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ANALYSIS OF WATERPROOFING SYSTEM OPTIONS

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Abstract

The article analyzes the main types of waterproofing systems used in modern construction practice and systematizes them based on technical and operational characteristics. The areas of application, advantages and disadvantages of liquid-coated, wrapping (membrane), plaster coating, and penetrating waterproofing materials were assessed from a scientific and practical point of view. A comparative analysis of the water resistance, mechanical stability, service life, and installation technology characteristics of each type was carried out.

The need for a comprehensive assessment of technical, technological, operational, economic, and environmental criteria when choosing a type of waterproofing is also substantiated. The research results serve as a theoretical and practical basis for choosing a reliable and long-term waterproofing solution suitable for specific building conditions.

Keywords

waterproofing systems, liquid-coated waterproofing, wrapping waterproofing, membrane coatings, PVC membrane, TPO membrane, EPDM membrane, plaster-coated waterproofing, cement waterproofing, penetrating waterproofing, crystal technology, waterproofing level, hydrostatic pressure, adhesion, mechanical stability, service life, foundation waterproofing, underground structures, waterproofing selection criteria, operational efficiency.

Introduction

In modern construction practice, reliable protection of buildings and structures from the effects of moisture and water is one of the important technical tasks. Moisture penetration into structures reduces the strength of materials, accelerates corrosion processes, deteriorates thermal and technical indicators, and negatively affects the service life of the structure. The correct selection of a waterproofing system is especially important for foundations, underground walls,

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basements, tunnels, reservoirs, and industrial facilities operating in a humid environment.

In the construction market, there are various compositions, technologies, and areas of application of waterproofing materials. They differ in water resistance, mechanical stability, service life, installation technology, and economic indicators. Therefore, the selection of the most optimal type of waterproofing for specific building conditions requires scientifically based analysis.

In this article, modern waterproofing systems are analyzed by dividing them into main groups. The technical and operational characteristics of liquid-coated, wrapped (membrane), plaster-coated, and penetrating types of waterproofing are considered comparatively. The need for a comprehensive assessment of technical, technological, economic, and environmental criteria when choosing a type of waterproofing is also substantiated.

The purpose of the research is to scientifically substantiate effective waterproofing solutions that serve to ensure the operational reliability of structures and increase their long-term stability.

Main part

Analysis of waterproofing systems applied against back pressure

In underground structures, basements, and structures located entirely underground, waterproofing is associated not only with moisture limitation but also with resistance to groundwater pressure. Under these conditions, hydrostatic pressure constantly acts on the walls and floors of the structure.

If waterproofing is carried out not from the outside, but from the inside of the structure, the water pressure will act on the pavement in the "reverse" direction. That is, water tries to separate the coating from the base. Therefore, simple applied waterproofing materials may not be sufficiently effective in such conditions [1-4].

Reverse-pressure-resistant systems should have the following characteristics:

- high adhesion (strong adhesion to the concrete or brick base);
- high degree of water impermeability;
- crack resistance and elasticity;
- resistance to separation from the coating under pressure.

In practice, for this purpose:

- modified polymer coatings based on cement;
- crystal-forming (penetrating) waterproofing materials;
- two-component elastic lubricating compositions are used.

At the same time, simply selecting the material is not enough. Proper preparation of the base (cleaning dust and loose layers, closing cracks),

strengthening angles and joints, and fulfilling the layer thickness in accordance with regulatory requirements ensure the reliability of waterproofing.

In conclusion, applied waterproofing systems operating under reverse pressure have high requirements for material selection and technological discipline. Proper design and high-quality work ensure the longevity of underground structures [4].

Characteristics of Negative Hydrostatic Pressure

Under reverse pressure conditions, groundwater acts on the waterproofing layer from the inside of the structure. That is, the water pressure tries to separate the coating from the base. This differs from the normal (direct) pressure state, since in this case the water acts not directly over the coating, but behind it[5].

In such conditions, the main requirement for the waterproofing layer is its strong connection to the base. If adhesion is insufficient, under the influence of water pressure:

- separation of the coating;
- appearance of blisters on the surface;
- formation of microcracks;
- moisture leakage may increase over time.

Therefore, waterproofing materials used under reverse pressure must meet the following requirements:

1. High adhesion - must adhere firmly to concrete, brick, or other mineral bases.

2. A high degree of water impermeability - water impermeability even under hydrostatic pressure.

3. Crack closing ability - should prevent water from passing through even when small structural cracks appear.

4. Mechanical stability - must maintain its integrity under the influence of pressure and deformation.

5. Long-term durability - must not lose its properties under the influence of aggressive environments and constant humidity.

In conclusion, under reverse pressure conditions, waterproofing is evaluated not only by water impermeability but also by its ability to work as a whole with the structure. High quality is required when selecting materials and performing work, otherwise the waterproofing system may lose its effectiveness in a short time [6].

Types of coated waterproofing

Under reverse pressure conditions, ordinary bituminous mastics are not effective, as their adhesion and mechanical stability are limited. For this reason, cement-polymer-based applied waterproofing materials are mainly used [7].

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1. Mineral (cement) waterproofing

Cement-based waterproofing mixtures consist of mineral binders, fractionated sand, and special polymer or hydrophobic additives that form chemical and mechanical bonds with the concrete surface. During the hardening process, they partially penetrate the porous structure of the concrete and form a solid, waterproof layer on the surface. Due to this property, such materials can work stably even under reverse hydrostatic pressure.

Their main advantages are:

- high adhesion - strong adhesion to concrete, low risk of detachment;
- resistance to hydrostatic pressure - stable maintenance of the coating under the influence of water pressure;
- possibility of working in a humid environment - possibility of application on the surface of wet concrete;
- Internal applicability - convenience for caisson-free waterproofing in underground structures;
- Mechanical stability - resistance to external influences during operation.

Mineral waterproofing materials are especially effective in protecting basement walls, foundations, and underground floors from reverse hydrostatic pressure. Due to the fact that concrete forms a strong bond with the structure, water pressure cannot separate the coating from the surface.

In practice, it is recommended to apply the coating in at least two or three layers. The application of layers in mutually perpendicular directions ensures uniform distribution of the coating. Corners, floor-to-wall joints, and technological joints are reinforced with special reinforcing tape or mesh. Also, preliminary mechanical cleaning of the surface, dust removal, and, if necessary, moistening increase the effectiveness of waterproofing.

Mineral (cement) waterproofing, applied according to the correct technology, ensures long-term water resistance of the structure and increases the operational reliability of underground structures.

2. Cement-polymer elastic waterproofing

Two-component cement-polymer waterproofing compositions consist of a mineral binder (cement powder component) and polymer dispersion (liquid component), which, after mixing, forms a solid coating with high elasticity. Polymeric substances reduce the brittleness of cement stone and retain a certain degree of stretchability even after hardening. Due to this property, such materials can compensate for possible microcracks and small deformations in the structure [5].

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Cement-polymer elastic waterproofing is especially suitable under the following conditions:

- in cases of seasonal groundwater rise - additional stresses arise in the structure as a result of changes in the water level;

- when there is a possibility of deformation in the floor-wall joint - cracks may appear due to the different operation of different parts of the structure;

- in industrial or technical premises with high humidity - where temperature and humidity fluctuations are frequently observed.

The degree of elasticity usually allows closing cracks up to 1-2 mm, which ensures the continuity of the coating under reverse hydrostatic pressure. Due to high adhesion to the concrete surface, the risk of water pressure separating the coating is reduced. Also, polymer additives reduce the water absorption of the coating and extend its service life.

In practice, such waterproofing is applied in 2-3 layers. The first layer provides a strong bond with the base, while the second and third layers create the necessary thickness and elasticity. It is recommended to use special reinforcing strips or nets at floor-to-wall joints, joints, and communication lines.

Thus, cement-polymer elastic waterproofing provides reliable and stable protection under reverse pressure conditions and serves to ensure the long-term operational safety of underground structures.

3. Penetrating (permeable) waterproofing

One of the most reliable solutions under reverse pressure conditions is penetrating waterproofing materials that penetrate into concrete and form crystals in its structure. These materials consist of special chemical additives based on cement, which, when applied to the surface of moist concrete, penetrate deep into its capillaries and microcavities [7].

The active substances in the material react with the free lime and moisture in the concrete, forming water-insoluble crystalline structures. As a result:

- the internal capillary channels of the concrete are closed,

- water passages are blocked,

- increases the water resistance of the structure.

Importantly, waterproofing works not only on the surface as a coating, but also on the structure itself. Therefore, there is practically no risk of its detachment or swelling. Benefits:

- There is no risk of coating detachment, since the material forms a continuous structure with concrete;

- Works inside the structure, that is, water penetration is limited even if the surface is damaged;

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- Resistant to high hydrostatic pressure;
- Has a long service life, since the crystalline structure coexists with concrete;

Over time, when moisture enters, the crystallization process can continue (self-restoration effect).

This method is especially effective for fully underground basements, underground parking lots, and technical rooms. Because external waterproofing is not always possible in such facilities.

In practice, a comprehensive approach is often used:

First, a penetrating layer is applied to the concrete, then a protective layer is created with a cement-based elastic coating. This secondary protection system further increases the degree of water impermeability and ensures the reliability of the structure.

Thus, penetrating waterproofing is one of the most stable and long-term solutions under reverse pressure conditions.

Technological aspects

When applying reverse-pressure waterproofing systems, along with material quality, work execution technology is also crucial. Practice shows that if the requirements of the technology are not met, even the highest quality material will not give the expected result. The following stages are especially important:[4]

1. Mechanical surface cleaning. The base (concrete or brick wall) must be strong, dry, and clean. If dust, oil, loose layers, cement "milk" and other impurities are not cleaned, adhesion decreases. As a result, the coating may detach under pressure.

2. Repair of cracks and joints. Cracks, joints, and communication entrances in the structure are processed separately. If they are not sealed in advance, the risk of water passing through these points is high.

3. Formation of a fillet in the corners. At the intersection of the wall and floor, an acute angle of 90° should not be left. In this area, the unevenness of the coating layer increases the risk of cracking. Therefore, a rounded fillet is formed with a cement-sand mixture or a special composition.

4. Priming or moistening. Basis depending on the type of material:

- or ground with a special primer,
- or moistened with water (for cement-based compositions).

This stage increases adhesion and ensures uniform distribution of the coating.

5. Applying the coating in several layers. Waterproofing is usually applied in 2-3 layers. Each subsequent layer is applied after the previous one has partially dried. The thickness of the layers must comply with the project requirements. A very thin layer may not withstand water pressure.

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6. Temperature and humidity regime during the drying process. During operation and freezing periods - the air temperature must be within the normal range, protect from direct sunlight, and prevent freezing. An incorrect temperature regime can lead to cracking of the coating or a decrease in adhesion.

In conclusion, waterproofing against back pressure is not just a material, but a complete technological system. Proper preparation of the base, layers of standard thickness, and compliance with construction conditions ensure the long-term reliability of waterproofing.

Selection criteria. When choosing waterproofing against back pressure, the following is taken into account:

- maximum groundwater level;
- type of concrete or brick structure;
- condition of the wall and floor;
- operating conditions;
- economic efficiency.

If the water height is low (for example, up to 1 meter), cement pressure-resistant waterproofing can be sufficient. In the presence of high pressure or active water leakage, a comprehensive solution with penetration technology is recommended.

Conclusion

The correct choice of waterproofing material under reverse hydrostatic pressure is crucial for ensuring the reliability and long-term stable operation of the structure. When groundwater pressure acts from the inside, the waterproofing layer is required not only to be waterproof, but also to be firmly connected to the base.

Practice shows that ordinary bituminous coatings may not be sufficiently effective in such conditions. They are prone to splitting or cracking under high pressure. Therefore, cement and cement-polymer-based elastic materials, as well as penetration technologies that form crystals inside concrete, are among the most optimal solutions against reverse pressure.

The best result is usually achieved through a comprehensive approach. That is, it is advisable to combine several protection methods, taking into account the condition of the structure, the level of water pressure, and operating conditions. At the same time, strict adherence to technological requirements, such as base preparation, layer thickness, and drying regime, ensures the long-term effectiveness of the waterproofing system.

Thus, scientifically based material selection and correctly performed work serve to reliably protect basements and underground structures from the effects of water.

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