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VLASTITE DEFORMACIJE U STRUKTURI BETONA TIJEKOM NJENOG RAZVOJA

OWN DEFORMATIONS IN SELF-DEVELOPMENT OF CONCRETE STRUCTURE

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Stručni članak

Sažetak: *U članku je izložena analiza organizacije strukture betona kao mreža interno povezanih procesa i fenomena na mikro i makro nivoima strukturne heterogenosti u pogledu deformacija različite prirode nastanka.*

Ključne riječi: *heterogenost, mikro i makro struktura, razvoj strukture betona, vlastite deformacije.*

Professional paper

Abstract: *The article presents an analysis of the organization of the concrete structure as a network of interrelated processes and phenomena on the micro- and macrolevels of structural heterogeneity in view of its deformations of a different nature.*

Keywords: *heterogeneity, micro- and macro structure, development of concrete structure, own deformations*

1. INTRODUCTION

Concrete is represented as a polystructural material [1, 2] with the characteristic levels of heterogeneity, each of which includes a set of own substructures with the unique set of elements. All components of the concrete are related to certain relationships and initiate the organization of each other through the positive and negative feedbacks. The implementation of the structural components interactions occurs not only on the individual levels, but also at the level of the concrete structure. This is because the concrete itself can create and manifest itself in the form of a hierarchy of heterogeneities. They are subsystems of concrete and systems for forming their substructures simultaneously [3]. Thus, all the processes of self-production structure of composed mixed material are combined into a single complex interdependent dynamic network of continuous cycles of birth, changes and additions [4]. It can be assumed that the kind of co-ordination of system material components should be executed by localized deformation and energy flows to ensure its required macro state responsible for the manifestation of the level of properties. In the initial period the most of active processes take place, accompanied by heat and the change in volume. The accepted model of concrete allows selecting the thermal and volume deformations as elements of the overall network of interactions, gradients which can have a significant impact on its structural design. On this basis, the task has been defined – to analyze the deformation phenomena involvement in the self-construction of concrete as a complex organized material and to identify the factors controlling their gradients.

2. THE IMPACT ON THE STRUCTURE OF ITS OWN DEFORMATIONS OF CONCRETE AS A COMPLEX ORGANIZED MATERIAL.

Article under certain assumptions and estimates, the microstructure was presented in the form of a multiphase heterogeneous highly concentrated coarse lyophobic system of freeze phase boundary [2], which allowed analyzing her structural organization based on unbalanced interparticle interactions. The processes at the level of binder particles are fundamental for the concrete structure formation as a complex dynamical system. This is dominated by the physical and mechanical processes that result in the formation of cluster structures (aggregates) of grain binders [5], and physico-chemical processes leading to the modification of their surface [6]. These processes and resulting effects at the micro level provokes the development of thermal effects and volume deformations, transmitted and perceived levels of other heterogeneity that react in response to them appropriate rearrangements of its structure.

The system with a fairly complex source composition spontaneously builds a path of self-initiation of physical and chemical, physical and physical-mechanical processes [7]. One of the main places in these processes takes thermal effects that arise as a result and is the cause of deepening self-organization phenomena. To identify the factors of self-motion process control system it is important to take into account not the cumulative effects of energy and its internal desire for order, which is realized through the ion gradients, temperature, concentration.

The analysis of the researches has shown [8, 9] that the first peak of heat release is associated with the formation of the dispersed system and is caused by reformation of the interface from the "solid - gaseous" in the state "solid - liquid". When asymmetric water molecules has been adsorbed on the surface of the solid particles of the dispersed phase the energy is released. The amount of this energy must be proportional to the surface area of the section and the surface tension at the interface (contact angle). Use of the average value is valid only in the case of similar size monomineral particles. Assuming the use of different-size particles, even the same nature, possible fluctuation of temperature change due to the change of the heat capacity, which depends on weight (volume) of the particles. Due to the different values of the surface area and size, the surface temperature of the particles, and particle volume of the dispersion medium will be different T1□T2□Tn. A temperature gradient caused by internal diffusion, flow around, sliding across the surface, runoff, exchange charges. Local perturbations in the dispersion are possible even if the composition of particles is mono-mineral one. Polymineral nature of the grain binder only increases the number of fluctuations. This is provoked with unequal thermal capacity of minerals, different orientation of individual minerals in the volume particle diffusion, and the difference in the coefficients of wetting (contact angles) that leads to the formation of local heat zones according to the number of mineral components.

Multifocal hydration mechanism is implemented in the multimineral and polydisperse systems that initiate the energy chaos. It is important that the phenomena that occur as a consequence of the defining processes may become dominant in the initiation of chemical phenomena with less chemically active ingredients. Furthermore, local changes in pH of the dispersion medium due to differences in the solubility of minerals, together with the local temperature gradients cause a local change in ion concentration, which leads to a localization process, and nucleation of the material composition and fluctuations in density.

Physical and chemical processes of the organization structure of the concrete at the level of binder particles are the source of origin of the volume deformations. Due multimineralit y and polydispersity of the original composition of the binder caused uneven changes in local volumes of grains of different nature and size. Also, a disproportionate amount of the dispersion medium is changed. As a result, the particles and the liquid phase of the waves propagate deformations. Given the gradient thermal effects, volumetric deformation of the microstructure essentially determines the self-organization.

Introduction concrete as a polystructural material suggests that the microstructure forms part of a macrostructure which may be recognized as heterogeneity "matrix material - fillers". Groups of fillers and the matrix material concluded between them form structural cells, which differ in form determined by the way of packaging and relative orientation of the fillers. Also they differ in the size depended on the distance between the inclusions and the ratio of adhesive-cohesive binding forces at the interfaces between the matrix and fillers. [5] Macro organization is carried out by reacting the matrix with fillers and is accompanied by display of volume deformation gradients and forming phenomena at the interfaces between the two [2].

The distribution of the particle binder in clusters leads to formation an interconnected web of inter-cluster interfaces at the micro level. Simultaneously with this formation of the interface between the matrix material (microstructure) and fillers is occurred. Continuous volume changes of the structural units are responsible for the development of deformation processes at the interfaces between them, which leads to the localization and expression of deformation gradients in the microstructure of different volumes. This forms the initial wave, resulting in deformation gradient micro transferred to the level of the macrostructure. This will cause a spontaneous deformation of the interfaces between the matrix and the fillers, unique for each cell structure, which will affect the terms of interparticle and interfacial interactions going on in the microstructure, and will initiates a new deformation flow. Formation of return waves transition volume deformations from one level to another allows the influence the concrete structure heterogeneities on the organization of each other through mutual disturbances. It should be aware that each of the levels can only direct the structural transformation of other subsystems of the concrete, but not define them. Management of micro- and macrostructures structure formation is done by their own intra-potential; they can decide how and to what extent they respond to possible changes in their environment. Based on this, it seems reasonable to separate the driving forces (conditions) or that commits process (phenomenon) in the management factors and factors of nonspecific activation. And those and others are placed in the concrete in the molding products, but the first is responsible for the structural organization level, the components of which they are nationals, while the latter act as external influences, pushing design structures interacting levels on certain ways and forms of development.

Typical microstructure control factors include the quality and quantity of binder, by means of which aimed changes in structure formation processes are occured [2], thereby performing suggestive action on the formation of a macrostructure. It allows selecting the initial composition of the dispersed phase as a factor in the indirect (non-specific) activation of self-production structure of the macro-level. For the microstructure heterogeneity factors of indirectly influence parameters are structural cells, which at the same time, manifest themselves as intrinsic characteristics of macrostructure. They define the length and configuration of the external borders of the matrix material and the conditions for its adhesion to the surface of the filler.

The structure organization, both of separate levels of heterogeneity, and of the concrete, occurs under continuous action of generated streams of their own deformations. Deformation waves provoke self-generation and self-development at all levels of heterogeneity various sorts of flaws which as new elements automatically join in the organization of their structure, participating in manifestation and allocation of gradients of deformations. Thus there are prerequisites for emergence of such structural components of concrete as technological cracks and inner interfaces of partition which in total with set tensions define heterogeneity of a material of a construction, and, so and safety of its operation.

3. CONCLUSION

Thus, we can conclude that the structure formation of concrete as a hierarchy of levels of homogeneities in structure is the result of interference of certain processes and phenomena connected with each other on the network principle. The net is defined as a special order of the structure organization of complex dynamic systems, in which they produce themselves by interrelated cycles of structural changes. All the network elements are involved in the origin and transformation of each other. This implies the dynamics of the highly ordered concrete structure through the coordination of joint activities of its structural components at different levels of irregularities. Deformations are also included as an element in the general network of recursive interactions. This suggests that deformations are generated by these interactions, but they also stimulate their manifestation. Thus external and internal factors can only initiate responses of material to the influence, but not operate them. This approach in the appointment of composition and technological modes of production of concrete products and structures will allow realize their potential more fully and provide reliable behavior under different operating conditions.

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