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Solid Organic Silicon Additives as Effective Modifiers of Building Mortar

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Abstract

A series of organical silicon damp-proofing modifying additives "TKD" has been developed. TKD's may be added to building-mortars in the form of powder or paste in an industrial way or on the building-site. The results of tests showed that in all the cases of the use of additives the durability and imperviousness to corrosion as the result of physical erosion increases.The additives practically do not decrease the diffusion of vapour. The adoption of these newly developed modifiers of the building mortars in the practice of building and restoration may be considered as quite promising and as a technological innovation.

Keywords: TKD, additives, durability, vapor diffusion

1 Introduction

It is well known, that an effective protection of enclosing constructions against humidification can be secured by a plaster finish if a double finishing-system is used, consisting of a decorative layer and a priming layer underneath. The latter should have the function of a damp-proofing buffer in the case of a damaged upper layer and to provide for a reliable protection against the agressive influence of polluted air in the urban environment. Often these last mentioned functions of the priming layer are transferred onto the plaster-layer. Existing methods of modification of priming and plaster layers, such as impregnation or addition of polymers to the mortar have quite a lot of shortcomings. The effectivity and reliability of impregnation with silicons greatly depends on the humidity of the surface to be treated, and of the air.

Modification of the mortar with polymers may provide for protection against humidity as a result of rainfall, although this mehod significantly reduces the diffusion of vapours in the enclosing constructions. Reduction of diffusion of vapour leads to a disturbance of the hydrostatic balance in the walls. As a result of capillary condensaion and the disturbance of the moisture-exchange the walls do not ensure the proper thermal insulation anymore and processes of biological corrosion of the building materials will be activated.

The Moscow State Building University in collaboration with DWRus Ltd. has developed a series of organical silicon damp-proofing modifying additives 'TKD', consisting of two groups: gas-generating additives (H) and polyfunctional additives with structuring effect (S). Samples were examined of the series of additives TKD-H and TKD-S, obtained from silicon-compounds (silanes) by way of a reaction of hydrolytical condensation. A side-product (TKD-S-AI) of the synthetic reactions involved in the purification of industrial circulating water was also examined.

2 Characterisation of additives

The additives were physico-chemically examined by means of X-ray structural analysis (fig. 1), infra-red spectroscopy (fig. 2), electronic microscopy (fig. 3), enthalpiometric and volumetric analyses. The TKD's turned out to

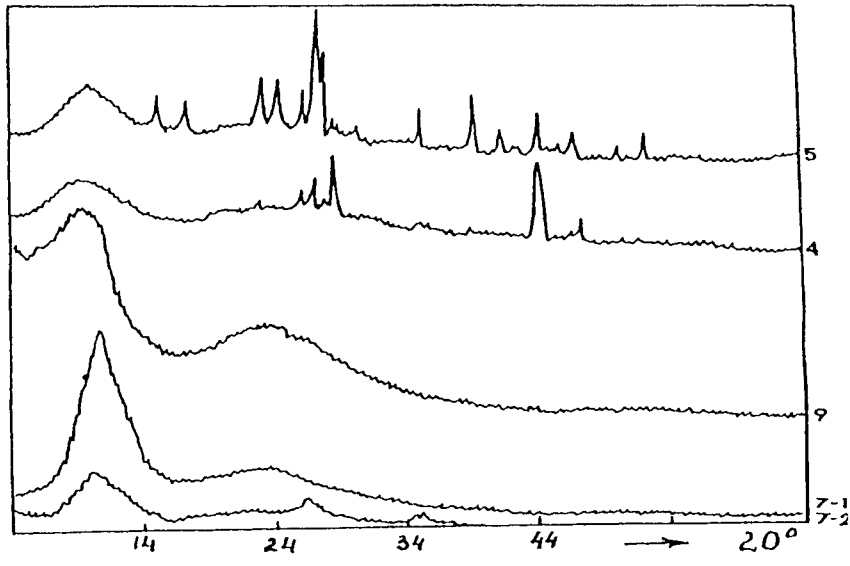

Figure 1: X-ray structural analysis of additives

have an oligomeric structure and to contain the following active functional groups: -H, Si-Si, -OH, -OR, -R and others. The amorphous phasic composition of the additives, similar to that of silicon gels, enlables ttheir active participation in the formation of microstructures of building-mortars, and as a result of a reaction with the alkaline component of the astringent, the additive increases the imperviousness of the mortars to corrosion. The presence of organic radicals such as methyl and propyl gives the additives their damp-proofing quality.

TKD may be added to buiding-mortars in the form of powder or paste, both in an industrial way, i.e. in plants, as on the building-site. The modification of the mortar ensues in a physico-mechanical way from mixing, etc.

The modifying effect of TKD was examined in building mortars with traditional astringents, such as lime, Portland-cement and gypsum. As a result of the structuring effect of the additives the character of the poreous structure of the material changes.

The modification of cement-brick by means of TKD-S, for instance, leads to a decrease of the general microscopic poreousness of 4,6 % up to 12,5% (in comparison with control-material), and furthermore to a decrease

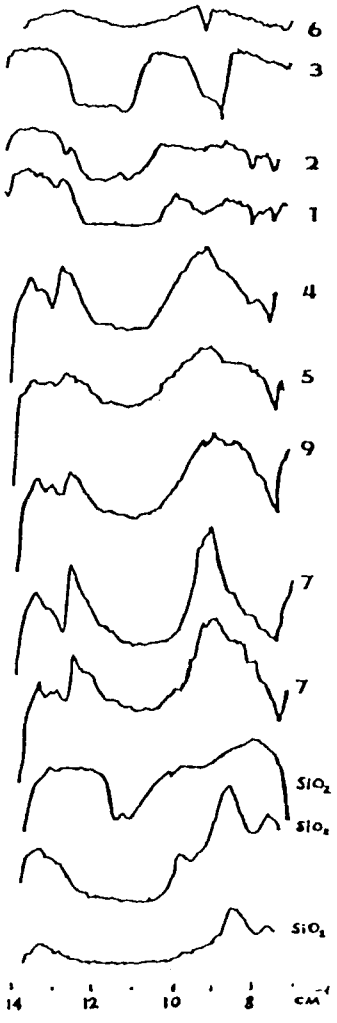

Figure 2: IR-spectroscopy of additives

of the size of the pores where the fine poreousnetss is concern.ed. The formation of the improved structure of cement-brick has a very favourable effect on its solidity and durability as far as corrosion is concerned. The tests have shown the propitious effects of a series of additives on the imperviousness of cement-brick and building mortar to corrosion Samples of cement-brick were kept for 12 months in agressive solutions and after this period the

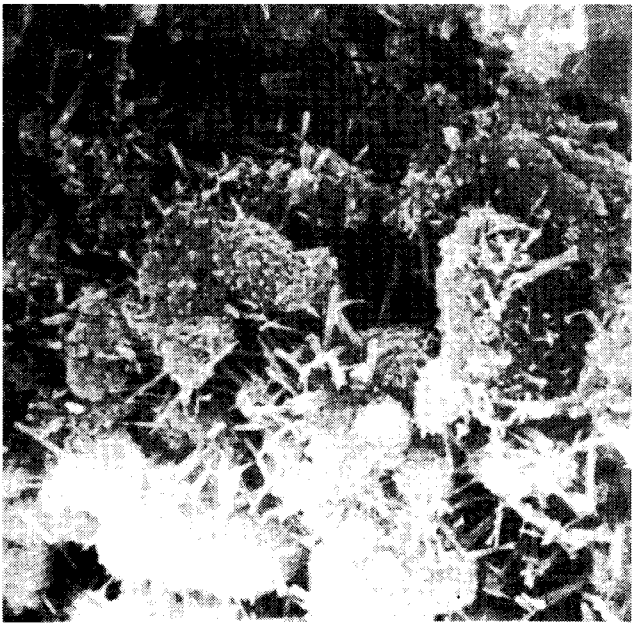

Figure 3: electronic microscopy

durability coefficient of modified cement-brick turned out to be: 0,96 in a solution of HCl and 0,95 in a solution of $MGSO_4$, which is respectively 31% and 22% more than in the case of the control-samples. In the case of modified building-mortar with a cement-sand proportion of 1 : 3 the durability-coefficient also turned out to be higher than in the case of control-samples that were kept in the aforementioned agressive environments. After a test-period of 12 months the durability-coefficient turned out to be 0,98% in a solution of HCl and 0,96% in a solution of $MGSO_4$, which is respectively 24% and 20% more than in the case of the control-samples.

In all the cases of the use of additives the durability and imperviousness to corrosion as the result of physical erosion increases. For example, tests in a sprinkler system (these tests were carried out at the Technical University of Western Berlin) showed that samples of gypsum to which TKD-S-AI was added, retain their durability up to 40 cycles. The solubility of the gypsum-astringent decreases and its imperviousness to water increases. When TKD-N is used to modify gypsum-stone, the result is a poreous type of stone with improved hydro-physical and thermo-physical qualities: its density equals

up to 300kg/m^3, its strength on contraction 0,6 MPa, and on bending 0,3 MPa.

The additives practically do not decrease the diffusion of vapour, and the absorption of water, determined according to the "Karsten" method, remains zero, when measured during an hour with a water-column of 92 ml.

3 Conclusions

Thus, the adoption of these newly developed modifiers of building-mortars in the practice of building and restoration may be considered as quite promising and as a technological innovation. The group of TKD compounds, produced by means of ethorefication and the hydrolysis of silanes may be at the same time effectively used for specific purposes, such as the improvement of the thermo-protective qualities of building mortars, the increase of their imperviousness to acid, to bio-chemical corrosion, etc. For the modification of plaster-mortars in order to improve their water-proofing quality in the case of use on a large scale the solid additives of the series 'AI' are recommended because of their relative low price, as they are the side-product of the purification of circulating waters of industries where the synthesis of organic silicon compounds takes place.

References

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