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MODERN MATERIALS FOR APPLIED WATERPROOFING AND THEIR USE IN CONSTRUCTION

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Abstract: The article analyzes coated waterproofing materials used to protect construction structures from the effects of groundwater and moisture. The composition, performance characteristics, and application areas of bitumen, bitumen-polymer, and polymer-cement-based waterproofing materials have been studied. The reliability of the waterproofing coating was theoretically analyzed in terms of adhesion and the influence of water pressure. Research results indicate that polymer-cement-based materials are considered effective in modern construction due to their high adhesion, elasticity, and waterproofing properties.

Keywords: waterproofing, bitumen, polymer cement, mastic, adhesion, water pressure.

Introduction

The operational reliability of buildings and structures largely depends on the degree to which the structures are protected from the effects of moisture and groundwater. The penetration of moisture into structures negatively affects the strength of concrete and brick materials, leading to reinforcement corrosion, material wear, and a reduction in the service life of the structure. Therefore, in construction practice, reliable protection of structures from moisture is one of the most important tasks. Waterproofing works are of particular importance in foundations, basements, tunnels, and hydraulic structures, as these parts are constantly exposed to moisture and groundwater.

The effect of moisture in such structures is related not only to the direct influence of water but also to the hydrostatic pressure generated by groundwater. Especially in the basement and foundation walls, there are cases of reverse pressure acting from the outside. In this case, the water pressure is directed from the outside to the inside of the structure and has a constant impact on the internal waterproofing layer. If the waterproofing system is not sufficiently strong and airtight, water can penetrate through the pores and capillaries of the structural material, causing moisture, cracks, and rapid wear of the material.

The applied waterproofing materials are applied to the surface of the structure using specialized tools, creating a continuous and integrated protective layer. Such materials are produced on the basis of bitumen, polymer or bitumen-polymer and have high water resistance.

One of their main advantages is that they fill small cracks and pores on the surface of the structure, limiting water penetration into the structure. At the same time, these coatings are characterized by important physical and mechanical properties such as high adhesion, mechanical strength, elasticity, and resistance to aggressive environments.

Modern surfacing waterproofing materials are widely used in construction practice, serving as an effective solution for protecting premises from water seeping through basement walls and floors, concrete structures, and other moisture-prone elements under the influence of hydrostatic (reverse) pressure. As a result, the sanitary and hygienic condition of the premises is improved, and the operational reliability of the buildings is ensured.

Main part

Effect of reverse pressure on the structure. Under conditions of reverse hydrostatic pressure, several types of forces act simultaneously on the waterproofing coating. Such conditions are typically observed in underground rooms, basement walls, and foundation structures [8].

Under reverse pressure conditions, the waterproofing coating operates simultaneously under the influence of hydrostatic pressure, soil pressure, dynamic loads, and thermal deformations. Therefore, coating materials in such structures are required to possess high strength, adhesion, and waterproofing properties [5].

Under reverse pressure conditions, the waterproofing coating operates under the influence of hydrostatic pressure distributed in a triangular pattern along the wall. Therefore, the load on the waterproofing in the lower part of the wall will be the largest, and the coating materials must have a strength corresponding to these conditions.

Hydrostatic pressure is determined by the following relationship:

$$P_{max} = \gamma \ H$$

where γ is the volume weight of the water, and H is the total height of the water column.

As can be seen from this formula, the higher the water level, the higher the reverse pressure. For example, when groundwater levels rise seasonally, the pressure acting on the waterproofing coating also increases significantly [2].

As the water level rises, the pressure increases, which places high demands on the adhesion of the coating to the base. That is, the waterproofing layer must be firmly connected to the base. If the bond between the coating and the base is insufficient, defects such as pressure swelling, layer separation, micro-cracks, and water penetration behind the coating may occur [6].

Furthermore, soil pressure and external dynamic influences create additional mechanical stresses in the pavement. A sharp change in temperature causes expansion and contraction processes in the material. If the coating is not sufficiently elastic, this condition can lead to the formation of cracks.

Therefore, when designing a waterproofing system under reverse pressure conditions, it is important to accurately calculate the amount of hydrostatic pressure, ensure the adhesive strength of the coating, and take into account the mechanical and thermal stability of the material.

Figure 1 shows the process of water penetration into the structure under the influence of reverse hydrostatic pressure in the walls of basements or premises located below ground level, and the method of applying waterproofing applied from within the room against it. This situation usually occurs under conditions where the groundwater level is higher than the wall level. In Figure 1, the water level on the outside is represented by WL (Water Level), and the water pressure is directed through the wall into the interior of the room.

When groundwater pressure affects the wall, moisture can pass inward through the capillary pores of concrete structures. If the waterproofing layer is not applied from the outside or is damaged, water pressure will pass through the structure, causing moisture, condensate, and even water leaks in the basement rooms. This leads to the deterioration of the sanitary condition of buildings, the destruction of structural materials, and the corrosion of reinforcement.

Figure 1 shows the process of applying a special waterproofing material by a worker using a spatula at the junction of the wall and the floor. These materials are usually made on a cement-polymer, bitumen-polymer, or mineral base and adhere to the concrete surface with high adhesion. The coating is applied to the wall and floor surfaces in a continuous layer, filling the pores of the structure and creating a strong barrier against water seepage.

Figure 1. Reverse pressure waterproofing

This method of waterproofing is especially effective when using materials that can operate under reverse pressure conditions. Because in this case, the water pressure will try to separate the waterproofing layer from the wall. Therefore, it is required that the adhesion, mechanical strength, and waterproofing properties of the material be high. The coating is usually applied in several layers, and an additional reinforcing layer (galtel) is formed at the corners of the wall-floor junction [8].

As a result, the applied waterproofing layer works against the back pressure of groundwater, limiting water penetration into the structure. This method is widely used to protect basements, basements, tunnels, and other underground structures from moisture and serves to ensure the operational reliability of buildings.

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Modern waterproofing materials are divided into two main groups:

1. Waterproofing materials based on organic binders include coatings based on bitumen, bitumen-polymer, and various synthetic polymers. Bituminous materials are manufactured based on petroleum products and are distinguished by their low cost and technological convenience. However, under the influence of reverse pressure, the adhesion of bitumen coatings may be insufficient in some cases. Therefore, in practice, modified bitumen compositions are produced by adding polymers or synthetic rubbers to the bitumen composition. Such materials possess high elasticity, resistance to temperature changes, and a long service life [7].

Modified bitumen waterproofing materials include bottle rubber mastics, bitumen-rubber mastics, emulbites, and polymer-bitumen compositions. These materials are used to protect reinforced concrete and metal structures from moisture and form a waterproof elastic protective layer on the surface of the structure. However, under conditions of reverse hydrostatic pressure, the efficiency of bituminous coatings can sometimes be limited [3].

The ability of waterproofing materials to adhere to the base under the influence of back pressure is of decisive importance. If the waterproofing layer does not adhere to the structure sufficiently, the coating may detach from the base under the influence of groundwater pressure. Therefore, polymer, epoxy, and polyurethane-based waterproofing materials with high adhesion are widely used in modern construction practice.

2. Materials based on organomineral binders. In recent years, polymer-cement compositions have gained particular importance among waterproofing materials used under reverse pressure conditions. These materials are manufactured based on a combination of mineral binders (cement, gypsum, etc.) and organic polymers. Polymer-cement compositions possess high adhesion, elasticity, and waterproofing properties and can be applied even to wet surfaces. This makes them an effective material for the internal waterproofing of basements and underground structures.

The content of polymer substances in polymer-cement waterproofing materials is usually around 2–20% of the cement mass. Although these materials are more expensive than traditional cement mortars, their high adhesion, elasticity, and long service life are economically justified.

Currently, various waterproofing materials based on polymer-cement are being produced on the construction market. These include materials such as BARRALASTIC, AQUAFIN, THOROSEAL, Ceresit, Polimiks GS, ZikaTop Seal, and Mapei Malingastic (Table 1). These materials possess high adhesion, elasticity, and waterproofing properties, and adhere well to concrete and reinforced concrete structures. Therefore, they are effectively used for the internal waterproofing of basements and underground structures.

Table 1.

Main technical parameters of polymer-cement waterproofing materials

№	Material name	Adhesion strength, MPa	Elasticity, mm	Water pressure resistance, MPa	Field of application
1	BARRALASTIC	0.8 – 1.2	0.7 – 1.0	0.5 – 0.7	Basement walls, tanks

2	AQUAFIN	0.8 – 1.0	0.5 – 0.8	0.5 – 0.8	Underground structures
3	THOROSEAL	0.6 – 0.9	0.3 – 0.5	0.5 – 0.7	Concrete walls, basements
4	Ceresit (CR series)	0.8 – 1.2	0.5 – 0.8	0.5 – 0.8	Foundations, basements
5	Полимикс ГС	0.7 – 1.0	0.5 – 0.7	0.4 – 0.6	Underground structures
6	SikaTop Seal	1.0 – 1.5	0.8 – 1.2	0.7 – 1.0	Reservoirs, tunnels
7	Mapei Mapelastic	1.0 – 1.5	1.0 – 1.5	0.7 – 1.0	Balcony, pool, basements

As seen from the data in Table 1, polymer-cement waterproofing materials possess high adhesion properties, good elasticity, and resistance to water pressure. This allows for their application in waterproofing systems operating under reverse hydrostatic pressure conditions. In particular, materials such as ZikaTop Seal and Mapei Madanastic are distinguished by their high elasticity and adhesion.

Under conditions of reverse hydrostatic pressure, the adhesion of the waterproofing coating to the base is of particular importance. It is known that the pressure of groundwater is approximately 10 kN/m2 per meter of depth. Therefore, it is required that the adhesion index of the waterproofing coating be no less than this pressure. Polymer-cement waterproofing materials meet these requirements and provide reliable protection for structures against moisture exposure.

Thus, waterproofing materials applied under reverse pressure play an important role in protecting underground and basement structures from moisture. Modern polymer and polymer-cement composite materials are an effective and reliable solution compared to traditional bitumen coatings due to their high adhesion, elasticity, and waterproofing properties.

Conclusion

The research results demonstrated that applied waterproofing materials play a crucial role in protecting construction structures from the effects of moisture and groundwater. High requirements are imposed on the waterproofing system, especially in basements and underground structures where water passes through the structure under the influence of reverse hydrostatic pressure. In such conditions, the decisive factors are the strong adhesion, elasticity, and waterproofing properties of the waterproofing coating to the base.

The conducted analysis showed that modern polymer and polymer-cement-based waterproofing materials are more effective than traditional bitumen materials due to their high adhesion, good elasticity, and resistance to water pressure. Such materials combine well with concrete and reinforced concrete structures, creating a reliable barrier against water leakage by filling the pores of the structure.

Furthermore, the correct design and application of waterproofing coatings allows for the effective protection of basements and other underground structures from moisture exposure. This serves to increase the operational reliability of buildings and extend their service life

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