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FAST-SETTING WATERPROOF REPAIR COMPOSITION FOR SHELL ROCK BUILDINGS

Levytskyi D., Tihoniuk S., *postgraduate students*
Scientific supervisor – **Kersh V.**, *PhD, professor (Department of Urban Construction and Management, Odesa State Academy of Civil Engineering and Architecture)*

Abstract. The possibilities of using gypsum-containing materials for repairing buildings from shell rock are considered. Their water resistance is investigated using two criteria: the softening coefficient and the water resistance index. Their significant dependence on the measurement conditions was established. Mathematical models of properties were constructed to analyze the role of components in ensuring water resistance.

State of the problem. The construction and facade cladding of most buildings in the historic part of Odesa is made of local limestone-shell rock, which has good enough performance properties but requires careful maintenance.

The most important reason for the destruction of buildings made of limestone-shell rock is the moisture in the material of the supporting structures when the plaster layer is damaged or absent. The process of destruction is accelerated in winter when water freezes in the pores and cracks of the material.

The widespread practice of repairing damaged structures from shell rock with cement compositions leads to an acceleration of destructive processes, the main reasons for which are as follows: 1) a stronger plaster cement composition during setting has shrinkage and creates stresses in the surface layers of the shell rock, 2) the vapor permeability of the cement layer is significantly lower than the vapor permeability of the shell rock; cement plaster prevents steam from escaping from the structure.

The mechanism of destruction in a simplified form can be represented as follows. The cement mortar, freshly applied to the damaged surface, penetrates the pores and cavities of the limestone-shell rock and hardens there, adhering to the material of the base layer. After several freezing-thawing cycles, the plaster cement layer begins to separate from the base material. At the same time, due to its higher strength, the cement plaster tears off the layers of the base layer, intensifying the process of destruction of structures and the building as a whole. The use of lime-sand mixtures for facade works is problematic due to their prolonged hardening.

The relevance of the study. In connection with the above, an urgent task is to develop limestone-compatible repair compositions of domestic production that can compete with foreign, much more expensive analogues. The repair and protective composition being developed should be chemically compatible with the limestone-shell rock material and have additional special properties: strength and vapor permeability consistent with the base material, increased water resistance, improved adhesion, accelerated curing, and relatively low cost.

The aim of the study is to analyze ways to improve the water resistance of plaster mixtures based on gypsum binders intended for the repair of exterior walls of limestone-shell rock buildings.

Analysis of research and publications. In order to meet the above requirements, the main component of the plaster mixture is G5 construction gypsum. This is justified by the following properties of the material, namely: chemical compatibility with limestone; accelerated hardening and strength gain of the plaster; eliminates shrinkage of the cement component; is a relatively cheap, environmentally friendly substance; meets the requirements for saving resources and energy during its production.

However, a significant drawback of materials based on pure gypsum binders is their low water resistance, the main reasons for which are: high solubility of calcium sulfate dihydrate, wedging effect of water molecules and high binding porosity of hardened gypsum stone [1]. One of the most effective ways to increase the water resistance of materials based on gypsum binder is to create mixtures based on gypsum and cement with the addition of components with pozzolanic activity [2].

Results obtained. At the first stage of the development of the repair composition, a variant was implemented using the so-called gypsum-cement-pucolanic binder (GCPB) – gypsum in combination with cement (ground clinker) and ash as a pozzolanic additive. Slaked lime was added to the original mixture to increase plasticity and water resistance. In the planned 3-factor experiment, the mass content of cement, lime, and ash was varied from a stable amount of gypsum. This paper deals with the issues related to increasing the resistance of the developed plaster mix to the action of water.

The water resistance of building materials and products is usually assessed by the softening coefficient, which is the ratio of the strength of a material saturated with water to its dry strength – $K_s = R_{wet}/R_{dry}$. If the coefficient of softening is greater than 0.8, the material is considered water resistant. The softening coefficient of construction gypsum ranges from 0.3 to 0.45. The determination of the softening coefficient of gypsum-containing materials is complicated by the lack of regulatory requirements for measurement conditions. In principle, the softening coefficient ambiguously reflects the actual water resistance of the material. Its value depends on the ratio of strengths in the water-saturated and dry states, and in some cases, materials with lower strengths may have a higher Ks than materials with higher strengths. A more correct criterion for assessing water resistance, in our opinion, may be the water resistance index, in which the role of material strength in the wet state is "enhanced" – $I_w = R^2_{wet}/R_{dry}$ [3].

The water resistance was determined after 2 hours of soaking the samples and after 48 hours of soaking, taking into account the presence of slow-hardening components in the mixture – cement and lime. The strength loss in the latter case averaged 30 percent. However, the minimum strength of the samples after 48 hours of soaking was in the range of 2.5÷4.5 MPa, which exceeds the strength of limestone-shell rock even in the natural state of moisture. The strength in the dry state was taken as the strength of the dried samples after 7 and 28 days of curing.

Conclusions and results. The softening coefficient (as well as the water resistance index) significantly depends on the test conditions, especially for mixed binder formulations with different curing times; the water resistance index more accurately reflects the water resistance of the material. The softening coefficients, defined as the ratio of the strength of the samples after 2-hour exposure to water to the dry strength at 7 days of age, are maximum for all samples; the Ks values of some samples are close to 0.8, which allows us to consider these compositions as waterproof even without the use of hydrophobic additives.

The water resistance of the repair compound under development can be further increased by volumetric hydrophobization during the manufacture of the mixture or during surface treatment of the already applied plaster layer. From the point of view of process manufacturability and durability of the plaster, volumetric hydrophobization is more appropriate. Six hydrophobic additives of different chemical nature were selected for studies to determine the comparative effectiveness of water repellents. The following indicators were taken as criteria for the effectiveness of a water-repellent additive: water absorption (by weight), wetting edge angle, and softening coefficient.

The most effective of the considered water repellents was the domestically produced additive GKZH-11K, the use of which made it possible to obtain a material with a Ks exceeding 0.8.

References:

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