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EFFECT OF BASALT FIBER ON THE VIABILITY OF SAND CONCRETE MIXTURES

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Abstract. The influence of the basalt fiber on the viability of the sand concrete mixture and its mobility on the reference cone depth penetration is investigated. All sandy concrete had a cement/sand ratio of 1/3. In all mixtures, a hyperplasticizer Relaxol was added in an amount of 1% of the cement mass. The introduction of basalt fibers (up to 2 kg/m^3 of concrete) practically does not change the depth of the immersion of the cone in the sandy concrete mixture at the initial moment of time compared with the additive mixture. After 2 hours of hardening, the depth of the pencil cone in the concrete mixture without the addition of basalt fibers is 3.1 cm, and with the addition of 2 kg of basaltic fiber per 1 m^3 of mixture – 0.8 cm (control). The introduction into the concrete mixture of the same amount of basaltic fiber, pre-treated with silicone fluid GKZ-10, makes the deepening of the reference cone in a mixture at a depth of 2.9 cm, which allows to increase the time required movement of sandy concrete mixture for 40...60 minutes in comparison with control.

Keywords: hydrophobization, fibre, penetration, mixture.

ВЛИЯНИЕ БАЗАЛЬТОВОЙ ФИБРЫ НА ЖИЗНЕСПОСОБНОСТЬ ПЕСЧАНЫХ БЕТОННЫХ СМЕСЕЙ

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Аннотация. Исследовано влияние базальтовой фибры на жизнеспособность песчаной бетонной смеси и ее подвижность по глубине пенетрации эталонного конуса. Введение базальтовой фибры практически не изменяет глубину погружения конуса в бетонную смесь в начальный момент времени по сравнению с бездобавочной смесью. После 2-х часового твердения глубина пенетрации конуса в бетонной смеси без добавки базальтовой фибры составляет 3,1 см, с добавкой 2 кг базальтовой фибры на 1 м^3 бетонной смеси – 0,8 см (контроль). Введение в бетонную смесь того же количества базальтового волокна, предварительно обработанного кремнийорганической жидкостью ГКЖ-10, вызывает погружение конуса в смесь на величину 2,9 см, что позволяет увеличить время необходимой подвижности смеси на 40…60 минут по сравнению с контролем.

Ключевые слова: гидрофобизация, фибра, пенетрация, смесь.

ВПЛИВ БАЗАЛЬТОВОЇ ФІБРИ НА ЖИТТЄЗДАТНІСТЬ ПІЩАНИХ БЕТОННИХ СУМІШЕЙ

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Анотація. Досліджено вплив базальтової фібри на життєздатність піщаної бетонної суміші та її рухливість за глибиною пенетрації еталонного конусу. Введення базальтової фібри практично не змінює глибину занурення конуса в піщану бетонну суміш в початковий момент часу в порівнянні з бездобавочною сумішшю. Після 2-х годинного твердіння глибина пенстрації конусу в бетонну суміш без добавки базальтової фібри, складає 3,1 см, а з добавкою 2-х кг базальтової фібри на 1 м^3 суміші – 0,8 см (контроль). Введення в бетонну суміш тієї ж кількості базальтового волокна, завчасно обробленого кремнійорганічною рідиною ГКЖ-10, викликає заглиблення еталонного конусу в суміш на глибину 2,9 см, що дозволяє збільшити час необхідної рухливості піщаної бетонної суміші на 40…60 хвилин в порівнянні з контролем.

Ключові слова: гідрофобізація, фібра, пенетрація, суміш.

Introduction. It is well known that the technological characteristics of sand concrete mixtures, such as workability, mobility, water retention ability, delamination the vitality of the sand mixture has important meaning [1, 2]. The ability to maintain mobility during the certain period of time, which evaluated by the depth of immersion of the reference cone has accepted like the viability of a mixture [3]. Increasing the viability of sand concrete mixtures is important especially in their centralized production at concrete mixing units. Delivery of mixtures to objects often takes a long time (more an hour) it can lead them to premature setting. The loss of mobility of sand mixtures reduces its process ability, it leads to production losses. The presence of fibrous filler in the mixtures can further reduce the time of their viability; it will lead to even more technological problems.

The statement of the problem in its general form and its connection with important scientific and practical assignments. Carried out experiment [4-9] indicates that the introduction of fibrous filler in concrete improves the crack resistance of the material, improves its strength characteristics. Concretes with the addition of basalt fiber are especially relevant. High tensile strength (up to 3000 MPa) and the temperature exploitation of fiber (-260 to +700 °C) are characteristics of basalt fibers. Concretes with basalt fiber are indispensable for the construction of high-strength finishing and waterproofing layers, concrete floors. At the same time, there is no information about the influence of basalt fiber on the viability of sand concrete mix.

Analysis of recent research and publications. It is well known [10, 11] that the using of basalt fiber allows to improve simultaneously several quality indicators of concrete. In particular, the introduction of basalt fiber in concrete increases tensile strength, splitting, impact resistance, and wear resistance, it allows to use concrete in production of floors, seismic structures, and explosion-proof facilities. Basalt fiber has almost the same coefficient of temperature expansion as the cement stone, and has a high adhesion with it. Fiber has resistant to all chemicals that make up the concrete, it has no corrosion, it is durable and compatible with any additives including superplasticizers.

Defining the purpose and objectives of research. It is known that the retention of mobility (viability) of sandy concrete mixtures with mineral binders is a prerequisite for their process ability.

Too rapid loss of the mixture mobility, as unreasonably long, significantly influences on rate of construction works and their quality. The influence of basaltic fiber on the viability of sandy concrete mixtures, which estimated from the depth of penetration of a standard cone in time, was interesting to determine [6].

The main part of the research. Properties of sand concrete mixtures with a constant cement/sand ratio of 1/3 by weight were investigated. Hyperplasticizer Relaxol – Super PC in the amount of 1% of the mass of cement was injected into all mixtures. The amount of basalt fiber in the mixtures was 0.1 and 2 kg/m^3. Mixtures of similar compositions with hydrophobic and non-hydrophobic fiber were studied at the same time. All mixtures had an equal initial mobility of 6 ± 0.5 cm on the penetration of the standard cone.

Mobility of the mixture has been checked every 20 minutes for 2 hours from the moment of preparation of the mixture. The obtained experimental data are given in Table 1. Graphical interpretation of tabular data is shown in Fig. 1.

As you can see from the table, in order to achieve an equal initial mobility of sandy concrete mixtures with the introduction of basalt fiber, slightly varied the value of W/C (within 2-5%), at the same time the effect of hydrophobizing of fiber further reduced this effect. Analyzing the data, given in Table 1 and Fig. 1, shows that the mobility of the mixture gradually decreases with time.

The nonlinear character of the changing of the penetration value, in our opinion, is explained by the more intensive processes of hydration of Portland cement in the initial period of hardening. It is especially noticeable at the first 20 minutes of the solution hardening. The depth of penetration of the cone to the mixture decreased from 4.5 to 5.5 cm (depending from the concentration of fiber and the state of the basalt fiber surface – hydrophilic or hydrophobic).

Table 1 – Variation of the sandy concrete mixtures mobility (depth of the cone penetration) in time

№	Quantity of basalt fiber, kg/m^3	Initial W/C		Depth of penetration of the cone (cm)													
				0 min.		20 min.		40 min.		60 min.		80 min		100 min.		120 min	
		Hydrophobic. fiber	Control	Hydrophobic. fiber	Control	Hydrophobic. fiber	Control	Hydrophobic. fiber	Control	Hydrophobic. fiber	Control	Hydrophobic. fiber	Control	Hydrophobic. fiber	Control	Hydrophobic. fiber	Control
1	0	0.481		6.5		5.6		4.8		4.2		3.7		3.3		3.1	
2	1	0.484	0.487			5.3	4.9	4.4	3.8	3.8	3	3.3	2.3	2.9	1.8	2.6	1.4
3	2	0.487	0.494			5.1	4.5	4.2	3.3	3.5	2.4	3	1.7	2.6	1.1	2.3	0.8

Increasing of the mixture age from 100 to 120 minutes from the time of preparation reduced the penetration depths of the cone by no more than 0.3 ... 0.4 cm. It should be noted that at the initial moment of the mixture preparation, the introduction of basalt fiber didn't influence on the penetration depth of the cone.

Over the time the mobility of the mixture had significantly reduced. In 2 hours the penetration value for a fiber-free mixture was 3.1 cm. The introduction of basalt fiber is leading to loss of the sand concrete mixture mobility. Thus, the using of non-hydrophobized fiber in the amount of 1 and 2 kg/m^3 leads to 1.4 and 0.8 cm of penetration depth of the cone in the mixture after 2 hours accordingly.

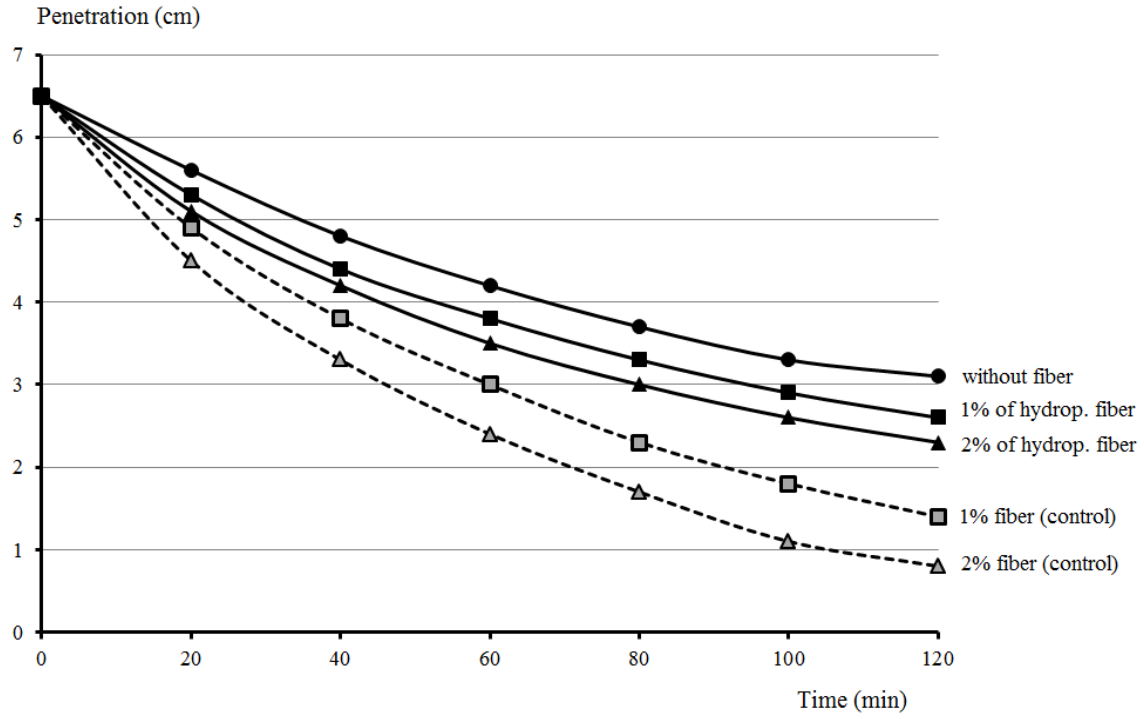

Fig. 1. The influence of the amount of fiber and time of hardening on sandy concrete mixtures mobility

To reduce the negative effect of disperse reinforcement on the viability of sandy concrete mixtures a technological method for hydrophobizing fibers of basalt fiber with silicone liquid GKZh-10 is proposed. As can be seen from Table 1, using of hydrophobized basalt fiber in an amount of 1 and 2 kg/m^3 after two hours of hardening, the penetration depth of the cone was 2.6 and 2.3 cm, respectively. Mobility of mixtures with hydrophobic fiber was higher than the mobility of mixtures with a similar amount of untreated fiber already starting from 20 minutes of hardening.

Thus, it can be argued that the hydrophobization of basalt fiber significantly increases the viability of sandy concrete mixtures and improves their process ability. The results of mixtures viability give grounds for further research on the properties of sandy concrete with the using of hydrophobized basalt fiber [12].

Conclusions:

1. The introduction of basalt fiber in quantities of 1 ... 2 kg/m^3 into the sandy concrete mixtures does not influence on penetration depth of the standard cone into the freshly prepared mixture.

2. Aged of 2 hours, the penetration depth of the standard cone into the sandy concrete mixtures with the addition of 2 kg/m^3 of untreated basalt fiber (control) was 0.8 cm. The introduction of a similar amount of hydrophobized basalt fiber increased the penetration depth of the cone by 1.5 cm, which prolonged the viability of the sandy concrete mixture by 40 ... 60 minutes compared to the control.

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