

TEORIJSKE OSNOVE PROJEKTIRANJA RECEPTURE ŽBUKE ZA ZAŠTITU ZIDOVA ZGRADA I OBJEKATA IZRADENIH OD PORASTOG AERIRANOGA BETONA

THEORETICAL BASES OF PLASTER SOLUTIONS DESIGNING FOR WALL PROTECTION OF BUILDINGS AND STRUCTURES MADE OF AUTOCLAVED AERATED CONCRETE

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Professional paper

Abstract: *Plaster covering and AAC masonry compatibility work depends on its specification and structure. It is therefore necessary to understand the processes of structure formation during the stucco compound solidifying and deliberate action on it. The article reviews the processes of polymer-cement plaster covering structure formation. The role of mix ingredients in the process of the structure formation is marked and also their influence on plaster covering. On the basis of understanding the structure formation process, a technologist can structure the material purposefully and by that give certain physical and mechanical properties and crack resistance to plaster covering.*

Keywords: *Plaster covering, processes of structure formation, AAC masonry.*

Stručni članak

Sažetak: *Zajednički rad obloge žbukom i AAC zidova ovisi o njegovim karakteristikama i strukturi. Stoga je potrebno razumjeti procese formiranja strukture tijekom stvrdnjavanja žbuke i potrebnih planiranih djelovanja. U članku se razmatraju procese formiranja strukture polimerne žbuke. Označena je uloga komponenata smjese u procesu formiranja strukture i njihov utjecaj na svojstva žbuke. Na temelju razumijevanja procesa formiranja strukture tehnolog može svrhovito oblikovati strukturu materijala i time dati određene očekivane fizičke i mehaničke osobine i otpornost žbuke na pucanje.*

Ključne riječi: *žbuke, procesi formiranja strukture, zidovi od porastog aeriranog betona*

1. INTRODUCTION

The structure of polymer-cement stucco compound consists of polymer-cement matrix, aggregate, the filling agents and micro-dispersed reinforcement. Since the characteristics of stucco depends on its structure, it is important to understand the processes of structure formation and influence on its progress purposefully.

The structure formation of polymer-cement composition is predetermined by the cement hydration processes and the formation of polymeric membranes, their interaction with micro dispersed reinforcement, filler agent and aggregate. The process consists of the following stages: wettability, adsorption, dissolving, hydrolysis, nucleation, crystal growth, recrystallization, formation of the polymer membrane [1, 2].

Mechanism of hardening includes:

- dissolving of cement and polymer, cement hydration to form a gel and the nucleation of crystalline hydrates
- adsorption of polymeric particles on the surface of the gel, crystalline hydrates, fine aggregate and filling agent
- the formation of polymer-matrix contact zone for fine aggregate and filling agent

- the formation of the contact zone «gas concrete bond-plaster coating»
- splicing together of crystal hydrates and their germination through polymeric membranes
- the evaporation of water and the formation of polymer membranes as the final stage of polymer-composite structure formation

Consider the structure formation processes in details. Cement hydration starts after mixing with water. In the process of hydration, water free brick minerals (silicates, aluminates and aluminates ferrites calcium) turn into the corresponding crystalline hydrates - hydro silicates, hydro aluminates, hydroferrity calcium, and calcium hydroxide. Super plasticizing agent, adsorbing on the hydrating cement grains, reduces their clustering and disaggregates cement conglomerates formed [1,3]. Fast (30-60 seconds) redispersable polymeric powder (RPP) dispersal in water is taking place, forming an aqueous dispersion with a particle size of 0.01-0.5 mm [2,4] (Fig. 1).

Upon reaching a certain critical concentration in the liquid phase dispersion medium, aggregation unstable system proceeds to coagulative structure. There volumetric space frame formed by the dispersed

particles, which are interconnected through thin aqueous layer and aqueous polymer dispersions.

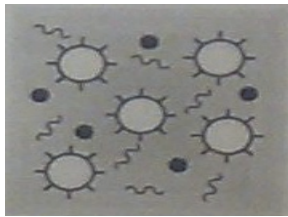


Figure 1 Formation of aqueous dispersion polymers PFR

Polymer particles influence on material structure formation. The particles settle down on the surface of the cement gel, unreacted grains of cement, fine aggregate, and aggregated as a polymer membrane, which comprises a volume of water molecules (Fig. 2).

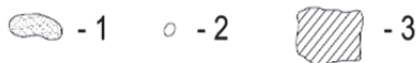
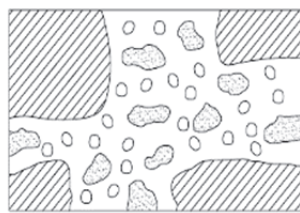


Figure 2 The Structure of stucco compound after mixing with water, 1. Nonhydrated cement grains 2. Polymer particles 3. Fine aggregate and filler agent grains

Availability of such membranes changes the kinetics of brick minerals hydration, positively affects the hydrated new-growth structure formation. Polymer additives have the greatest impact on the interaction of C3A with water, and it changes not only the speed of the process, but also the phase composition of the cement stone. There is a slight slowdown C3A hydration within one hour after mixing. In subsequent periods, they accelerate the hydration of tricalcium hydroaluminates that practically complete by 28 days.

The system intensive hydrating is accompanied by C3AH6 predominantly hexagonal calcium hydrate synthesis [5, 6]. C3S hydration process in the presence of polymers slows, especially in the early stages of hardening. However, by 20-30 day of hardening the same degree of hydration is in the alite, as well with polymer binder, also with cement stone without additives [6]. The phase composition of the cement stone is represented by fibrous silicate and calcium hydroxide [7]. C2S hydration polymer additives have practically no influence, since this mineral is characterized by low activity at initial stages, and in the later stages the impact of the polymer component is reduced.

Methylcellulose particles scattered between the grains of cement, are absorbed in their active sites. Its molecules hold water by intermolecular interactions action (van der Waals force) to form aqua complexes, exerting an inhibitory effect, providing uniformity and huge degree of cement hydration [8].

Aqua complexes formed slowly down the hydration and tricalcium aluminate, which is manifested before the period of 28 days. In subsequent periods, the formation of C3AH6 is going on in the system. New-growth qualitative composition and quantitative ratio between them corresponds to that which occurs when C3A hydration is held in water without additives [7].

In the future, the seed crystals are done and structure takes form (Fig. 3).

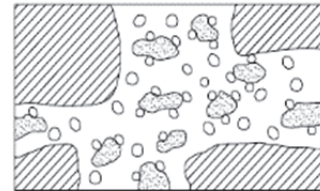


Figure 3 Coagulation structure of polymer-cement stucco compound, 1. Nonhydrated cement grains 2. Polymer particles 3. Fine aggregate and filler agent grains 4. Polymer particles

At the same time, strong chemical bonds between the inorganic and organic components of the structure are not observed, and the interaction has coagulation character based on weak hydrogen bonds and van der Waals bonds.

An important element of the structure is the contact zone between the polymer-cement stone, aggregate and filling agent. Its formation begins at the initial stage of the mortar compound setting. Surface aggregate and filling agent grains serves as a substrate to facilitate the nucleation of crystalline hydrates.

On the surface of the quartz aggregate, crystal seeds are shown up, represented mainly by calcium hydro silicates. In micro-atomized slag particles, which constituent to slag portland cement composition, the hydration products deposition is taken place, these particles serve as nucleation and crystallization centers. On their surface from a liquid phase OH⁻, Ca²⁺, K⁺, Na⁺ chemisorptions occurs, which prevents the *ettringite* crystallization and pozzolanic reaction begins. The formation of additional CSH (1) is getting on due to the interaction of Ca(OH)₂ active silica or silica-alumina filling agent. The consequence of this is the formation of additional phase contact (coalescence between crystalline hydrate), which improves the structure of the composite.

There is a chemical interaction with limestone Ca(OH)₂, resulting in the formation of calcium bicarbonate CaCO₃ · Ca(OH)₂ · H₂O, firmly binding the crystals of calcium hydroxide to the surface of limestone (Fig. 4.). This explains the increased mechanical strength of the contact zone between the cement matrix and carbonate rock [10].

When interacting with the tricalcium aluminate (C3A) and its hydration products hydrated carboaluminate phases (3CaO · Al₂O₃ · CaCO₃ · 12H₂O etc.) form. In the presence of limestone an increase of speed in limestone tricalcium silicate hydration rate is occurred [1, 8].

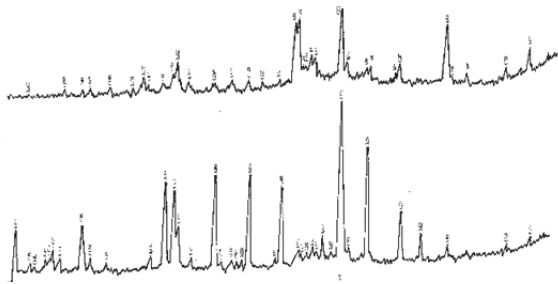


Figure 4 XRD data of polymer-cement stucco compound

Aggregates of volcanic rocks (perlite, vermiculite) actively interact with portland cement minerals (Fig. 4). When using keramzite sand and filling agent, their constituent amorphized clayey material and aluminosilicate glass interact with $\text{Ca}(\text{OH})_2$, forming predominantly silicate.

The presence of polymer in the polymer-cement binder increases its bond on aggregate. Bond growth is explained due to the fact that the liquid phase of the cement stone, containing polymer particles, calcium ions, aluminate anions and silica penetrates into the pores of a filling agent, and processes under hydration and polymerization firmly bonded contact material.

In the future, there is an increase number of new-growths crystals, they grow and merge. Strength and toughness of the resulting structure increases (Fig. 5).

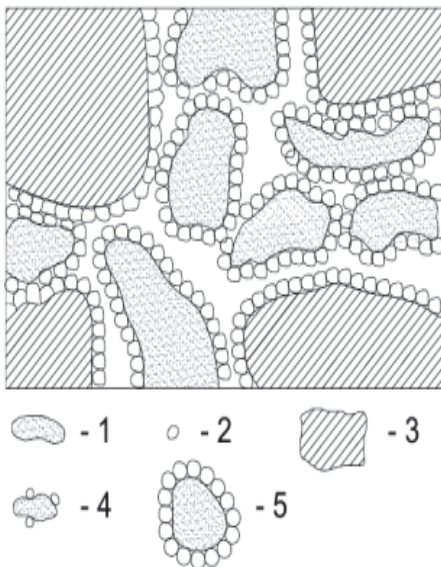


Figure 5 Coagulation and crystallization structure of polymer-cement stucco compound 1. Nonhydrated cement grains, 2. Polymer particles, 3. Grains of fine aggregate and filling agent, 4. Polymer dispersed particles; 5. Crystal seeds with polymer particles adsorbed on the surface

As a result of the hydration of cement, a part of the chemically bound water, there is also its partial evaporation. This leads to coagulation of the polymer phase and the formation of membrane fragments between crystals of new growths, aggregates and filling agent. In the subsequent period relative germination of two phases (inorganic and polymer) occurs, poly-dimensional component fills the pore space and the emerging defected places, sealing and connecting them further. Polymer

fibers as a result of these processes are inside polymer-cement matrix. As a result polymer-cement conglomerate is formed (Fig. 6).



Figure 6 Structure of hardened mortar 1. Nonhydrated polymer-cement grains. 2. Polymer particles. 3. Fine aggregates and filling agent grains 4. The mixture of nonhydrated concrete particles and cement gel with residuum of polymer particles on their surface. 5. Mixture of cement gel and nonhydrated cement particles, tightly surrounded by polymer particles layer 6. Cement hydrates surrounded by polymeric films or membranes. 7. Entrained air.

The processes of contact zone formation of plaster covering with gas concrete masonry are simultaneous. These include: adsorption and chemisorptions, diffusion, etc. The mortar mixture liquid phase containing the polymer particles, calcium, and aluminate, silica anions penetrates into the pores of gas concrete masonry. Hydro silicates, hydro aluminate aerated concrete masonry act as crystallization centers, accelerating the polymer-cement mortar hardening and of a defect free contact zone is forming.

The result is a plaster coating associated with masonry as chemical, molecular attraction, and mechanically by bonding polymer-solution with surface irregularities aerated concrete masonry (Fig. 7).

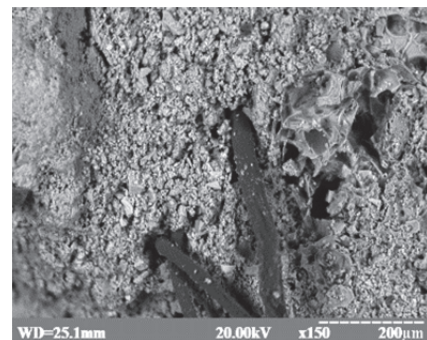


Figure 7 Contact zone «gas concrete-masonry, plastering»

As a result of the processes described structure of plaster with a pronounced heterogeneity is formed. It consists of unreacted water particles of clinker, cement gel, crystal growths, polymer films adsorbed on the gel particles and new growth crystals, polymer fibers and pores filled with air or water (Fig. 8).

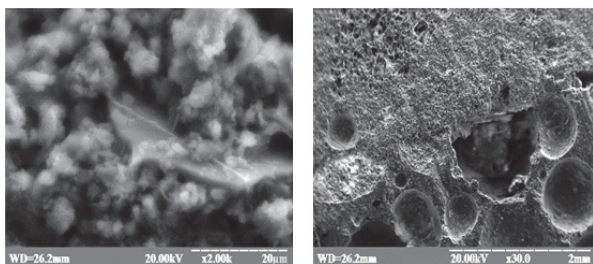


Figure 8 Polymer-cement stucco compound structural model and the structure

Material with a structure characterized by a greater elongation, fracture toughness, has a typical character elastoplastic time violations, which ensures optimum operating conditions of the system *AAC masonry-plaster covering*. Increased fracture toughness of broken plaster, allows increasing the durability of the wall structure, the turnaround time and reducing operating costs for current and capital repairs.

2. LITERATURE

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