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PRINCIPLES OF STRUCTURE FORMATION OF MODIFIED MATRIX OF CORROSION RESISTANT CONCRETE

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Summary. In the article is introduced the theoretical objectivation of peculiarities of structure formation of modified cementing matrix of corrosion resistant concrete. Established regularities allow to define the ways of purposeful management this process with the aim of increase of service characteristics of concrete.

Key words: cementing matrix, structure formation, concrete, corrosion resistance.

INTRODUCTION

Process management of hardening compound dispersive structures which are cementing matrix and concrete is possible on the basis of a deep understanding of physical and mechanical and chemical technological nature of their interaction. To this question is devoted a great number of investigations in hydration kinetics of cementing agents and technological analysis of hardening process [Sawaide M., Iketani J. 1992, Shayan A., Quick G.W. 1992, Mchedlov-Petrosyan O.P., Babushkin V.I. 1992]. Despite the great number of fulfilled investigations is impossible to create a general quantitative theory of hardening and structure formation of composites on the basis of cementing agents. As it's well known, a cementing agent reacting with water is converted into new chemical compounds which are in marked contrast to a source substance. A source substance has a large solvability than the products of hydration and formed products have been saturated in relation to a hydrate.

According to A.A. Baykov shortly after mixing of cement it's dissolved as well as by Le Chatelier [Okorokov S.D. 1956, Rebinder P.A. 1968]. But at the moment of achievement of saturation concentration the process of source substance dissolving should be stopped, however its chemical conversion into a hydrate cannot be stopped. Herefrom A.A. Baykov having based on topochemical ideas comes to the conclusion that the products of hydration should be evolved by way of finely divided system because of direct water adjoining to clinker minerals of cementing. The core which unite all these theories is that after adjoining cementing substances with water the hydrates are formed by the way of ultimate particles having the properties of colloids and being in the balance with environment. Irrespective of whether these particles are

being formed as the result of separation out of solutions or at the reaction of topochemical hydration or after the dispersion of cementing seeds, the hydrated particles have all the properties of colloidal formations.

Le Chatelier and A.A. Baykov consider that the development and the growth of crystallohydrates go through the solution. V. Michaelis explains hardening of cementing pastes out of cementing substances by appearing the coagulative structure between the particles of hydrates of colloidal sizes.

A.F. Polak [Polak A.F. 1986] is reasoning this way. On coming in contact with water a cementing substance is dissolved and an oversaturated in relation to hydrate solution is formed out of which the nucleating seeds drop. Growing small crystals of a hydrate come close and aggregate forming lithoidal structure. It's reasonable at this the division of a compound process of hardening into elementary stages: the dissolution of a source cementing; the formation of nucleating seeds of a new phase – a hydrate; the growth of crystals of hydrate neoformations; the formation of colloidal and crystallized structures.

RESEARCH OBJECT

In order to define the principles of structure formation of modified cementing matrix of concrete is necessary to examine the processes coming at a mixing of cement. By this is necessary to take into consideration the important role of water, its density and viscosity as the change of water properties defines the dissolution rate of cement particles and kinetics of further processes of hydration of clinker minerals.

At a mixing of cement the dispersive system is formed in which the properties of cement and water change depending on their quantitative ratio, temperature, pressure and other characteristics. Right after mixing of cement only the physical processes take place based on the distribution and water adsorption on the surfaces of cement particles, their sedimentation in micro volumes. Change in chemical composition of cementing particles takes place and this plays by no means unimportant role in the formation of a further structure. One can imagine a cementing powder as a polydisperse uncompensated system in which small particles form between themselves the aggregates characterized by lower surface potential and lower activity [Sawaide M., Iketani J. 1992].

Setting strength and hardening of a mixing cement from the chemical and physical chemical point of view is characterized by the processes of dissolution, polymerization and hydration [Sawaide M., Iketani J. 1992]. Water which is between the particles of a cement and which lost its flow is polarized at the expense of diffusive effects, dipole structure of particles and inductive influence of polarized filmy water [Boykova A.I. 1994]. Orientation of polar water molecules is maximum developed on the adsorption layer near the surface of separation.

In the process of formation of salvation spheres on the surface of particles of plaster stone (at the presence of plaster stone) is observed their interaction under the influence of Van der Waals forces. At binding of solvated cementing particles to the effective range of molecular forces of gravitation they stick together. At this there are still thin adsorption layers between interacting surfaces resisting to further

agglomeration of particles. Such systems consider being stable and forming coagulative structures of a compact, group, isolated, disconnected kind [Jost K.N., Zimmer B. 1994].

At mixing of cement in the process of intermixture a cementing gel is formed, non-homogeneous dispersive system which consists of micro agents and separate particles connected by Van der Waals forces which finally lead to the formation of a coagulative structure. The formation of coagulation structure of cementing gel takes place from the moment of mixing of cement and comes to an end in general after completing induction period which is between the period of time of beginning and finishing of setting strength. This period is characterized by water adsorption on the particles of hard phase and gradual saturation by its products of hydration of clinker minerals [Nonat A., Lecoq X. Gauffinet S., 1997].

There are several points of view on the mechanism of water binding by the surface of particles, but all of them accept the dominating role of forcing near-surface field of gravitation. Specific properties of adsorbed water influence the processes of formation of physical mechanical properties of cementing gel and its conversion into solid body [Tomosawa F. 1997].

The particle of a cement interacting with the solution is a compound complex in which the solid phase is connected with the environment through the stabilized double electrical layer of ions and in some cases through the solvate sphere. Degree of stability of initially formed structure is defined in general by the forces of interaction between the particles. The development of the process of coagulation of cementing gel depends on the mineral composition and dispersity of a cement and also the presence in it additive agents-electrolytes forming the double electric layer of one mark at the surface of cementing particles and resisting their adhesion. If a double electric layer of one mark is absent then comes next coagulation and cementing gel is quickly set strength converting into lithoidal body.

At mixing of cement appear the forces providing the formation of coagulation structure of a cementing gel which has rheological properties, ability to thixotropic conversions and compression and hardening as ion bonds arise at the moments corresponding to the formation of centers of crystallization. The fields of maximum probability of formation of a new phase will be solvate layers.

Adsorption ability of a cement pre-configuring the properties of a coagulation structure is changing violently in dependence on physical activity of force field, pressure, temperature etc. Adsorption ability of a cement in cementing gel is increasing by different force fields and contributes to interaction of dipole water molecules with the forces of gravitation concentrated on the surface of solid phase.

Hardening of coagulation structure of cementing gel is accompanied by rearranging and partial banding of water by binding of particles of solid phase that is by contraction of volume of the system «cement + water». As the result of this takes place the volume pressure of cementing gel with the exudation of liquid phase to which especially should contribute the force field. The representation of these physical chemical processes of coagulation structure formation of cementing gel is the reduction of terms of setting cementing strength as its transformation out of plastic viscous state into solid one takes place.

The end of setting strength according to its physical sense is near the moment of time at which the induction period of crystallohydrate structure formation takes place. Further hardening of coagulation structure is determined by appearance and development of crystallized process at which ion dipole and ion ionic bonds dominate contributing to the lost of plastic properties by cementing gel.

In the formation of structure of hardening adhesion bonds of electric nature also play the role. By the moment of structure formation the particles of a cement (dispersive phase) convert into three-layer where the core (inner layer) is a seed of a cement, medium amorphized layer is the film of a hydrate and outer layer is the film of structured water.

RESULTS OF EXPERIMENTAL RESEARCH

In the process of conversion of modified cementing system into solid body, the kinetics of crystallization of neoformations, sizes of crystals and resistance of contacts of coalescence depend on the composition of liquid phase and value of its relatively new hydrate phases that finally provides the structural resistance. Any effects contributing to the growth and banding of crystallohydrates prosper the high-strength structure.

As the result of the processes of colloidation, crystallization and consolidation of hydrate neoformations the stable cementing matrix is formed. The main condition providing hardening of modified dispersive system is the following: viscous properties in such system begin to appear in the case if neoformations contain polar groups and the media itself is also polar and the optimal conditions for the structure formation have been created. The surface of crystals is covered by fluent adsorption layer. The inner pressure contributes to coming closer to the distances at which the possibilities of formation of resistant nucleating seeds between them appear and appearance of molecular bonds between mobile molecules out of opposite adsorption layers and this creates crystalline bridges between separate small crystals. Finally the crystalline structure is formed.

CONCLUSION

The analysis of structure formation of modified cementing system of concrete leads to the conclusion about the possibility of results-oriented management this process with the help of simple technological techniques. First of all, here should be referred:

a) regulation of quantitative ratio or concentration of cementing in a unit of a volume of water medium;

b) change and development of force field (pressure) in the process of hydrate neoformations formation;

c) lowering of volume water content of a system «cement + water» in the process of product formation (modification of cementing matrix of concrete).

Simultaneous performance of these conditions represents considerable technological difficulties, however in principal it can be fully realized. Especially it concerns the development of structure formation of cement stone directly in concrete.

REFERENCES

1. Boykova A.I., 1994. Solid solutions of cement minerals. – L.: Science, Leningrad department. – 100 p.
2. Jost K.N., Zimmer B., 1994. Relation between the Crystal Structures of Calcium Silicates and their Reactivity against Water //Cem. and Concr. Res. – V. 14. – P. 177-184.
3. Mchedlov-Petrosyan O.P., Babushkin V.I., 1992. Application of thermodynamics to concrete research //Papers of conference in chemistry and technology of concrete «New in chemistry and technology of concrete». – M.: Gosstroyizdat. – P. 92-103.
4. Nonat A., Lecoq X., Gauffinet S., 1997. Calcium hydroxide concentration on Solution: parameter determining the early hydration of tricalcium silicate and the characteristics of the products //Proc. of the X International Congress on the Chemistry of Cement. – Geteborg. – Vol. 2. – P. 50-55.
5. Okorokov S.D., 1956. To the question about mechanism of colloidation by Baykov A.A. at hardening viscous substances//Papers of conference in chemistry of concrete. – M.: Promstroyizdat. – P. 45-59.
6. Polak A.F., 1986. Hardening of monomineralic cementing. – M.: Stroyizdat. – 208 p.
7. Rebinder P.A., 1968. Problems of dispersive systems formation and structures in such systems. Physical chemical mechanics of dispersive structures and solid bodies //Modern problems of physical chemistry. – M.: Pub. Moscow State University. – P. 334-414.
8. Sawaide M., Iketani J., 1992. Rheological Analysis of the Behavior of Bleed Water from Freshly Cast Mortar and Concrete //ACI Materials Journal. – Vol. 89. – No. 4. – P. 323-328.
9. Shayan A., Quick G.W., 1992. Microscopic Features of Cracked and Uncracked Concrete Railway Sleepers //ACI Materials Journal. – Vol. 89. – No. 4. – P. 348-360.
10. Tomosawa F., 1997. Development of a kinetic model for hydration of cement //Proc. of the X International Congress on the Chemistry of Cement. – Geteborg. – Vol. 2. – P. 43-50.

ЗАКОНОМЕРНОСТИ СТРУКТУРООБРАЗОВАНИЯ МОДИФИЦИРОВАННОЙ МАТРИЦЫ КОРРОЗИОННОСТОЙКОГО БЕТОНА

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Аннотация. В статье представлено теоретическое обоснование особенностей структурообразования модифицированной цементной матрицы корозионностойкого бетона. Установленные закономерности позволяют определить пути целенаправленного управления этим процессом с целью повышения эксплуатационных характеристик бетона.

Ключевые слова: цементная матрица, структурообазование, бетон, коррозионная стойкость.