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STUDY OF DYNAMİC STABİLİTY OF POLYPROPYLENE FİBER REİNFORCED CONCRETE WİTH MODİFİED ADHESİVE

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Abstract. The main objective of the current work was to study the dynamic stability of fiber concrete reinforced with various fibers with modified adhesives. In the research, the impact resistance of concrete samples prepared with the application of metal, plastic and polyethylene terephthalate fibers was studied. For comparison, samples made of ordinary heavy concrete were also tested in parallel as a control test sample.

Key words: *concrete, fiber, polypropylene fiber, metal fiber, modified adhesive*

Introduction. Concrete is one of the ancient and most widely used construction material. In recent decades, numerous advances and developments being made in the field of concrete, which were implemented in practical applications. Nowadays, the term modern concrete refers to concrete with good workability, high fracture toughness, high mechanical strength and chemical durability. Structural elements from such materials extends the frontiers of the design and enables the implementation of outstand, durable, ecological and safe structures of the highest quality. The aim of this Special Issue is to publish current research on concrete composites based on Portland cement or other blended cements and binders containing inclusions of waste materials, special aggregates, e.g., from recycling and/or fibers. The Special Issue focuses on presenting the results of research on the properties and performance of concrete composites, novel experimental techniques, analytical methods, modelling, design, production and practical applications of these materials, and studies regarding the behavior [1].

With the world's population steadily increasing and the demand for improved urban infrastructure increasing, there is expected to be a corresponding increase in greenhouse gas emissions from the construction sector. The current pace of CO_2 emissions poses a threat of pushing the planet beyond a critical threshold, potentially leading to catastrophic impacts on the climate. The Earth's capacity to naturally offset the effects of CO_2 emissions within the carbon cycle has reached its limit. Adopting technologies that capture and store CO_2 generated from practices such as construction and building is of utmost importance. The most practical method is to identify efficient waste resources that can be seamlessly incorporated into the production process of cement-based materials. The possible integration of biochar as an effective CO_2 absorptive material and used in construction materials shows promise due to its unique properties and sustainable benefits. This review article comprehensively analyses biochar's source and properties to evaluate its effectiveness as a cement substitute in cement-based materials and concrete. The review begins by exploring the different methods utilized in biochar production, focusing on how they influence its chemical properties. This review assesses the properties of fresh and hardened cement mortars and concrete, incorporating biochar while investigating their microstructural characteristics. In conclusion, biochar is primarily composed of carbon, with percentages ranging from 19,67 % to 76,60 %. In its initial state, concrete incorporating biochar displayed densities ranging from 2245 to 2330 kg/m³. Upon reaching the hardened state, these values were observed to be 2013 and 2195 kg/m³, representing the minimum and maximum densities, respectively. The tensile strength exhibits

variability, ranging from 1,9 to 4,9 MPa, with BC content ranging from 0,1% to 5,0%. Regarding flexural strength, there is a variation from 2,1 to 8,8 MPa, corresponding to changes in BC content ranging from 0,25 % to 10 %. Moreover, there is an increasing need for sustainable concrete with low carbon emissions, incorporating carbon-negative elements to improve its performance [2].

The resistance of concrete to axial tension is much less than the resistance to compression and is largely determined by the adhesion of its components. The low tensile strength of ordinary concrete is explained by the heterogeneity of its structure and the discontinuity of concrete, which contributes to the development of stress concentration, especially under the action of tensile forces. To increase the tensile strength of concrete, it is necessary to eliminate, first of all, the heterogeneity of the structure of concrete - one of the main reasons for the large dispersion of the results of mechanical tests of this material, which affects the experimental determination of compressive strength. A significant difference between the compressive strength for ordinary concrete indicates a rather large spread of such values. This scatter is explained by the different influence of factors on tension and compression. For example, for ordinary concretes, it was found that with an increase in W/C , the tensile strength decreases, but to a lesser extent than the compressive strength. With an increase in the grade of concrete, the tensile strength increases. High-strength concretes, as a rule, prepared on concrete mixes with low W/C and on clean conditioned aggregates in the form of crushed stone and sand, have an increased density, therefore, they have less variation in strength readings both in compression and at stretching [3].

The possibility of using waste from aluminum oxide production (APW) of the Ganja production association "Gil-Soil", located on the territory of the Republic of Azerbaijan, as a mineral active additive was experimentally determined. When using the APV additive up to 10% of cement consumption, the flexural strength of cement-sand systems increased by 6.2-6.4 MPa in 28 days, and the compressive strength-by 39.5-41.4 MPa in 28 days. Comparison of the obtained results with parameters without additives showed that the activity of the modified adhesive increases by 3.2% and 4.8% respectively. The use of a modified adhesive material was experimentally studied and the issue of processing heavy concrete and polymer fiber-fiber concrete compositions was considered. The development of modified concrete compositions was carried out using the method of mathematical statistical analysis of experiments, mathematical models of the limiting parameters of concrete compressive strength were created, and the properties of the composition were optimized using short rises (replicas) taking into account influencing factors. Experimental tests were developed for modified 520 S fiber-reinforced concrete with a compressive strength of 46.51 MPa and HP 777 reinforced polypropylene fiberreinforced concrete with a compressive strength of 48.49 MPa. The compressive strength of such fiberreinforced concrete increased by 7.01% and 11.5%, respectively, compared with the same indicator of fiberreinforced concrete without additives [4].

The feasibility of preparing fiber-reinforced concrete mixtures from polyethylene terephthalate-containing plastic waste has been studied. It has been established that fibers can be obtained from them and used in concrete. By using polyethylene terephthalate-containing plastic waste fibers, it is possible to obtain water-resistant, crack-resistant, abrasion-resistant concrete [5].

Ensuring efficiency in the construction, reconstruction and repair of transport facilities can be achieved by using fiber concrete with high deformation properties. This article discusses the possibility of using complex additives to optimize the composition of fiber concrete with high deformation properties. It was found that the use of chemical and ultra-dispersed additives in the composition of fiber concrete significantly increases the compressive and bending strength. This is due to the fact that the use of steel fiber allows for uniform reinforcement of concrete throughout the volume, which has a beneficial effect on the distribution of stresses in the concrete mass and leads to a decrease in stresses in hazardous areas [6].

Purpose of the work: The dynamic stability of modified adhesive fibre concrete was studied using different fibres.

Materials and methodology used in the study. In the experiments, Holcim Expert 42.5 R cement produced in the Republic of Azerbaijan, sand from the Bahramtepe deposit and crushed stone from the Gudiyalchay quarry located in the Guba region, as well as fine sand were used as fine fillers. n the experiments, considering the application area of fiber concrete, a 500 brand heavy concrete composition was used. In order to improve the properties of fiber concrete, the proposed mineral additives and S520 brand superplasticizer, HP 777 brand hyperplasticizer, and SikaFiber T-60s brand polypropylene fibers were used.

Execution and resolution of the case. The dynamic strength of concrete was determined in accordance with the GOST 10180-2012 test methods using an automatic copier device of the PMA-F brand [7]. Although this device is used for crushed stone, the tested sample is placed in the device's cavity on a 1-2 cm thick layer of sand.

The main purpose of this method is to determine the maximum number of impacts and impact resistance that occur on the sample during the formation and collapse of cracks.

In accordance with the requirements of the GOST 10180-2012 test methods, the tensile and bending strength of fiber concrete samples was tested in a CD-40 bending press.

When determining the tensile and bending strength, the samples are placed in the bending press according to the following scheme.

Figure. Sample placement diagram in the press

Three samples measuring 70×70×70 mm were molded from the prepared mixtures. The samples were tested after 28 days of curing. The sample is placed in the slot of the device. The samples are placed in the groove so that the falling load falls exactly on the middle of the sample. The test was carried out by turning on the device using a remote control. In total, testing of each sample lasted 98 seconds. During this time, 40 blows were applied to the sample. The blow was lowered from a height of 50 cm using weight stones weighing 5 kg (device force 0.55 kN). After each blow, the sample was automatically moved along the vertical axis at an angle of 45° with a slot placed. The process continued until the sample was completely destroyed, after which the device was stopped. The results of the experimental tests are presented in the table [5].

Results of dynamic stability tests of fiber-reinforced concrete samples

N	Test sample name	Test results			
		Number of impacts at the time of first crack formation		Number of destructive blows	
		in the example	mean	in the example	mean
1	Heavy concrete	10	11,66	21	20,33
		12		20	
		10		20	
2	Fiber concrete with metal fibers	13	13,3	25	23,33
		14		23	

		13		22	
3	Fiber concrete with polypropylene fiber	12	13,0	22	24
		14		26	
		13		24	
4	Fiber concrete with polyethylene terephthalate fiber	12	12	22	21,33
		11		22	
		14		20	
5	Polypropylene fiber fiber concrete with modified glue	14	14,35	24	25
		15		25	
		14		26	

Analysis of the results shows that the first crack formation is 14.06% more impact resistant in metal fiber samples, 11.5% more impact resistant in polypropylene fiber samples, and 10.6% more impact resistant in polyethylene terephthalate fiber fiber concrete compared to heavy concrete samples. In terms of collapse, the impact resistance of metal and polypropylene fiber concrete in both samples is 14.75% higher, while the impact resistance of polyethylene terephthalate-based waste fiber concrete is 4.92%.

CONCLUSION

The test results show that modified adhesive fiber concrete reinforced with various fibers is a durable concrete.

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