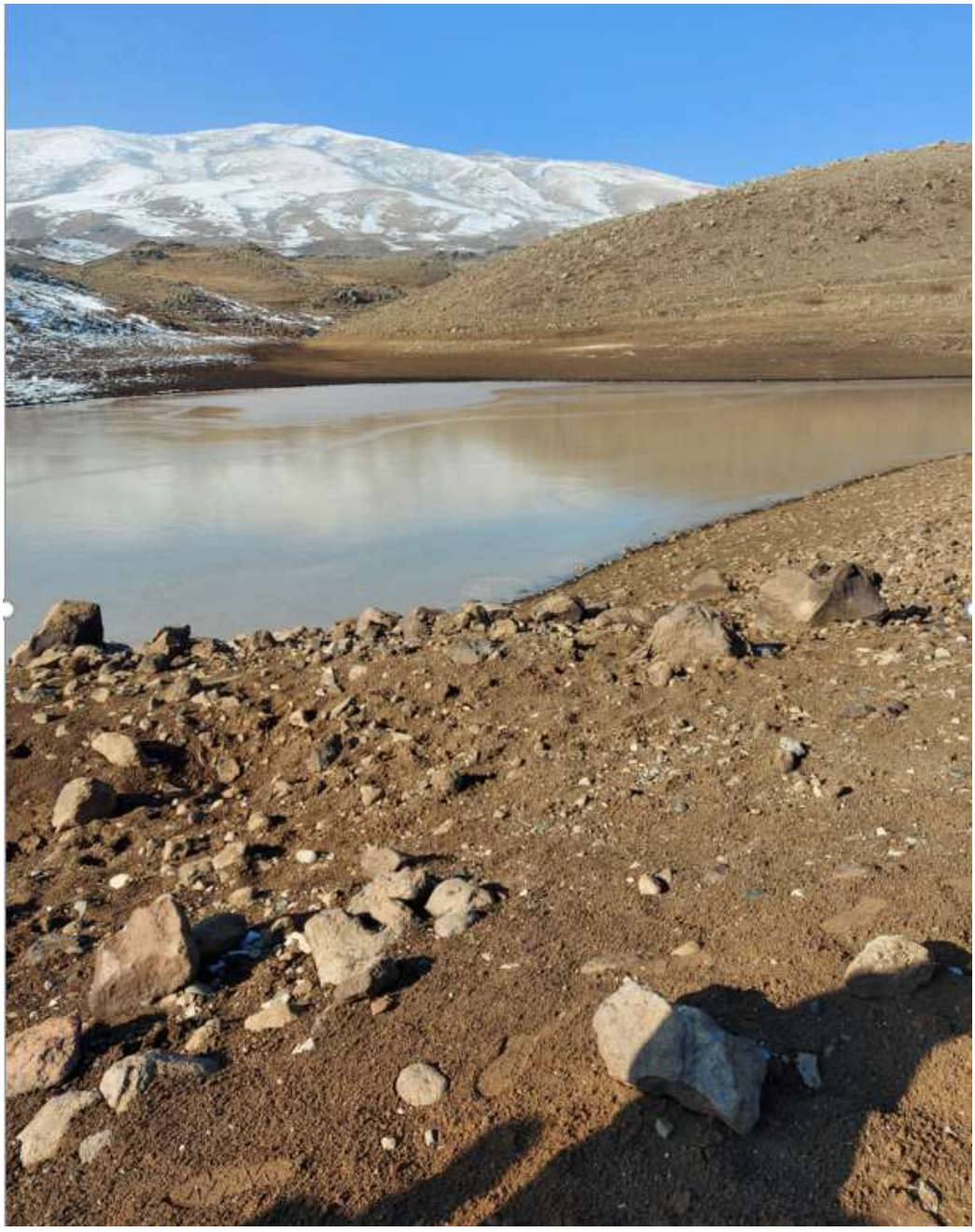

Fig. 2 Tsakhkashen reservoir

The water in the bowl doesn't stay for long, and the reservoir is emptied at the start of summer. Studies have shown that most of the water loss happens at the lower part of the dam, where there are many washouts (Fig. 3).

This means the reservoir not only fails to serve its main purpose but also poses a significant threat to the Tsaghkashen community if the dam were to fail.

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Fig.2. Washouts on the dam body

After conducting tests to address leakages in the dam body of the Tsaghkashen reservoir, the following actions are necessary:

1. In the dam body, in an area of 600 m^2 adjacent to leakages (Fig. 1), collect stones and remove the soil to a depth of 1 m with an excavator.
2. Remove the excavated soil to an area at least 1 km away from the dam.
3. Dig another 1 m (total: 2 m) in places where leakages (local) appear, fill the formed cavities with stones by tamping (the compaction can be done by hitting the bucket of an excavator), and then tamp the existing cavities with moistened high-quality clay and tamp at least 20 cm layer.
4. Sandy clay from the area next to the reservoir dam, about 700 meters away, can be used for creating a 0.6-meter thick layer (360 m3) on top of the removed soil. Ensure thorough compaction for good quality.
5. Place "PMM"-modified polymer-mineral material at a ratio of 4 kg/m^2. Perform high- quality tamping. The total mass of the material was 2400-3000 kg. Considering the complexity of the

material installation technology, alternative material installation technologies should be developed.

6. Place a 0.15 - 0.2 m thick sandy clay layer on the tamped "PMM" modified polymer-mineral material and perform high-quality tamping.
7. Place a layer of heavy (blue) sand (thickness of 0.15 m and arrange the previously removed stones (by hand) in the treated area.

Conclusion

1. The potential to seal the leakage in earthen dams and restore the normal operation of the dam using the modified polymer-mineral material «PMM» is supported by the analysis of test results conducted in collaboration with the employees of the Institute of Mechanics of Moscow State University after M.V. Lomonosov. In particular, to prevent leaks in the Tsaghkashen reservoir dam, we studied the anti-filtration processes for sandy loam soil around the dam and tested a waterproofing layer designed to withstand at least 10 m of water pressure. A waterproofing layer model is developed. It consisted of three layers. The first layer is a tamped bottom layer of sandy clay soil taken from the area next to the reservoir dam under repair. The goal is to create a smooth surface. The second layer involved placing a 4 kg/m2 layer of «PMM» modified polymer-mineral material on top of the leveled bottom layer. The third layer requires placing a compacted 0.15 m thick layer of sandstone soil, followed by adding a 0.15 m thick layer of heavy blue sand on top of it. The previously removed stones were placed on the treated area.

2. The experimental results indicate that the waterproofing layer of the new technology remains practically impermeable at a 15-meter water column pressure throughout the entire observation period.

3. The findings of these studies offer encouragement that advancements in the proposed technology will lead to a reduction in the expenses associated with implementing waterproofing solutions.

4. Considering that it is planned to conduct the initial test of the proposed technology in the Tsaghkashen reservoir where there is no prior experience with its real-life implementation; the sandy clay soil is very close to the reservoir and the logistical costs are low; the reservoir tailwater has steep slopes and important to protect the village of Tsaghkashen from from potential dam-wave bursts, to it is recommended to increase the thickness of the lower layer of sandy clay from its current 0.15 m to 0.6 m.

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ՊՈԼԻՄԵՐԱՀԱՆՔԱՅԻՆ ՆՅՈՒԹԻ ՕԳՏԱԳՈՐԾՄԱՄԲ ԳՐՈՒՆՏԱՅԻՆ ՊԱՏՎԱՐՆԵՐՈՒՄ ԼՎԱՑԱԿՈՐՈՒՍՏՆԵՐԻ ՆՈՐՈԳՄԱՆ ՀՆԱՐԱՎՈՐՈՒԹՅԱՆ ՄԱՍԻՆ (ԾԱԽԿԱՇԵՆԻ ՋՐԱՄԲԱՐԻ ՊԱՏՎԱՐԻ ՕՐԻՆԱԿՈՎ)

Գ.Լ. Հայրիյան
Ակադեմիկոս Ի.Վ. եղիազարովի անվան ջրային հիմնահարցերի և հիդրոտեխնիկայի ինստիտուտ

Առաջարկվում է նոր տեխնոլոգիա, որը թույլ է կտա փակել Ծաղկաշենի ջրամբարի պատվարի մարմնում լվացակորուստները և կանխել ֆիլտրացիոն ելքերը: Տեխնոլոգիան հիմնված է «PMM» մոդիֆիկացված պոլիմերահանքային նյութի կիրառման

վրա: Ծաղկաշենի պատվարի լվացակորուստներից ազատվելու համար առաջարկվում է այդ նյութը տեղադրել 4 կգ/մ^2 համամասնությամբ:

Բանալի բառեր. ջուր, գրունտ, ֆիլտրացիա, պոլիմերահանքային նյութ, ավազակավ:

О ВОЗМОЖНОСТИ РЕМОНТА ПРОМОЙН ГРУНТОВЫХ ПЛОТИН С ИСПОЛЬЗОВАНИЕМ ПОЛИМЕРО-МИНЕРАЛЬНОГО МАТЕРИАЛА (НА ПРИМЕРЕ ПЛОТИНЫ ЦАХКАШЕНСКОГО ВОДОХРАНИЛИЩА)

Г.Л. Айриян
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Предложена новая технология, которая позволит закрыть промывные потери в теле плотины Цахкашенского водохранилища и предотвратить фильтрационные расходы. Технология основана на использовании модифицированного полимеро-минерального материала «ПММ». Чтобы избавиться от фильтрационных потерь Цахкашенской плотины, рекомендуется устанавливать этот материал в пропорции 4 кг/м^2.

Ключевые слова: вода, грунт, филцтрция, полимеро-минерального материал, глина.

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