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Preliminary communication

THE INFLUENCE OF CONSTRUCTION AND PROCESS DESIGN ON IMBIBITIONAL PROPERTIES OF "WATERPROOFING − LIMESTONE SHELL" SYSTEM

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Abstract: Absorption capacity and water absorption as the main factors determining the strength and adhesion of waterproofing with stone have not been sufficiently studied. The need to establish this characteristic of the stone is due to the difference in the behavior of its porous system in the dry state and after absorbing moisture from the volume of water and the solution. The article presents a solution to the problem of increasing the effectiveness of waterproofing plastering systems by selecting the optimal technological factors: the type of material, the number of layers and the time of full water saturation.

Keywords: imbibitional properties; limestone shell system; mastic waterproofing; plastering waterproofing

1 INTRODUCTION

In the modern world, most people prefer to live in houses with good ecological characteristics. This promotes the use of natural building materials, with excellent environmental qualities. One of such material is limestone-shell.

Since several thousand years, buildings and structures have been constructed from this material [1]. Today, many of them are monuments of architecture. In the last century, the issue of preserving monuments of cultural heritage, including Odessa, was sharply raised. In the official list of monuments of town-planning and architecture of Odessa, 700 buildings and structures were added. Only 31 % of them are in good technical condition and do not require major repairs and restoration. The remaining 69 % of monuments of cultural heritage require, to different extents, major repairs, restoration or replacement of structures and building elements.

Based on the results of the processing of technical and design documentation from the archival data of the housing and communal services and design organizations, buildings and structures that are made of bond shell - limestone or have constructional structural parts from this building material, make up 26 %.

The reasons for damaging the waterproofing course are most often the following: non-compliance with the technology of the waterproofing device; low quality of the material; change in groundwater table; incorrectly chosen type of waterproofing; low adhesion bond strength; works on the base with excessively high humidity; violation of the dosage of waterproofing components; deformation caused by the displacement of the individual building elements relative to each other, etc. Moreover, the practice of building management shows that the destruction of open joints, and consequently the disruption of the continuity of waterproofing, is one of the main reasons for premature deterioration of structures, increased costs for repair, and restoration work and deterioration of the operational characteristics of the building. The damages of the waterproofing system are the most common cause of failure of subsurface structures [2].

Thus, one of the topical problems of the building complex is the problem of destruction of shell - limestone structures due to the absence or damage of waterproofing.

One of the factors affecting the durability of the structure, shell-limestone in particular, is the effect of moisture; namely, alternate moistening and drying of the material, regardless of the temperature regime. This is especially true for materials with a capillary - porous structure. Evaporation of moisture from the structure occurs by drying, first from large, and then from smaller pores of capillaries.

It is assumed that for some period in completely air-dried conditions, the evaporation of free capillary and absorbed-bound water from the body of the structure is possible. At the same time, the wedging forces play out on the structure, and as a result, considerable shrinkage stress appears in the material.

With increasing relative humidity of the surrounding air, the material is again moistened, the cracks are unfolded. The rate of destruction of stone structures under the influence of stress, shrinkage and bulging depends on the intensity of moistening and drying [1].

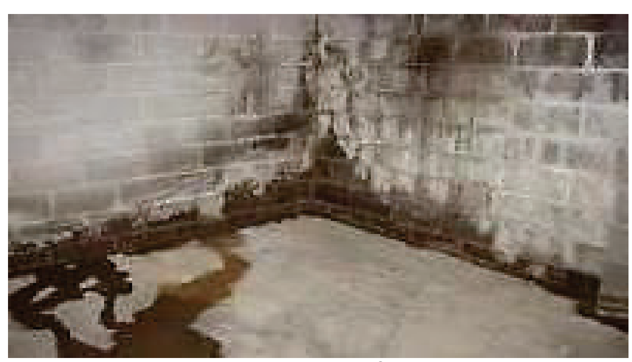


Figure 1 Mayakovsky Street 5

One can give enough examples of such buildings in the historic center of Odessa; several of them are shown in Fig. 1÷3.

Figure 2 Pushkinskaya Street 20

Figure 3 Kanatnaya Street 39

The study of the influence of constructive technological solutions of the system "waterproofing limestone-shell" will increase the protection from the effects of capillary rise and water absorption, providing reliable and durable operation of buildings and structures from shell limestone.

The following authors studied the absorption characteristics of shell-limestone: Komyshev A. V., Eremenok P. L., Izmailov Yu. V., Figarov A. G., Orujev F. M., Tursunov N. T., Shcherbina S. N. Scientific works of scientists such as Shilina A. A., Lukinsky O. A., Khomenko V. P., Leonovich S. N. were scientific and theoretical basis of waterproofing research conducted by Karapuzov E. K, Soha V. G., et al. However, the absorption characteristics of the "waterproofing - limestone-shell" system of the limestone-shell of the Odessa deposit have been little researched.

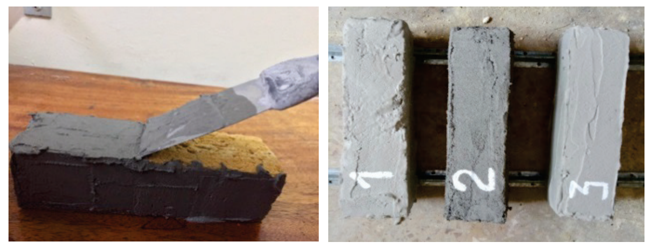
To a great extent, the main factor determining the formation of the strength of the mortar durability and the strength of adhesion in the bond is the suction capacity, determining the ability of the stone to absorb moisture out of the green mortar. The necessity in establishing this characteristic of the stone is due to the difference in the behavior of its pore system upon the absorption of moisture from the volume of water and from the mortar [7].

According to the results of the analysis given in [8], one of the rational methods of the waterproofing system is plaster waterproofing with the use of dry mixtures and cold mastics.

The pre-selected samples were weighed to determine the weight and volume in the dry state before the application of the waterproofing mixture itself, and marked with the number of the series and the direction of bedding of the stone structure.

Waterproofing mixture of dry powders was prepared by gradually adding them to the water under constant agitation until it turned into a viscous mass, which was applied with a spatula. The material was applied according to the experimental design in one, two and three layers on a dry and wet surface of the sample. To prevent coating during application, the direction of each subsequent layer was perpendicular to the previous layer. The thickness of the layers did not exceed 1÷2 mm to prevent the formation of cracks. Mastic was applied by brush. Each subsequent layer was applied only after the previous one had dried completely.

The process of applying plaster and mastic waterproofing are shown in Figs. 4÷5



a) b)

Figure 4 Application of waterproofing on the basis of dry mixes

a) b)

Figure 5 Application of bitumen-rubber and acrylic mastics

The essence of the investigation was the determination of the impact of structural and technological solutions on the absorption properties of the system "waterproofing - limestone-shell".

2 RESULTS OF EXPERIMENTS

The investigation of the intensity of the suction capacity was determined by the amount of water in grams absorbed in 1, 2, 3 minutes by one dm^2 of the air-dry stone surface and treated with a certain kind of waterproofing (according to the experiment's plan) immersed in water at a depth of 5 mm, 10 mm and 15 mm.

The graph of Figs. 6÷10 is constructed according to the results of the investigation of the water absorption of limestone-shell not treated with waterproofing composition.

Based on the results of the studies, graphs of the dependence of the water absorption coefficient of the "waterproofing - limestone-shell" system on variability factors are constructed, Figs. 11÷19.

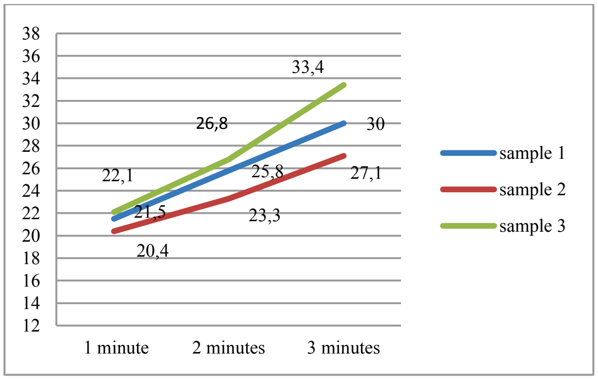


Figure 6 Determination of the water absorption coefficient of limestone-shell rock, "Gidrozit".

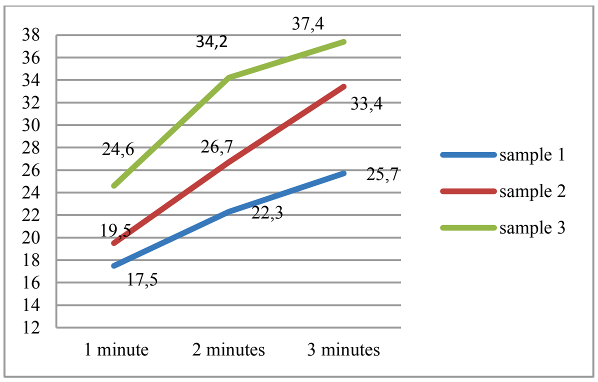


Figure 7 Determination of the water absorption coefficient of limestone-shell rock, "Siltek V-30".

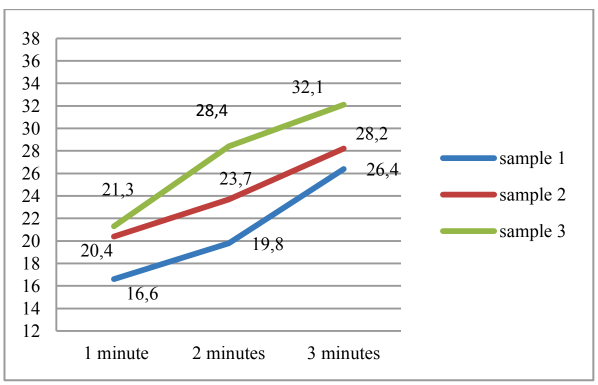


Figure 8 Determination of the water absorption coefficient of limestone-shell rock, "Ceresit CR 65".

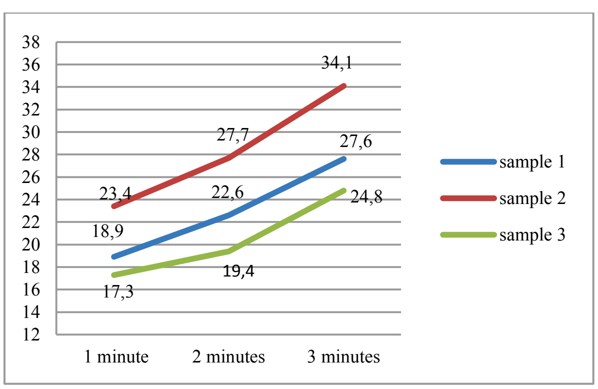


Figure 9 Determination of the water absorption coefficient of limestone-shell rock, mastic "AQUASTOP".

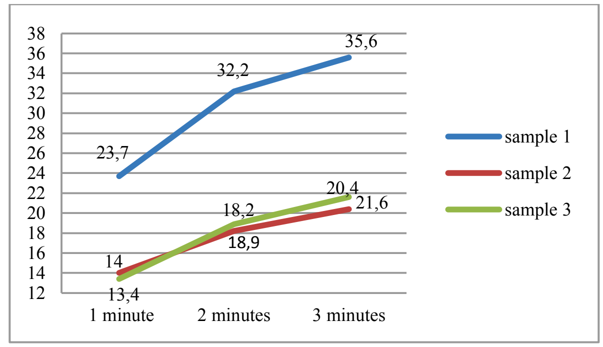


Figure 10 Determination of the water absorption coefficient of limestone-shell rock, Bitumen-rubber mastic.

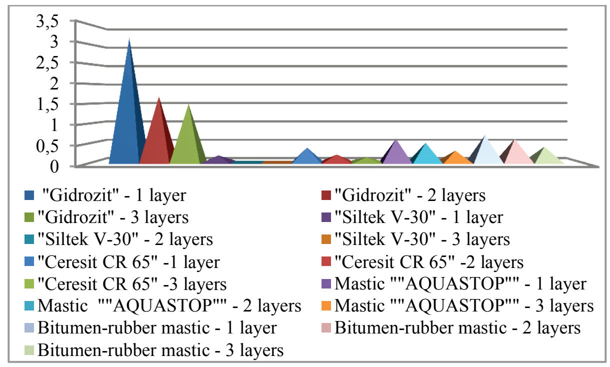


Figure 11 Values of water absorption of the "waterproofing-limestone-shell" system immersed in water by 5 mm, 1 minute.

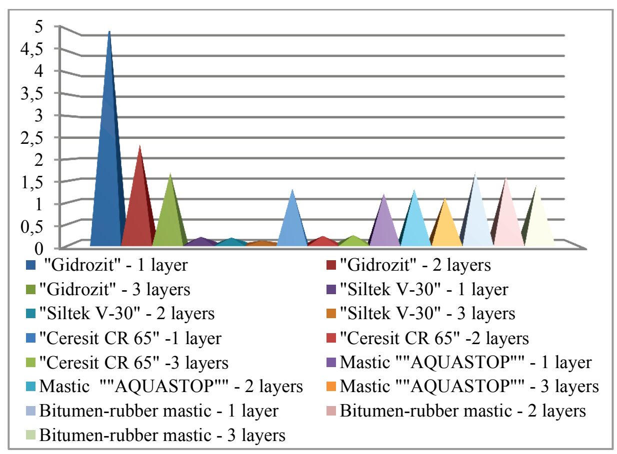


Figure 12 Values of water absorption of the "waterproofing-limestone-shell" system immersed in water by 5 mm, 2 minutes.

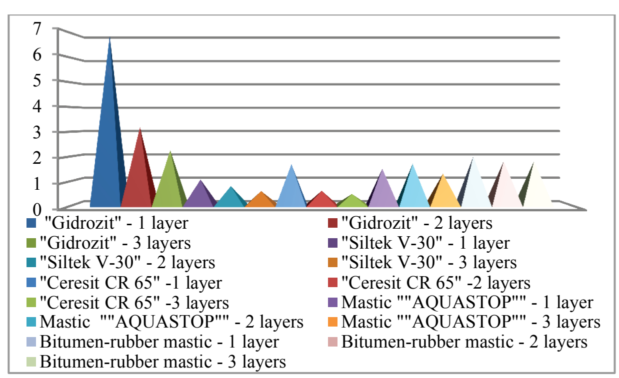


Figure 13 Values of water absorption of the "waterproofing-limestone-shell" system immersed in water by 5 mm, 3 minutes.

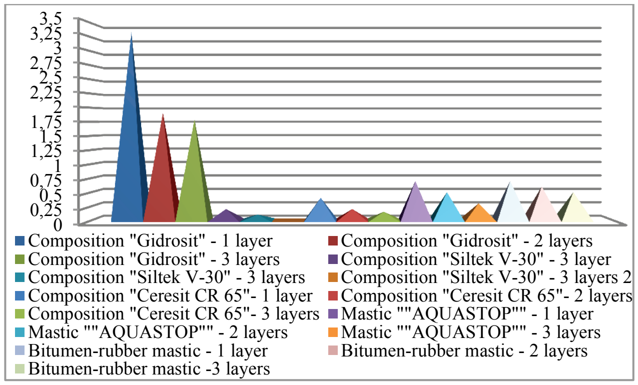


Figure 14 Values of water absorption of the "waterproofing-limestone-shell" system immersed in water by 10 mm, 1 minute.

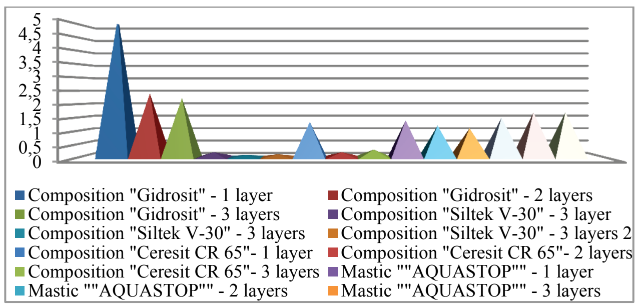


Figure 15 Values of water absorption of the "waterproofing-limestone-shell" system immersed in water by 10 mm, 2 minutes.

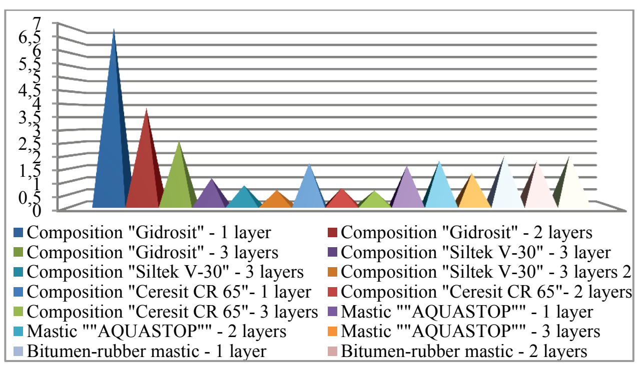


Figure 16 Values of water absorption of the "waterproofing-limestone-shell" system immersed in water by 10 mm, 3 minutes.

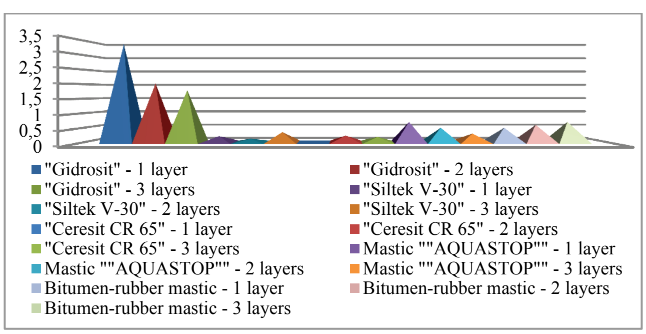


Figure 17 Values of water absorption of the "waterproofing-limestone-shell" system immersed in water by 15 mm, 1 minute.

The water absorption increases with increasing time from 1 to 3 minutes. At the same time, the water absorption depends on the type of material and the number of layers of their application.

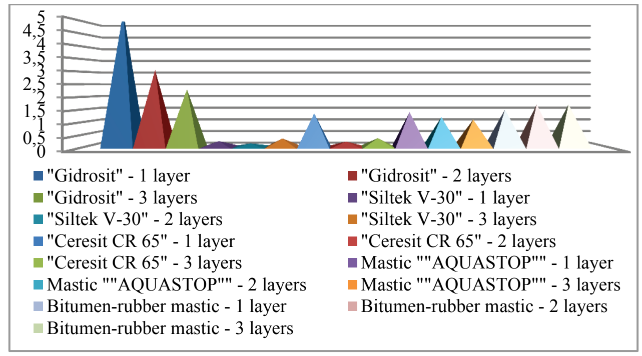


Figure 18 Values of water absorption of the "waterproofing-limestone-shell" system immersed in water by 15 mm, 2 minutes.

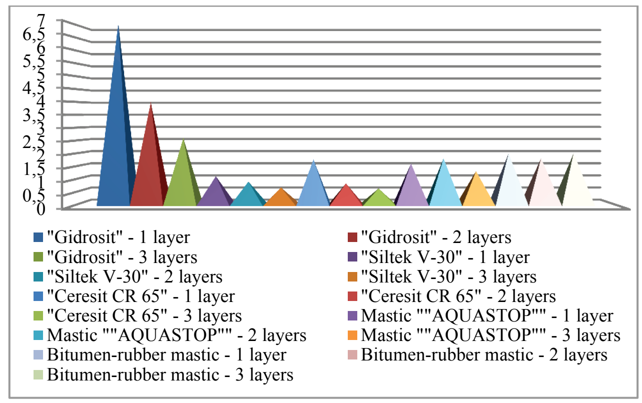


Figure 19 Values of water absorption of the "waterproofing-limestone-shell" system immersed in water by 15 mm, 3 minutes.

The directionality of the stone layers relative to the surface and its composition impact on the value of the suction capacity of the stone. The suction of moisture from the solution along the layers of rock is more intense than in the direction perpendicular to the bedding. The maximum value of the suction capacity for the stone of a given deposit is affected by the type of material that showed the minimum water retention capacity. These are samples processed by the composition "Hydrozit". For example, when immersed at a depth of 5 mm, treated in one layer with this composition, the samples showed water absorption: after 1 minute - 3.19 g; after 2 minutes - 5.25 g; after 3 minutes - 6.94 g. An increase in the immersion depth of the samples shows that the water absorption rate of samples treated with a layer increases by 0.16 g, by immersion at 10 mm and by 0.2 g -by immersion at 15 mm.

Varying the depth of immersion did not affect the water absorption rates of specimens treated with AQUASTOP mastic.

According to the comparative analysis, the initial intensity of water absorption of limestone-shell rock decreases with the installation of waterproofing systems, depending on the type of material and the number of layers.

This indicates a decrease in the intensity of water absorption compared to the initial intensity of limestone and waterproofing systems (3 layers of application), which is: Hydrosite - 4.96 times; Siltek V-30 - 63.4 times, Ceresit CR 65÷68.3 times; Mastics: "AQUASTOP" - 19 times; Bitumen-rubber mastic (BRM) - 12 times.

When comparing the parameters of the processed samples with one layer and three layers, it was found that the decrease in water absorption after 3 minutes is: Hydrozit ÷3.08 times; Siltek V-30 - 1.8 times, Ceresit CR 65 - 3.6 times; Mastics: "AQUASTOP" -in 1.15 times; Bitumen-rubber mastic (BRM) - in 1.1 times.

At the initial intensity, the structure of limestone-shell rock also has an impact. In most cases, the pores of limestones are of various shapes - micro-and macro capillaries of variable cross-section. The larger the diameter of the bulk of the capillary pores of the stone, the higher the value of its initial water absorption intensity. Results of the tests of the intensity of capillary suction capacity of the rock are constructed in Figs. 20÷28.

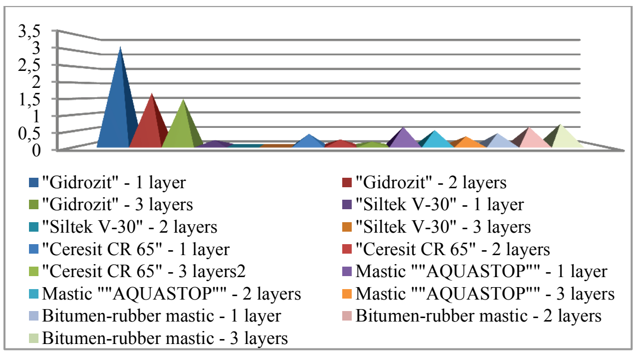


Figure 20 Intensity of capillary suction capacity of the rock submerged in water at 5 mm, 1 minute.

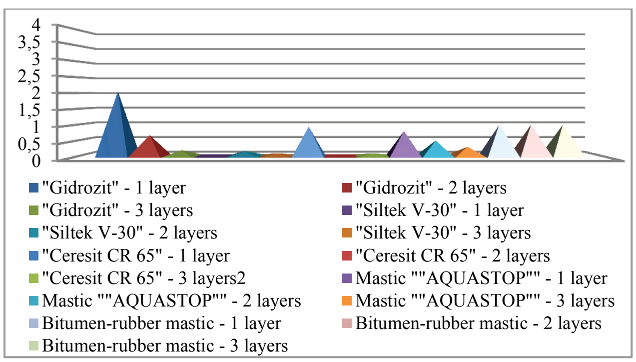


Figure 21 Intensity of capillary suction capacity of the rock submerged in water at 5 mm, 2 minutes.

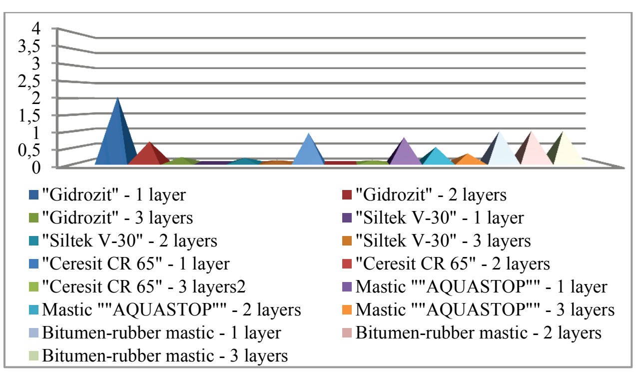


Figure 21 Intensity of capillary suction capacity of the rock submerged in water at 5 mm, 3 minutes.

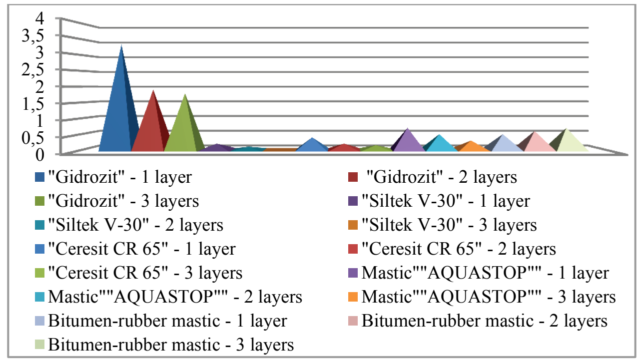


Figure 23 Intensity of capillary suction capacity of the rock submerged in water at 10 mm, 1 minute.

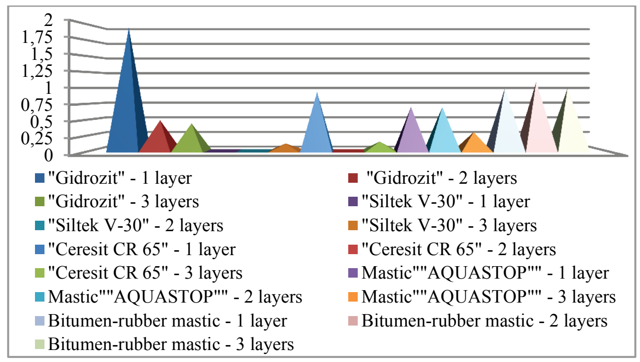


Figure 24 Intensity of capillary suction capacity of the rock submerged in water at 10 mm, 2 minutes.

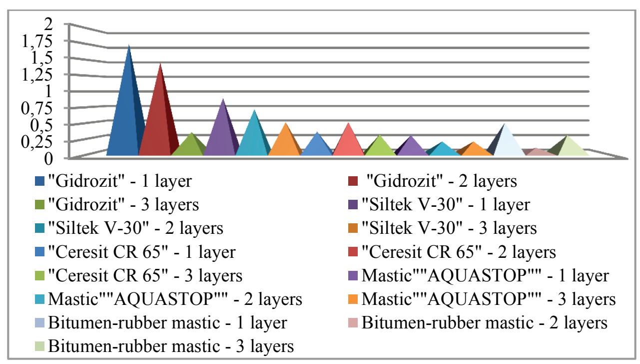


Figure 25 Intensity of capillary suction capacity of the rock submerged in water at 10 mm, 3 minutes.

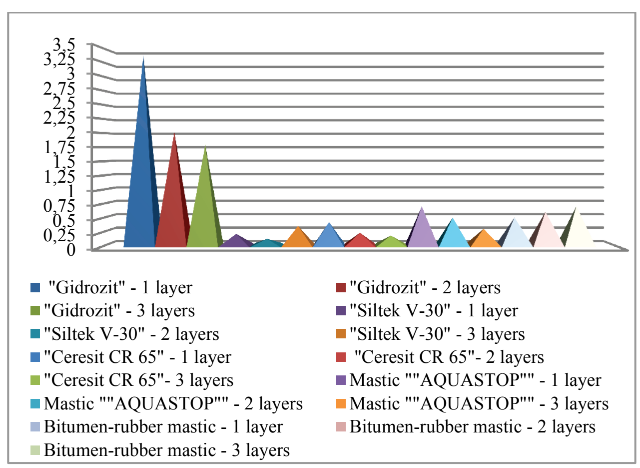


Figure 26 Intensity of capillary suction capacity of the rock submerged in water at 15 mm, 1 minute.

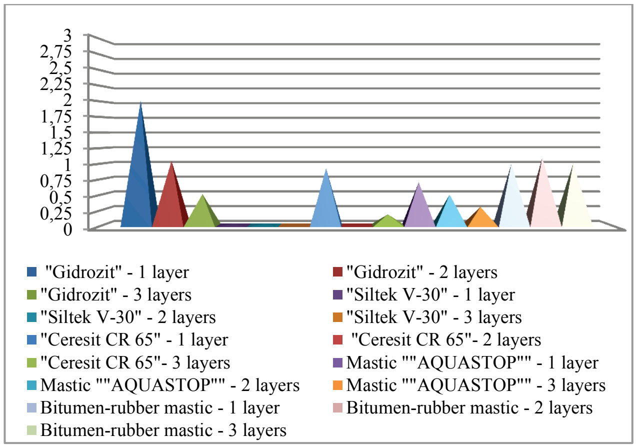


Figure 27 Intensity of capillary suction capacity of the rock submerged in water at 15 mm, 2 minutes.

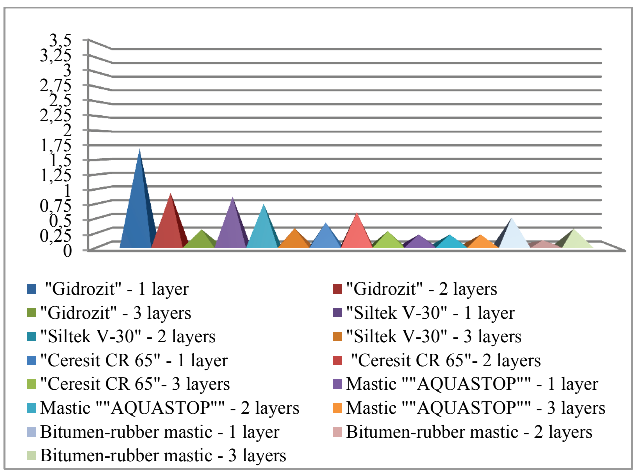


Figure 28 Intensity of capillary suction capacity of the rock submerged in water at 15 mm, 3 minutes.

The minimum value of water absorption (0.47 g) was shown by a series of samples No. 9 treated with Ceresit CR 65 in 3 layers after 3 minutes. At the same time, samples of the No. 6 series, treated with Siltek V-30 in 3 layers, showed a minimum of this value during the first 2 minutes (0÷0.09 g).

As the research results show, in most cases the suction intensity decreases after the elapse of time, except the Siltek V-30 waterproofing system (series of samples No. 4, 5, 6). As can be seen in the graph, the intensity of absorption increases at the third minute, regardless of the depth of immersion, and with increasing the number of layers of waterproofing, the intensity of the suction capacity decreases.

3 CONCLUSION

1) The effect of technological parameters of waterproofing on the capillary suction of the treated structure is studied.
2) The indicator of water absorption intensity of the system "waterproofing-limestone shell", limestone-shell was determined.
3) The indicator of the intensity of capillary suction capacity is determined.
4) The analysis of the obtained data is carried out.

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