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METHODS OF WALL PROTECTION FROM MOISTURE INFLUENCE IN THE PROCESS OF PERFECT REPAIR OF USED BUILDINGS

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Abstract: The results of research aimed at studying the technical condition of buildings and structures in recent years and archival data collected during their operation show that the technical condition of most previously constructed buildings has deteriorated, and their basements have become damaged. This article raises the issue of the fact that traditional methods of protecting building walls from soil moisture cannot be a reliable barrier to the penetration of soil moisture into the thickness of the wall and that a new approach is needed.

Key words:highly sedimentable soil, low binding, loose, dispersive.

1. Introduction. High humidity in the walls is a problem for buildings that are heavily used (operated). This problem is especially important for basement and basement walls, which operate in the most adverse conditions, in direct contact with soil moisture.

The practice of operating buildings has shown that when the external wall is wetted by soil moisture, the operational quality of the buildings, their strength and durability are significantly reduced, since the horizontal waterproofing between the foundation and the external walls loses its protective properties. Even the most common waterproofing methods (paint, adhesive, mastic) lose their ability to prevent moisture from penetrating the thickness of the external wall after 10-12 years. Cement-based waterproofing layers with various wetting or hydrophobic additives are used to protect the external walls of foundations from soil moisture, and this layer also loses its (waterproofing) properties over time [1] (Figure 1).

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Figure 1. The outer wall is damp from soil moisture.

During the operation of buildings, the long-term absence or damage of horizontal and vertical waterproofing layers leads to capillary absorption of groundwater and wetting of the lower parts of the walls. In this case, the moisture rise height for capillary systems is determined by the following formula:

$$H_{к} = 4\sigma / g \rho d. \quad (1)$$

Where σ - surface tension of water ($\sigma = 72,5 \cdot 10^{-3} н/м$);

d– minimum capillary diameter (for building materials $d = 2 \cdot 10^{-3} м$);

ρ - density of water ($\rho = 10^{3} кг/м^{3}$);

g - acceleration of gravity ($g = 9,81 м/сек^{2}$).

In practice, the capillary rise of moisture through brick walls reaches a height of up to 0.5 m. If the wall material contains chloride salts with high hygroscopicity, this moisture rises to a height of 3-4 meters, and sometimes up to 5-6 meters. The consequences of such moisture are a decrease in the heat-shielding qualities of external walls, contamination and deterioration of interior finishes, the appearance of salt stains on the facade of the building and mold and mildew on the inner surface of the damp external wall (Fig. 2). This situation can lead to a number of serious diseases for people who have to live and work in such buildings [2].

It should be noted that the results of studies conducted abroad (in particular, Germany, Norway and Finland) show that the mortality rate from diseases caused by these events exceeds the mortality rate from road accidents [3]. In addition to unfavorable hygienic conditions, increased humidity in external barrier structures leads to accelerated deterioration of external barrier structures, which leads to a significant increase in operating costs.

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Figure 2. Mold and fungi on the inner surface of the damp outer wall

2. The main part. Dehumidification of damp walls of buildings consists of two stages:
- drying the walls and foundations;
- restoring waterproofing.

It is very difficult and expensive to restore horizontal waterproofing of external walls using traditional mechanical methods.

Covering the internal surfaces of rooms with rolled (wrapping) materials only temporarily improves the hygienic condition in the room. However, such a layer usually contributes to the accumulation of moisture in external barrier structures. Because it makes it difficult for moisture to escape through the internal layers of the structure, and therefore, after such repairs, the humidity in the room increases. Especially difficult is the process of restoring the waterproofing of residential buildings that are in operation. To protect the structure from the effects of soil moisture, it is necessary to restore both the waterproofing on the vertical surface of the foundation in contact with the ground, as well as the horizontal waterproofing between the foundation and the wall [4]. In this case, the last resort is to dismantle the walls of the building down to the foundation and lay a new layer of waterproofing, followed by reconstruction (restoration) of the walls. At the same time, an alternative waterproofing method is to inject the damp walls into the thickness of their material (the injection material is injected into the wall through one or two rows of injection holes). This reduces their capillary permeability. However, such materials are very expensive and require drilling many holes in the walls for their use. This, in turn, can lead to additional moisture penetration into the wall thickness.

Thus, traditional methods of protection cannot be a reliable barrier to the penetration of soil moisture into the wall thickness.

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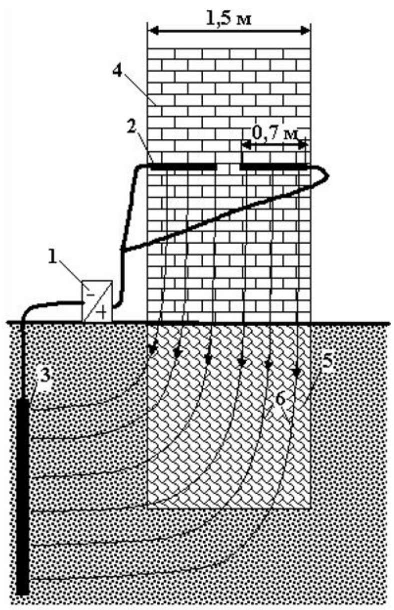
It has been established that 75% of all moisture rising through the wall structure occurs due to the action of electroosmotic forces. Electroosmotic forces are the result of an electric field that appears in the building structure as a result of the electric field of the earth, galvanic microelements of materials, thermal insulation layer, friction forces that arise on the surface of the building facade under the influence of wind, and many other factors. Therefore, in order to prevent the foundation from getting wet from soil moisture, it is necessary to eliminate the natural electric field created in the wall structure or change its direction.

According to this idea, one of the methods of combating the walls of buildings in operation is based on the so-called electroosmotic method, that is, by preventing the foundation from getting wet from soil moisture.

It should be noted that the discovery of the phenomenon of electroosmosis - the reverse movement of liquid through capillaries and micropores when an external electric field is applied - was discovered in 1808 by the Russian researcher, professor of Moscow University F.F. Reiss. For example, during the reconstruction of the building built in Kronstadt in 1825-1836 to accommodate the 1st Naval Cadet Corps, active electroosmotic drying was carried out. The first floor was built in an arched brick structure on a solid foundation. The walls were 1.5 meters thick, the building's waterproofing layer was broken, and there were no basements. The capillary rise of moisture in the walls of the first floor was 2-2.5 meters. In the humid zone, the humidity of the brick walls was 20-22%, that is, they were completely saturated with moisture. The work was carried out in three stages, each lasting three months. 900 anode electrodes were placed on the walls of the building and 48 independent power circuits were formed. 50 cathode electrodes are placed on the ground both inside and outside the building (Figure 3).

Figure 3. Schemes for installing anodes and cathodes: 1-DC source; 2-electrodes (anodes); 3-electrodes (cathodes); 4-drying wall; 5 - bush foundation; 6- power line.



One of the main problems associated with the use of electrical power up to 200 watts is the intensive melting of the anode electrodes, which occurs according to the following law:

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$G = D_E \cdot I_A \cdot t$ (2)

where: G is the mass loss of the material, kg;

I_A – anode current,A;

D_E- electrochemical equivalent mass of the metal, kg/(A · h);

t – time, hours.

To reduce the solubility of the anode electrodes in the cement mixture, the gap between the anode electrode and the brickwork is filled with graphite powder. Graphite has the same electronic conductivity as metal. Therefore, chemical reactions do not occur at the contact boundary of these materials, and the steel anode does not dissolve in places where it comes into contact with graphite.

Also, the electrochemical equivalent mass of graphite $(D_E = 0{,}91 \cdot 10^{-5})$ is twice as small compared to the electrochemical equivalent mass of steel $(D_E = 1{,}04 \cdot 10^{-3}, кг/(A \cdot соат))$.

Before starting to dry the control samples of the brick, its absolute weight moisture was determined. According to the results of 10 measurements, the absolute weight of the brick wall is equal to the moisture content. The volume of a brick wall in this humidity is 300 m3.

At the first stage, the electroosmotic device was connected to a 150-160 V power source. After three months, the electroosmotic dryer was switched to waterproofing mode, i.e. automatically controlled 6-12 Watt voltage regulation.

Final part. In conclusion, it should be noted that today there are no domestic research methods equipped with equipment and tested for a long time at specific facilities. Research conducted at facilities operated in the CIS mainly dates back to the Soviet era and was applied at several facilities, including two residential buildings of the Moscow Railway. These studies, conducted by the Drymatec company over a three-year period, proved the effectiveness of the electroosmotic drying method (for three years of observations in these buildings, the humidity of wet brick walls decreased to values close to equilibrium) [6], however, this method has not received a wide industrial program in our country. In this regard, the study of the research of German, Finnish and Norwegian specialists in the field of drying of building envelopes using electroosmotic methods, which included drying using galvanic cells, is of particular importance for those who are conducting research on this topic. The problem of wall dampness should be solved using all the accumulated experience and the latest materials and technologies. This will allow in the near future to develop a domestic scientifically based technique with appropriate equipment. This will allow for an objective analysis of the moisture content of walls during the dampness process.

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