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COMBINED COMPOSITE REINFORCED CONCRETE BEAMS

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Abstract
This article describes the analysis of the results of the research conducted on the study of the work of composite reinforced elements, which are widely used in the restoration of concrete structures in the buildings and structures currently being built in the Republic of Uzbekistan and in foreign countries.

Key words: composite, basalt, concrete, flexibility, strength, messura, polymer.

Introduction

In many countries of the world, in the field of construction, scientific work is being carried out on the use of reinforcements made of composite materials as an alternative to steel reinforcements in reinforced concrete structures and the introduction of their results into construction practice. Their volume is increasing year by year. As an example, we can cite researches and facilities built in Germany, Russia, China, Japan, USA, Canada and other countries. Currently, polymer composite fittings are used in road transport infrastructure facilities, in areas where high electromagnetic fields are generated, in the chemical industry, water treatment and purification, land reclamation facilities, in the construction of seaports and pre-port facilities, in urban engineering infrastructure facilities, mines and metros. It is effectively used in the construction of tunnels, as well as in the construction, repair and reconstruction of load-bearing and barrier structures of buildings and structures.

The use of flexible elements reinforced with composite reinforcements in industrial, residential, public buildings and engineering structures requires a scientific basis based on a new theory, confirmed by the results of experimental research. Appropriate recommendations and practical solutions should be developed based on scientific research.

Year by year, the volume of construction and improvement works is increasing in the Republic of Uzbekistan. In order to successfully implement the planned large-scale construction works, extensive use of new innovative technologies is required. The introduction of polymer composite reinforcements into the construction practice in the conditions of Uzbekistan requires their research in the conditions of our country. Therefore, conducting research in the direction of reinforcement of concrete structures with polymer composite reinforcements is an urgent problem of social and economic importance.[1-10]

Therefore, a number of scientific research works were conducted. One of them is a study on flexural concrete beams with combined composite reinforcement. In order to conduct this study, 2 Ø14BKA reinforcements were placed in the tensile area as working reinforcement, 2Ø12BKA reinforcements in the compressive area, and Ø6A-I reinforcements were placed in 7.5 cm increments as clamps. The Ø6A-I reinforcements for the tie-rods were welded to the longitudinal reinforcements with mild steel wires. Reinforcement wedges were installed and fixed in the formwork at the project site. Beam samples were made of B20 class heavy concrete. Together with the sample beams, 9 cubes of 10x10x10 cm size were made from the same concrete at the same time. Reinforcement of beams is presented in Table 1.

Concrete volume equal to 0.25 m3 was prepared in a concrete mixer and poured into molds and compacted using a vibrator.

The beam samples and cubes were kept in the mold for 5-7 days, then they were released from the molds and stored in laboratory conditions until the test. The first cubes were tested 28 days after molding. Then, directly before testing the beams, their cubic strength was determined. After 28 days, according to the results of the compression test of the cubes, it was determined that the concrete of the sample beams corresponds to the B20 compressive strength classes. Tests were conducted on a 50-ton hydraulic press. Cubes were tested until failure. The tests were performed based on the requirements of GOST 10180-2012 according to the standard method. The test results are presented in Table 2.

1- Table

Namuna №	Namuna to ‘sin shifri	O‘lchamlari, sm			Armaturalanishi			Yuklar oralig‘i, cm	Betonning loyihaviy sinfi
		b	*h*	h_0	Ko‘ndalang armatura (xomutlar)	Bo‘ylama cho‘ziluvchi	Bo‘ylama siqiluvchi		
BKPA -1		12	24	18,5	Ø 6 A-I	2Ø 14 BKA	2Ø 12 BKA	70	B20
BKPA -2		12	24	18,5	Ø 6 A-I	2Ø 14 BKA	2Ø 12 BKA	70	B20

2-jadval.

Beton turi	Qotish sharoiti	Beton yoshi, sutka	R, MPa	R_b, MPa	R_{bt} MPa	E_b*10^3, MPa	ε_{bn}	γ_{bn}	W, %
Oddiy og‘ir	Tabiiy sharoitda	28	25	14,3	1,33	30,1	205	0,82	3,6

The beams were mounted on 2 hinged supports of the stand for testing samples. One of the hinges is fixed and the other is movable. The distance between the forces was 700 mm, and the distance from the supports to the load was 420 mm. The distance from the base to the edge of the beams is 100 mm. The load was delivered using a 24-ton manually operated hydraulic jack. For this, dividing traverses were used.

Before starting the tests, initial measurements were recorded for all fixtures installed on the sample beam. These indicators were accepted as "conditional zero". The download was given slowly in several stages. The step load was approximately 10% of the calculated breaking load. After loading at each stage, it was waited for its stabilization for 20 minutes.

Deformations of concrete and reinforcement, coolness of beams, crack generation time (load) and opening width were measured until samples failed. The value of the load was recorded from the manometer of the jack. After the load reached the specified value, the valve of the jack was closed and kept at this value for 15-20 minutes. After the indicators were recorded through the devices, the load of the next stage was given. In this way, the tests were continued until the samples were broken [11-19].

Results of the Research:

After the tests, the location of the cracks was determined, the samples were photographed and the height of the cracks was measured, the distances between them were determined, the protective layers of the working fittings were determined and the working height was measured.

During the test, the deformations of concrete and reinforcements, the time of formation of normal and oblique cracks and the amount of load, the stiffness of the beam were measured and recorded.

Deformations are measured on a 300 mm base using a portable measuring instrument with clock-type indicators with an accuracy of 0.01 mm, deflections are measured at three points of the beam - between the spans and supports using clock-type indicators with an accuracy of 0.01 mm was measured. The deformations of the tensile and compressive reinforcements, as well as the concrete compressive zone, were measured at three predetermined points on the cross-section height on a 300 mm base.

During the experiment, the surface of the sample beams was carefully inspected at each stage, and when the first cracks appeared, they were immediately marked and recorded, and their width was measured. At the same time, the value of the load achieved was also determined.

When the value of the given load reached about 85-90% of the breaking load, the measuring devices were removed, the sample was loaded until it broke, and the nature of its breaking was monitored. In the sample beams BKPA-3 and BKPA-4, failure occurred due to concrete spalling in the compressive part of the beam.

During the experiment, the failure load of BKPA-3 and BKPA-4 samples was almost 2 times greater than the calculated load. In BKPA-3 and BKPA-4 sample beams, it was noted that the experimental load differs from the calculated load by 85-95% on average.

After the experiment, the samples were removed from the stand, placed in a separate place, and the crack map was drawn and photographed. It was noted that the location of the cracks in the beams, their sizes, and the width of the opening were very similar and close to each other. It was observed that the concrete lost its strength after the strength value reached (0.9-0.95) Kult values in most of the samples with failure in the compressive part. The formation of normal cracks in sample beams is presented in Table 3 [20-25].

Table 3.

Sample beam cipher	Shear span (distance from support to force)sm	Bending moment in the formation of normal cracks, kNm		M^t_{ult}	$\frac{M^t_{crc}}{M^t_{ult}}$	$\frac{M^t_{crc}}{M^x_{crc}}$
		Experimental M^t_{crc}	Accounting M^x_{crc}			
BKPA -3	42	3,15	2,16	22,7	0,229	1,458
BKPA -4	42	3,15	2,18	23,8	0,132	1,445

When the BKPA-3,4 specimen beams were loaded, at certain stages of loading (II and later) in the area of pure bending, up to 2 or 3 normal cracks first appeared in the beams, and then, as the load increased, new normal cracks formed. The opening width of the initially formed cracks was 0.05-0.09 mm, as the loads increased, normal cracks developed, their tip was observed to rise according to the height of the section, and at the same time, the width of the crack opening also increased. The opening graph of normal cracks is presented in Figure 1[26-29].

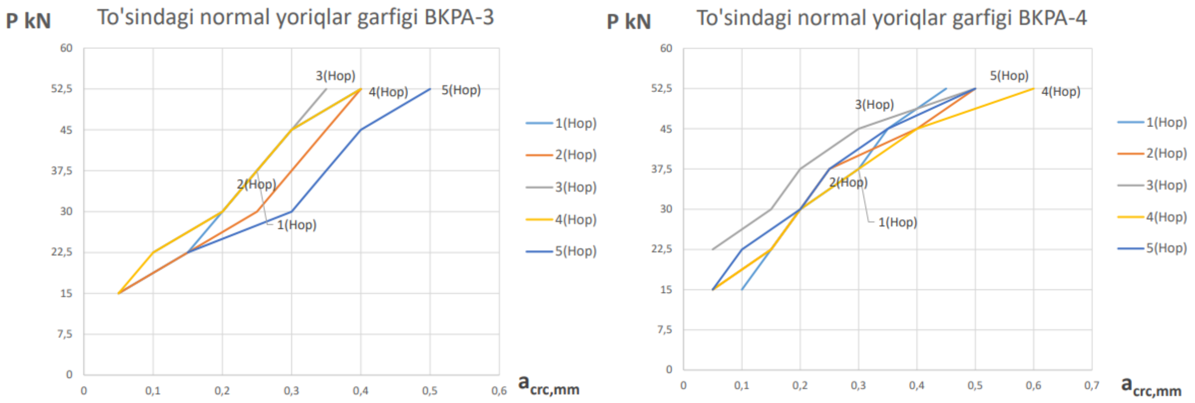

Figure 1. Opening graph of normal cracks in sample beams.

Formation of oblique cracks in sample beams

Table 4.

Sample beam cipher	Shear span (distance from support to force)sm	Transverse force in the formation of oblique cracks, kN		$\frac{Q^t_{crc}}{Q^x_{crc}}$	Q^t_{ult}, kN	$\frac{Q^t_{crc}}{Q^t_{ult}}$
		Experimental Q^t_{crc}	Accounting Q^x_{crc}			
BKPA -3	42	14,5	12,45	1,16	54	0,27
BKPA -4	42	14,9	12,65	1,18	57	0,26

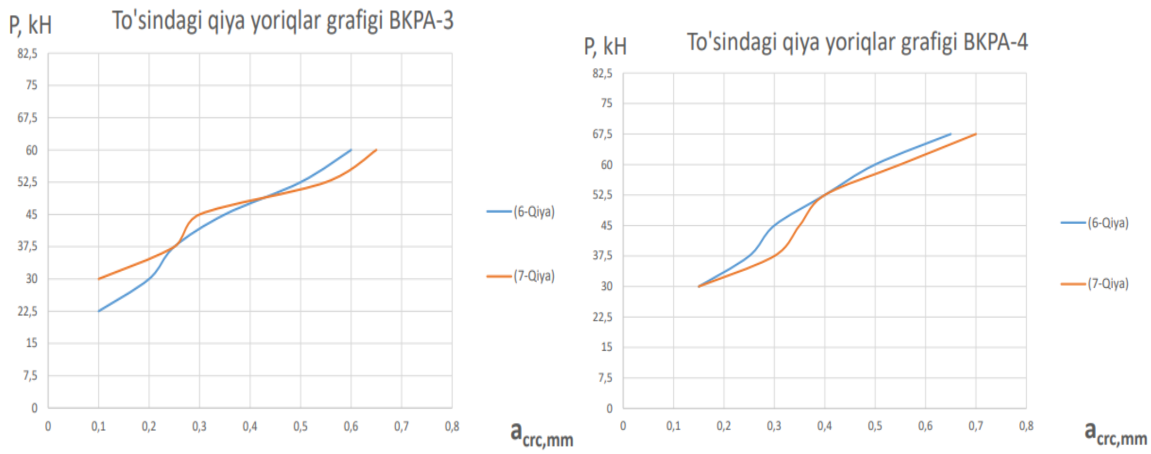

Figure 2. Opening graph of oblique cracks in sample beams.

Conclusions

- the load-carrying capacity of single-reinforced flexural concrete elements with basalt-plastic and glass-plastic rods is very close to that of similarly reinforced steel-reinforced elements;
- it is noted that the load-carrying capacity of elements reinforced with double-reinforcement scheme with composite reinforcements is lower than the load-carrying capacity of elements reinforced with steel reinforcements according to the same scheme, and this situation means that the compressive strength of composite reinforcement is low explained by being;
- it is noted that the crack opening width in flexible concrete elements with basalt-plastic and glass-plastic composite reinforcement is significantly higher (larger) than in elements with steel reinforcement, which is explained by the fact that the composite reinforcement has a small modulus of elasticity (~4 times);
- in flexible concrete elements with composite reinforcement, the stiffness is greater than that of elements reinforced with steel rods, this situation is explained by the fact that the modulus of elasticity is low in basalt plastic and glass plastic reinforcements; however, it was noted that at the level of normative loads, the amount of slack in flexural concrete beams with composite reinforcement is at the level of requirements for reinforced concrete structures.

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