REPAIR MIXTURE FOR LIMESTONE-SHELL BUILDINGS

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According to the analysis of the situation, the destruction of limestone-shell rock buildings in the historic center of Odesa has been increasing and accelerating in recent years. The most important reason for this phenomenon is the violation of the integrity of the plaster layer and the moisture of the wall material, which leads to a decrease in the bearing capacity of the structure and its destruction. In addition to the natural aging of materials and the effects of negligent operation, there has been damage and destruction of structures as a result of military operations.

When repairing damaged shell rock structures with cement-sand compositions, destructive processes are intensified due to the inconsistency of the properties of the materials of the repair composition and the base layer: the vapor permeability of the cement layer is less than the vapor permeability of shell rock, and its strength is significantly higher than that of shell rock.

Thus, the development of domestically produced limestone-compatible repair compositions capable of competing with foreign, much more expensive analogues is an urgent task. The following characteristics were chosen as the target settings for the development of the repair and protective composition under development: chemical compatibility with limestone-shell rock, strength and vapor permeability consistent with the base material, increased water resistance, improved adhesion, accelerated curing, etc.

Based on the above requirements, the main binder component of the repair mix is G5 construction gypsum, which is a relatively cheap binder that is "limestone-friendly" in its chemical composition, meets environmental safety requirements and saves resources and energy during its production. However, a significant drawback of materials based on gypsum binders is their low water resistance. Over the past decades, the most effective ways to improve the water resistance of gypsum binder-based materials have been identified: 1) creation of mixtures with reduced solubility based on gypsum and cement with the addition of components with pozzolanic activity (ash and slag, fly ash) to prevent the formation of ettringites; 2) use of water repellents. At this stage, the 1st option is being implemented, the so-called HCP binder is used.

The adopted composite binder consists of gypsum in combination with cement (ground clinker) and fly ash as a pozzolanic additive. Slaked lime was added to the original mixture to possibly increase plasticity and water resistance. The purpose of the research at this stage was to analyze the effect of the type and amount of cement, lime, and fly ash on the strength, water resistance, adhesion, and setting time of the mixture.

The composition of the binder part of the repair composition was selected based on the results of a 3-factor experiment according to the B3 plan. With a constant amount of gypsum for all points of the plan, the type and content of 3 components were varied - cement, lime (40-60% of gypsum) and ash (20-60% of gypsum). The test specimens were made in the form of beams with dimensions of 160x40x40 mm. The bending and compressive strength, water resistance, adhesion to shell rock, and vapor permeability of the cured mixture were determined.

Since the mixture contains a cement-lime component in addition to gypsum, which hardens more slowly, the strength measurements were performed at 7 and 28 days after the mixture was set. The graphs of strength versus density at the age of 7 and 28 days are shown in Figs. 1a and b, respectively. Blue marks indicate bending strength, red marks indicate compressive strength.

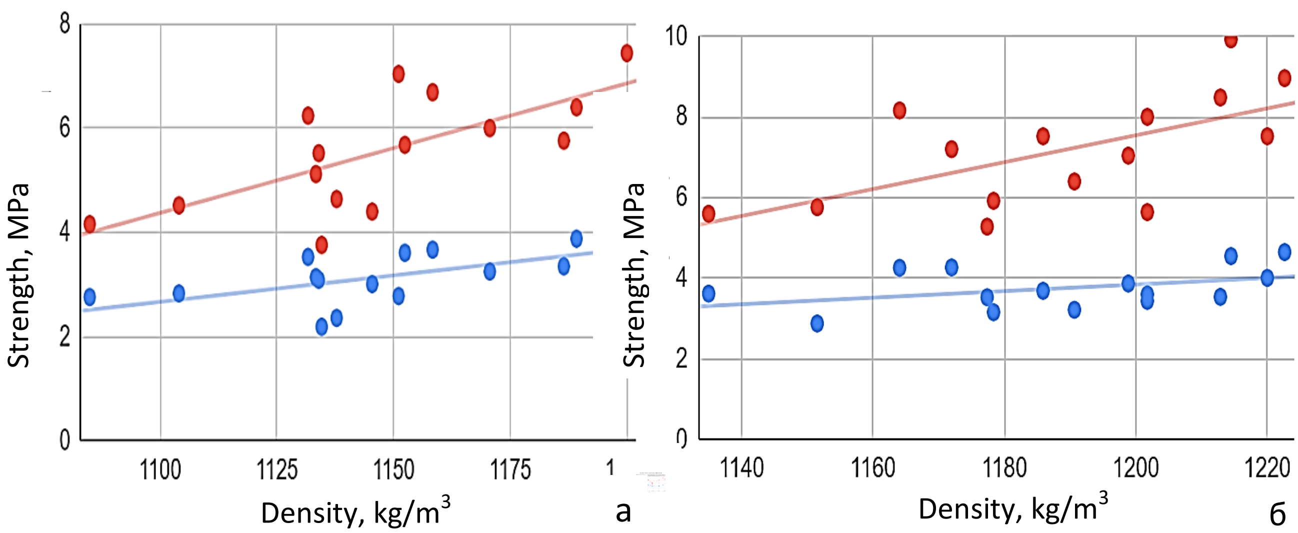

Fig. 1: a - bending and compressive strength at the age of 7 days; b - bending and compressive strength at the age of 28 days.

The increase in strength at 28 days compared to the strength after 7 days is about 30 percent. The compressive strength reaches almost 10 MPa and the tensile strength - 4 MPa. And this is with low-grade gypsum and without the use of plasticizing additives and reinforcing microfillers. Such a high strength of the plaster mixture in the hardened state is, in principle, unnecessary, especially for plastering limestone-shell rock, but it makes it possible to add various inert fillers to the mixture, such as ground stone heating waste, which will reduce the consumption of expensive binder and, accordingly, the cost of the repair mixture when bringing (reducing) the strength to the standard values.

The water resistance was determined after 2 hours of soaking the samples (standard requirements for gypsum mixes) and after 2 days. The strength reduction in the latter case compared to two hours of soaking was on average 30 percent. 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 in the natural state of moisture.

The influence of the mixture components on water resistance is studied both using the standard indicator - the softening coefficient - and using the water resistance index proposed by us, which takes into account the square of the strength in the wet state, which increases the role of this characteristic as more significant for designers. The water resistance of the mixture under development can be further increased by using water repellents in the manufacture of the mixture or in the surface treatment of the already applied plaster layer. Further improvement of the composition of the repair composition, in accordance with the specified quality criteria, is possible through the use of fillers and chemical additives for various functional purposes.