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MUHAMMADAMIN KABULOVICH TOHIROVNING TAVALLUDINING 80 YILLIGIGA BAG‘ISHLANGAN "SAMARALI QURILISH MATERIALLARI, KONSTRUKSIYALARI VA TEXNOLOGIYALARI" MAVZUSIDAGI XALQARO ILMIY-AMALIY KONFERENSIYASI ILMIY ISHLARI TO‘PLAMI

Toshkent davlat transport universiteti Rossiya Arxitektura va qurilish fanlari akademiyasining akademigi, O‘zbekiston Respublikasida xizmat ko‘rsatgan yoshlar murabbiysi, texnika fanlari doktori, professor **Muhammadamin Kabulovich Tohirovning tavalludining 80 yilligiga** bag‘ishlangan **"Samarali qurilish materiallari, konstruksiyalari va texnologiyalari"** mavzusidagi xalqaro ilmiy-amaliy konferensiya ilmiy ishlari to‘plami chop etildi.

Muhammadamin Kabulovich kompozitsion qurilish materiallarining polistrukturaviy nazariyasini rivojlantirishga ulkan hissa qo‘shgan olimdir. 1995-yilda Muhammadamin Kabulovich Rossiya Arxitektura va qurilish fanlari akademiyasining (RAASN) xorijiy a’zosi etib saylangan, bu esa ularning qurilish materialshunosligi sohasiga qo‘shgan ilmiy hissasining xalqaro miqyosdagi e’tirofi bo‘ldi. Ular o‘z ilmiy faoliyati davomida 6 ta monografiya, 200 dan ortiq ilmiy maqola va 25 ta ixtiroga mualliflik guvohnomasi yaratganlar.

Ushbu konferensiyaning asosiy maqsadi – qurilish materialshunosligi, bino va inshootlarni loyihalash hamda qurilish sohasidagi zamonaviy ilmiy tadqiqotlar natijalarini muhokama qilish, shuningdek, muhandislik ta’limini takomillashtirish yo‘llarini aniqlashdir.

Konferensiyada O‘zbekiston Respublikasi hamda xorijiy mamlakatlarning oliy o‘quv yurtlari va ilmiy-tadqiqot institutlari olimlari, shuningdek, muhim ilmiy tadqiqot natijalariga ega bo‘lgan ishlab chiqarish vakillari o‘z ilmiy ishlari bilan ishtirok etdilar.

"Samarali qurilish materiallari, konstruksiyalari va texnologiyalari" mavzusidagi xalqaro ilmiy-amaliy konferensiyaning asosiy yo‘nalishlari quyidagilardan iborat:

1. **Resurs va quvvatni tejaydigan qurilish materiallari va texnologiyalari** – zamonaviy ekologik va iqtisodiy talablarni qondirishga qaratilgan innovatsion yechimlar.
2. **Bino va inshootlarning qurilish konstruksiyalari, zamonaviy hisoblash va loyihalash usullari - muhandislik** va texnologik yechimlarni takomillashtirish yo‘nalishlari.
3. **Arxitektura va shaharsozlik** – estetik va funksional jihatlarni uyg‘unlashtirgan zamonaviy loyihalar yaratish.
4. **Zamonaviy muhandislik ta’limi tizimini takomillashtirish** – kelajak mutaxassislarini yuqori malakali darajada tayyorlash uchun ta’lim jarayonini modernizatsiya qilish.

Mazkur konferensiya ilmiy hamjamiyatning turli vakillarini bir joyga jamlab, qurilish materialshunosligi sohasidagi zamonaviy muammolar va istiqbollarni muhokama qilish uchun qulay platforma vazifasini bajardi.

Fine-grained basalt-fiber concrete for reinforced concrete structures of formwork-free production

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Abstract: Concrete mix for the production of precast concrete structures for the construction of buildings and structures for housing, public, industrial and transport purposes, containing cement, crushed stone, sand, chemical additive - superplasticizer C-3, still bottoms of the production of Na-carboxymethyl cellulose (KOH), mineral filler and water, as a chemical additive is used superplasticizer based on polycarboxylate esters MasterGlenium ACE 430, and as a mineral filler - basalt fibers with a diameter of 17 µm and a length of 6-12 mm with the following ratio of components, wt.

Keywords: Superplasticizer, concrete mixture, specific surface area, water requirement, mineral filler, naphthalene sulfonatesC-3, basalt fibers, portland cement

1. Introduction

The invention relates to the field of the building materials industry and can be used in the preparation of concrete mixtures for the manufacture of precast concrete and reinforced concrete structures.

Concrete mixtures are known that contain: cement, crushed stone, sand, superplasticizer, mineral additives and water [1,2]. In these concrete mixtures, fly ash from thermal power plants and screenings from crushed granite rocks are used as mineral additives. The use of these mineral fillers reduces the consumption of cement in concrete, but they are expensive, since their production and delivery require large energy and transport costs. In addition, fly ash is a man-made waste obtained from burning coal in thermal power plants, as a result of which it does not have a stable composition and properties, which certainly has a negative effect on the quality of the resulting concrete.

2. Research methodology

A concrete mixture is known that contains the following components, wt.%: cement - 17.41-18.37, crushed stone - 40.79-41.42, sand - 32.22-32.64, superplasticizer C-3 - 0.098-0.110, mineral filler - 0.96-1.91, water - the rest [3], where dusty waste from the production of asphalt concrete, formed during the heating and drying of fillers and captured by the aspiration system (finely dispersed mineral product of gas purification - TMPG), is used as a mineral filler.

The disadvantage of this composition of the concrete mixture is that the mass use of mineral filler TMPG in construction is not possible, since this mineral filler is used mainly for the preparation of asphalt concrete. In addition, the introduction of TMPG into the composition of concrete will contribute to a sharp increase in the water demand of the concrete mixture and, as a consequence, a significant decrease in the strength of the concrete.

A concrete mixture is known that contains the following components, wt.%: cement - 17.41-18.37, crushed stone - 40.79-41.42, sand - 32.22-32.64, superplasticizer C-3 - 0.098-0.110, mineral filler - crushed concrete scrap to a specific surface of 2200-2500 cm2/g - 0.96-1.91, water - the rest [4]. The disadvantage of this concrete mix composition is that obtaining a mineral filler in the form of concrete scrap crushed to a specific surface of 2200-2500 cm2/g requires significant energy costs associated with the processes of crushing and grinding solid construction waste, which will significantly reduce the efficiency of using this mineral additive in the concrete. In addition, the high degree of dispersion of the mineral filler leads to a significant increase in the water demand of the concrete mix, and this, as is known, contributes to an increase in the porosity of concrete and, as a consequence, is the reason for insufficiently high strength and frost resistance of concrete.

The closest in its essence, i.e. the prototype of the invention, is a concrete mixture containing the following components, wt.%: cement - 13.64-17.29, crushed stone - 40.84-41.16, sand - 32.00-32.43, superplasticizer C-3 - 0.049-0.054, still bottoms of the production of Na-carboxymethylcellulose (KOH) - 0.049-0.054, mineral filler - 1.91-5.81, water - the rest [5], where zeolite-containing rock crushed to a specific surface of 2500-3000 cm2/g is used as a mineral filler. The disadvantages of the prototype are the relatively low rates of the concrete mix hardening process, which leads to an increase in the time it takes to gain the stripping strength of concrete and a decrease in the turnover of forms in the production of factory-made structures, as well as relatively low: concrete compressive strength and frost resistance of concrete.

The aim of the invention is to ensure acceleration of the concrete mix hardening process, increase the tensile strength and frost resistance of concrete.

The stated goal is achieved by the fact that in the composition of the concrete mix, including cement, crushed stone, sand, a chemical additive - a superplasticizer based on naphthalene sulfonates C-3, still bottoms of the production of Na-carboxymethyl cellulose (KOH), a mineral filler and water, a superplasticizer based on MasterGlenium ACE 430 polycarboxylate esters is used as a chemical additive, and basalt fibers with a diameter of 17 µm and a length of 6-12 mm are used as a mineral filler with the following ratio of components, wt.%.

3. Results and discussion

The effect of using MasterGlenium ACE 430 as a superplasticizer in a concrete mix is that the molecules of this superplasticizer are quickly adsorbed on the surface of

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cement particles and promote accelerated dispersion of the latter due to electrostatic and steric repulsion forces. The molecular structure of the polymers of polycarboxylate ethers of the MasterGlenium ACE 430 superplasticizer has a significant effect on the strength of concrete at the early stages of hardening. The unique molecular structure of the MasterGlenium ACE 430 superplasticizer promotes a multiple increase in the contact surface of cement particles with water compared to the molecules of the C-3 superplasticizer, which completely cover the cement surface and prevent water from accessing them, slowing down the hydration process of the cement binder. As a result of the effect of the MasterGlenium ACE 430 superplasticizer molecules on the cement binder particles, an earlier release of hydration heat, acceleration of hydration product formation, and, as a consequence, an earlier increase in the strength of cement concrete are observed. The introduction of basalt fiber into the concrete as a micro-reinforcing mineral additive helps to increase the resistance of concrete to deformations without destruction in the most critical period of hardening, i.e. in the first 2-6 hours after laying the concrete mix. In addition, basalt fiber in the composition of cement concrete takes on tensile stresses from external loads and significantly increases the tensile strength of concrete. The positive effect on the frost resistance of concrete when using basalt fiber should be associated with the involvement of a certain amount of air bubbles by the fiber, which allow free water in the concrete structure to expand and contract in cycles of alternate freezing and thawing.

In the conducted studies for scientifically substantiated selection of modifiers of multicomponent concrete the criterion "indicator of reduced hydration activity" P pga proposed by Doctor of Technical Sciences Tsoi V.M. was used, which allows to estimate with a high degree of accuracy the contribution of surface activity of mineral fibrous fillers to the course of processes of interactions and transformations occurring in the hydratable environment of cement systems. For the mineral fillers accepted for the study, the calculation of the criterion of reduced hydration activity Ppga in Table 1. Comparative analysis of mineral fibrous fillers by the criterion Ppga allows to predict their efficiency in cement systems and characterize them by the degree of activity.

Table 1

Value of the P pga criterion and the modulus of elasticity and strength for mineral fibrous fillers

№ p/p	Name of mineral filler	Transformed datae		Criterion $P_{pga.}$	Modulus of elasticity, MGPa	Strength, GPa
		$0,33P_o$	$0.1\ P_{ol}$			
1	Glass fiber	2,65	0,87	12,77	80	5.0
2	Basalt fiber	7,72	1,12	30,71	70	2.0
3	Quartz fiber	33,68	1,26	59,44	75	3.6

In order to link the methodology for selecting the optimal composition of multi-component concretes to the technology of formwork-free molding of products, we proposed to use the Ppga criterion as a methodological approach to selecting a fibrous filler.

In our studies, the issue of adhesion between mineral fibrous fillers and cement binders was studied using the above methodology. It can be assumed that mineral fibrous fillers with a higher indicator of reduced hydration activity Ppga will exhibit the greatest activity towards cement and its hydration products.

The results of the study of the adhesion of mineral fillers to cement stone, fully confirm the above assumptions. Moreover, a clearly expressed relationship is observed between the Ppga values of mineral fibrous fillers and the processes of structure formation in the contact zone "binder-fibrous filler". A correlation analysis was also carried out between the adhesion value in the contact zone "binder-fibrous filler" and the index of reduced hydration activity Ppga using the standard Excel program, Fig. 1.

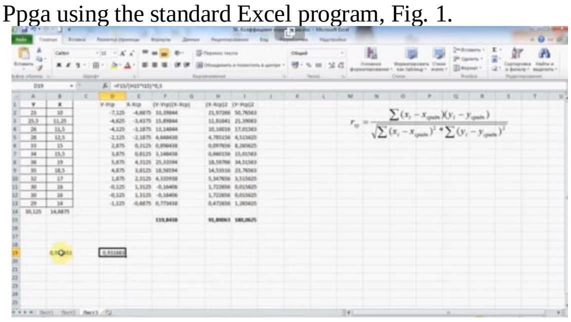

Fig. 1. Correlation analysis using Excel

According to Fig. 1. the correlation coefficient is 0.93.

Based on the results of the correlation analysis, a relationship was found between the adhesion values in the contact zone “binder-fibrous filler” and the Ppga criterion, which is expressed by the equation:

$$y=0,4036x+1,6 \qquad (1)$$

Graphical dependencies between the studied parameters are shown in Fig. 2.

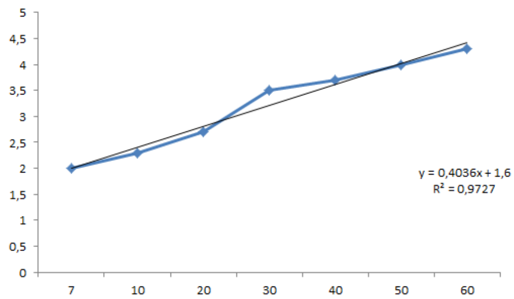

Fig. 2.Graphical dependence between the adhesion value and the Ppga criterion

Thus, the declared composition of the concrete mixture has novelty and an inventive step, since during the search of sources of patent and scientific and technical documentation, the applicant did not identify technical solutions similar to the solutions for the proposed invention.

To experimentally verify the declared composition of the concrete mixture, comparative studies were conducted on two competing compositions (the prototype and the proposed composition).

According to the prototype, the concrete mixture was prepared as follows. The zeolite-containing rock crushed to a specific surface area of 2500 cm2/g was mixed with cement until homogeneous for 45-60 s, after which this mixture was added to the pre-mixed crushed stone and sand. Then 2/3 of the mixing water was added to the mixer together with an aqueous solution of superplasticizer C-3 and the mixture was mixed for 60-90 s, then the remaining water was added and the final mixing of the mixture was performed. The declared composition of the concrete mixture was prepared as follows. Basalt fiber with a diameter of 17 μm and a length of 12 mm was mixed with cement until homogeneous for 45-60 s, after which the pre-mixed crushed stone and sand were added to this mixture. Next, 2/3 of the mixing water was added to the mixer together with an aqueous solution of the MasterGlenium ACE 430 superplasticizer and still residues from the production of Na-carboxymethylcellulose (KOH) in the ratio specified in the application (1:1), the mixture was mixed for 60-90 s, then the remaining water was added and the final mixing of the mixture was performed.

Table 2

Ratio of components of concrete mixtures and obtained results of tests of concrete mixture samples and concrete specimens

Type of superplasticizer and mineral filler	Degree of cement filling, %	Concrete mix composition: numerator – kg per 1 m3 of mix, denominator – wt.%							Compress… At the a…
		Cement	Filler	Sand	Crushed stone	Superplasticizer	JOM	water	1
Concrete mix according to prototype									
Superplasticizer C-3, zeolite-containing rock	10	416/17,29	46/1,91	780/32,43	990/41,16	1,31/0,054	1,31/0,054	170/7,07	14,1
	20	370/15,49	92/3,85	770/32,24	978/40,95	1,25/0,052	1,25/0,052	175/6,86	15,6
	30	324/13,64	138/5,81	760/32,00	970/40,84	1,17/0,049	1,17/0,049	180/7,07	24,4
Concrete mix on request									
Superplasticizer MasterGlenium ACE 430, basalt fiber	2	461/19,16	1,0/0,04	780/32,43	990/41,16	1,31/0,054	1,31/0,054	170/7,07	22,5
	3	460/19,10	1,6/0,06	770/32,00	978/40,95	1,25/0,052	1,25/0,052	172/7,16	24,4
	4	459/19,04	2,2/0,10	760/31,50	970/40,24	1,17/0,049	1,17/0,049	175/7,27	24,6

The following were used in the experimental studies: Portland cement grade CEM0 52.5N produced by JSC Akhangarancement (GOST 31108-2020), coarse aggregate - crushed stone of fraction 5-10 mm from the Eyvalek quarry, with an average density of 1400 kg / m3 (GOST 26633-2012), fine aggregate - river quartz sand from the May quarry with a fineness modulus Mkr = 0.68 and an average density of 2000 kg / m3 (GOST 26633-2012), basalt fiber with a diameter of 17 μm and a length of 6-12 mm produced by JV LLC MEGA INVEST INDUSTRIAL (Jizzakh region), polycarboxylate superplasticizer MasterGlenium ACE 430, produced by BASF (Germany), which is a cloudy beige liquid with a density 1.06±0.02 g/cm3, zeolite-containing rock of the Beltau deposit (Navoi region).

The obtained concrete mixtures were used to form standard-size 15x15x15 cm cube samples in the amount of 6 pieces for compression testing. The samples were stored under normal temperature and humidity conditions for 28 days, after which they were tested for compression. (GOST 28570-90). Frost resistance of concrete was determined using the standard method according to (GOST 10060.1-95).

The ratio of concrete mixture components and the obtained sample test results are given in Table 2.

4. Conclusion

The analysis of the obtained results (Table 1) shows that for the proposed composition of the concrete mix in all 3 examples there is an increase in the compressive strength of concrete compared to the composition of the concrete mix according to the prototype by 15-20%. At the same time, the increase in the strength of concrete in the early stages of hardening (1 and 3 days) also exceeds the indicators by an average of 10-15%. The tensile strength of concrete obtained according to the proposed composition exceeds the indicators of concrete according to the prototype by 1.8-2.0 times, and the frost resistance of concrete increases by 50%. In addition, the energy costs required to obtain mineral filler from zeolite-containing rocks are reduced, since grinding zeolite-containing rocks to a specific surface of 2500-3000 cm2/g requires grinding them in the most common ball mills for at least 1 hour. Thus, the proposed composition of the concrete mixture allows for the full achievement of the set goals: ensuring acceleration of the hardening process of the concrete mixture, increasing the tensile strength and frost resistance of the concrete.

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CONTEXT / MUNDARIJA

1 section. Resource- and energy-saving construction materials and technologies