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TECHNOLOGICAL PECULIARITIES OF FORMING OF AXISYMMETRIC UNREINFORCED CONCRETE PIPES

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Summary. The results of experimental theoretic investigations of properties of modified concrete for manufacturing of axisymmetric unreinforced products are introduced in this article. There have been proposed the ways of passage the main contradiction of technology of concrete with the aim to get special high quality concrete.

Key words: modified concrete, cement matrix, extraction, polyroll, liquid phase.

INTRODUCTION

The recovery of high effective artificial building conglomerates is possible by modifying the structure of cementing matrix and concrete [Ramachandran, Feldman, Boduen 1986, Batrakov 1998, Adylkhodzhaev, Solomatov 1993, Pilipenko 2010]. Thus, the modification of concrete's structure is destined to improve technologic and service properties of material. It's possible the change of kinetics of gain of physical characteristics and final values of concrete strength by modifying [Sviridov, Kovalenko, Chesnokov 1991, Babkov, Sahybgareev, Kolesnik and other 2006, Kaprielov, Travush, Karpenko and other 2006, Solomatov, Vyrovoi 1991, Paschenko 1991, Glukhovsky, Runova, Maxunov 1991, Rudenko 2010].

At present only separate attempts of physical modification of concrete, for example, at its vacuum processing are famous [Bazhenov 2005, Batrakov 1998, Glukhovsky, Runova, Maxunov 1991, Sakai, Sugita 1995]. In this case the limited quantity of water of mixing is spiked in concrete mix providing optimal response execution of hydration of cementitious agent. The subsequent vacuum dewatering changing the initial concrete composition leads to the deep modification of its structure formation. In particular, the density and strength of a material is considerably increasing. It should be marked that the physical modification of concrete leads to the change of character of fixation of particles of cementitious agent [Hewlett 1998, Glekel, Kopp, Akhmedov 1986, Adylkhodzhaev, Solomatov 1993, Tomosawa 1997].

OBJECTIVE AND SUBJECT OF RESEARCH

The objective of present research is the development of scientific and technical foundations of technology of modified concrete for the production of unreiforced axisymmetric goods.

The limited quantity of produced and applied unreinforced concrete pipes is explained by the circumstance that the resistance of concrete by intensity of tension is not considerable and makes up only 7…11 % of strength of concrete under compression [Gvozdev 1987, Ruben 1986, Trifonov, Dodonov, Kuznetsov 1998]. This problem is complicated by the main contradiction of technology of concrete:

- for the elevation of strength of concrete under tension is necessary the decrease of water-to-cement ratio (W / C) up to the values near to the normal density of cement-water paste at simultaneous fiscal cement restraint;
- for the elevation of placeability of concrete mix is necessary the contrary condition which – the elevation W / C, the increase of water content and, thus, the cement content.

The development of scientific foundations of technology of high quality concrete for the unreinforced pipes is possible by the complex solution of specified contradictions. For this is necessary to accept the following initial statements of developing technology of high quality concrete:

1. The properties of concrete mix must be defined by technological conditions of products' forming;
2. The concrete composition is defined by predesigned project properties of material in the product and, if necessary, it can differ from the initial concrete mix composition;
3. The process of vibro impact impulsive compression of concrete of forming product must provide the recovery of utmost compact structure of material, especially on coating surface of a product.

RESULTS OF EXPERIMENTAL RESEARCH

As the result of experimental theoretic research work there have been developed the scientific foundations of the recovery of extra high quality concrete, technological foundations of forming axisymmetric products, including the new installation for forming the concrete unreinforced pipes by vibro impact impulsive pressing. The installation is destined for forming pipes with little lift having a nominal inside diameter from 500 to 1500 mm and length up to 2000 mm. Forming of pipes can be done in plant and testing area conditions, on outdoor area, including temporary placing.

As it was supposed to achieve maximum strength and waterproofing of concrete by unwatering of concrete mix in the process of vibro impact impulse pressing, the great attention has been paid to the definition of optimal conditions of removal the surplus amount of water of mixing out of it [Pilipenko 2010].

Intensive unwatering of concrete mix by vibro impact impulse pressing can be achieved at optimal quantity of cement-water paste and mixture which is not only filling the gapes between grains of carcass, but also removes them from each other on the

minimum distance. Thus, the concrete composition and regime of vibro impact impulse pressing were defined under the condition of the recovery of concrete with the minimum remnant W / C and maximum strength. The criteria of full compression of concrete mix are the given level of extraction of surplus water of mixing and achievement of average density of molded concrete near to the theoretical ($Kc = \rho c / \rho theor \geq 0,97$).

Experimental investigations of voluminal state of stress have been made on the special laboratory installation. The special device gave the opportunity to realize pneumatically the impulsive air-feeding on cylinder piston. That has been imitating vibro impact impulse compression of concrete mix and concrete with the simultaneous modification in the developed technological process of production of axisymmetric products.

The concrete mix of the product between pressing clamping device and perforated timbering wall turns out to be in compressed state. Stress and strain state of concrete mix leads to the motion of filler raw staff, cement and water one from another under condition of the elevation of strain of ultimate strength to shearing. The great meaning for the process of compression of mixture has the cycling of application of stress from impulsive waves of compression and shuttle movements of moving form [Fedyaevsky, Ginevsky, Kolesnikov 1993, Shlikhting 1989].

The advantage of technology of vibro impact impulse compression of concrete of pipes is:

- the combination of laying, compression and modification of concrete mix and concrete in one process, including floating of inner cylindrical surface of a product;
- a high accuracy of geometrical dimensions of forming products;
- an increased degree of mechanization of production at minimal metal consumption of equipment;
- a high productivity at a low energy consumption;
- an immediate demoulding operation at products making metal saving of technology.

The installation is also equipped with measuring and registering apparatus for the analysis of the value of inner pressure and motions.

It was established by the research work that at physical modification of concrete mix with the usage of vibro impact, shearing and impulsive compression, the process of structure formation leads to the change of morphology of crystallohydrates in comparison with the usual vibrated concrete.

It was established by complex methods of chemical, X-ray phasic, submicroscopical, adsorptive, porometric analysis that the morphological structure of cementing matrix of concrete is characterized by the change of quantitative ratio of volumes of cryptocrystalline, needle-shaped fibrous and plate like prismatical ingredients at the end of structure formation, which is 1,5 times exceeding vibro compressed and vacuum treated concretes.

The analysis of hygrometric state and differential thermic analysis of concrete confirmed that the quantity of chemically connected water in cementing matrix of modified concrete exceeds on 23…39 % the analogical data of concrete subjected to vacuum treating and vibro compression.

Due to undertaken studies was obtained the system of regularities of vibro impact impulsive influence on concrete mix which revealed the considerable differences of the process of compression from the single impact and vibro compression. By this was proved the appearance of zones of high intensive compression and strain which alternatively change in time in the pyller of compressing mixture, there were also gained the quantitative characteristics for the definition of parameters of compression.

It was established that the physical modification of concrete is carried out by the extraction of surplus water which takes place in laminar, turbulent and non-continuous modes. There have been obtained formulas describing the regularities of movement of water-to-air phase depending on applied pressures and parameters of transmissibility of concrete mix and filtrational ports of form.

The developed technology is based on the combination of high intensive vibro impact impulsive compression and decrease of actual W / C in molded concrete up to the level equal to the normal density of cement-water paste. Thus, the optimal parameters of developed technology are provided due to the compression near to the theoretical level at simultaneous extraction of surplus water of mixing collectively with water-to-air phase of concrete mix.

There have been defined the technological parameters of proportional unwatering of concrete at the height of molded product due to the results of undertaken studies $(W / C)_{remn}$ = const.

The analysis of strength properties of concrete obtained by vibro impact impulsive method of compression has been carried out on the samples-cylinders and kerns of equal diameter drilled out of unreinforced pipes. The results of research work of strength properties of concrete are introduced in table 1.

The results of experimental investigations show that with the increase of the quantity of extracted water from 18 to 24 % the strength of concrete of vibro impact impulsive pressing is notably increased. The strength of the samples from which is extracted the equal quantity of surplus water of mixing at the equal regime of vibro impact impulsive pressing with the usage of different diameters and conicity of filter ports is nearly equal. But only with the increase of the thickness of the layer of compressing concrete mix is increasing the time of extraction and the necessary quantity of filter ports. It testifies that exactly the quantity of extracted water of mixing defines the structural strength of compressed concrete by vibro impact impulsive pressing.

As the criteria of evaluation of properties of filter ports proposed by us defining the efficacy of the process of vibro impact impulsive pressing of concrete mix and concrete was proposed the coefficient of effective compression (CEC), which shows the approaching of values (W / C)remn to the index of planned [W / C] = 0,253.

It was carried out the series of experiments to study the dependence of CEC on given quantity of extracting surplus of water of mixing. For the increase of accuracy of obtained values of CEC of filter was defined as simple average of the results of three observation values CEC at the quantity of extracting water of mix from 18 to 24 %.

It was marked that in the process of effective pressing of concrete mix at inlet part of filter ports of form the compacted layer can be formed. [Altshul 1990, Vulis, Kashkarov 1985].

Table 1. **Physical mechanical characteristics of modified concrete, drilled out of unreinforced pipes with the length 1500 mm**

№№	Sample of test concrete	Density, kg / m^3		Strength, MPa	
		in kerns	average index	in kerns	average index
Concrete, obtained by vibro impact impulsive method of compression					
1	Cylinder laboratory	2480	2480	91,3	91,3
2	Kerns, drilled out of pipes with diameter 500 mm	2498 2511 2516 2516 2517	2512	96,7 97,4 98,6 101,0 101,7	99,1
3	Kerns, drilled out of pipes with diameter 1000 mm	2527 2529 2531 2530 2531	2530	104,8 107,0 111,6 113,4 114,7	110,3
Concrete, obtained by traditional method					
1	Cylinder laboratory	2235	2235	45,8	45,8
2	Kerns, drilled out of pipes with diameter 500 mm	2273 2285 2302 2314 2316	2298	45,3 45,7 46,2 46,8 46,5	46,1
3	Kerns, drilled out of pipes with diameter 1000 mm	2300 2314 2329 2340 2354	2327	46,0 46,7 46,8 47,1 47,6	47,0

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In accordance with the conditions of investigations in case of pressing of concrete mix with the usage of concrete form with filter ports which size exceeds the sizes of particles of fine aggregate the firm ground copes out of particles of fine aggregate will be formed at inlet part of port. Intergranular pores of these copes will fulfill a function of filters preventing loss of cement. While using the filters with ports removed from each other on sufficient long distance it should be expected the forming not complete compacted layer in concrete mix but in separate compacted dome-shaped shells. Directly at inlet part of filter ports the rate of flow of extracting fluid is considerably higher than in separate sections near inlet part of filter ports. It can cause external wash out of cementing particles that is their carry-over from the surface of concrete sample on the surface of the form. Laying bare of some section of mineral carcass of cope near filter ports is limited as the rate of flow of extracting water of mix is decreasing proportionally to squared distance from the port. The formation of washed out zones should increase the rate of extracting surplus water of mix because of partial destruction of the shells with increased resistance to flow.

The truth of these statements has been checked by experiment. The main method of the study of structure of concrete compressed by vibro impact impulsive pressing with the usage of perforated concrete forms with diameter of filter ports 1 mm and 2 mm, it was accepted the definition of microhardness of cementing matrix of modified concrete on thin sections with the size 55×55 mm.

The selection of method of investigation is due that the definition of microhardness gives the opportunity to get the information of structural mechanical properties on limited sections of the sample [Moranville-Regourd 1999]. The microhardness depends not only on crystallized factors but also on mechanical ones: pinhole rating; the presence of internal stresses [Blais 1999]. The type and concentration of new formation, the peculiarity of capillary interspace, microdefects, and uniformity of microstructure influence the microhardness of cementing matrix.

In conducted experiments was used fine grained concrete of composition 1:2. It is due to the presence of coarse aggregate increases the variation of values of microhardness.

At the first stage was investigated the structure of concrete compressed with the usage of filter ports characterized by increased separation of ports to expel their interaction. As the perforated concrete form was used steel push barrel with the diameter and height of 150 mm, thickness of wall 6 mm, with conical filter ports of input diameter 1mm and 2 mm at outlet diameter 55 mm. The pressing of concrete mix has been made within 10 min. While using metal filter ports of the form on the surface of concrete sample washed out zones are formed introduced by copes of particles of fine aggregate. Washed out zones have the forms near to hemispheric with diameter from 14 to 2,5 mm at input diameter of filter ports 1 mm and 2 mm respectively. The obtained

data show that microhardness of cementing matrix on the distance of 1…5 mm from filter port 2,0…2,7 times higher than on the distance of 25 mm.

For each of tested filter ports the character of change of microhardness of cementing matrix at the removal from the center of the port in the direction perpendicular its plain is the same as at the removal in parallel direction. This gives the opportunity to make the conclusion that the shells of increased microhardness of cementing matrix at inlet part of filter ports have hemispheric form. The values of microhardness of the sample compressed with the usage of filter ports with input diameter 2 mm in all points exceed the microhardness of the sample compressed with the usage of filter ports with input diameter 1 mm. The increase of the size of input diameter of filter ports together with the increase of washed out zones also causes the increase of sizes of hemispheric shells of increased microhardness. This is explained by the fact that the increase of diameter of washed zone of areneceous cope takes place under the action of high resistance to flow. Considerable compressive impacts caused by the action of pressing of concrete mix spread over more remote sections and this causes the compression of larger section in size at input part of filter ports.

The analysis of experimental data show that the diameter of hemispheric shells with increased microhardness of cementing matrix in the place of input part of filter ports achieves 15…25 mm. At a filter port with separation 25×25 mm can be reached the formation of overlap single complete medium of increased microhardness.

CONCLUSION

It was proved that maximal compression of concrete mix ($K_c \rightarrow 1,0$) can be reached with the help of vibro impact impulsive influence describing by the system of analytical regularities revealed considerable differences of the process of compression by single impact including vibrocompaction. It was proved the appearance of compressed mixture of alternatively changing in time zones of high intensive pressure and strain in the pyller.

It was established that the high effect of physical modification of concrete can be made by the extraction of surplus water of mix which takes place in laminar, turbulent and broken regimes. The quantitative description of the process of extraction of water-to-air phase can be produced using classical laws of filtration taking into consideration the degree of gas content of fluid by air bells and final broken regime of extraction of water of mix.

There were established by the complex of fulfilled investigations the regularities of placing and configuration of filter fields of concrete form taking into consideration the form and diameter of ports preventing their fouling in the process of product's forming.

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ТЕХНОЛОГИЧЕСКИЕ ОСОБЕННОСТИ ФОРМОВАНИЯ ОСЕСИММЕТРИЧНЫХ НЕАРМИРОВАННЫХ БЕТОННЫХ ТРУБ

Владимир Пилипенко

Аннотация. В статье представлены результаты экспериментально-теоретических исследований свойств модифицированного бетона для изготовления осесимметричных неармированных изделий. Предложены пути преодоления основного противоречия технологии бетона с целью получения особо высокопрочного бетона.

Ключевые слова: модифицированный бетон, цементная матрица, отжим, уплотнение, жидкая фаза.

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