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Research Article

CALCULATION OF STRENGTH OF FLEXIBLE CONCRETE BEAMS WITH BASALT REINFORCEMENT ON VERTICAL SECTIONS

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ABSTRACT

This article presents the methods of calculating the fracture resistance of bending concrete beams with basalt reinforcement on vertical (normal) sections, the conducted research and the analysis of comparing the experimental results with the calculated results.

KEYWORDS

Mirror composite materials, basalt-plastic reinforcements, strength, stress-strain state, crack formation, loading stages, shear range, deformations, breaking moment.

INTRODUCTION

Today, in the world, a lot of scientific and research work is being carried out, aimed at ensuring their priority, strength and longevity, using carbon, glass and basalt reinforced concrete structures made on the basis of mirror composite materials in the construction of buildings and structures. In construction practice, using mirror composite reinforcements, conducting research in the directions of increasing the fire resistance and elasticity module of concrete, and improving the stress-deformation state, strength, and crack resistance properties of bending elements has become one of the urgent tasks.

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Therefore, it is advisable to conduct complex experimental and theoretical studies to determine the state of stress-deformation, strength, formation of cracks in their constructions, development, failure patterns and uniformity of bending concrete beams with basalt reinforcement under the influence of external forces.

The main part. To conduct an experimental study, test sample beams with a rectangular cross-section were prepared. Ordinary heavy concrete was used for the beams. Portland cement of the "Yasin" cement factory in Fergana region was used as a binder. Granite flint and quartz river sand were used as fillers. The composition of the concrete was chosen so that the cubic strength was equal to the compressive strength corresponding to the V20-V25 class.

12 sample beams with cross-sectional dimensions b×h=16×30 cm, length l=240 cm, support interval l_o=210 cm were tested on a specially prepared test stand. As working fittings, Ø12, Ø14, Ø16 BPA were placed in the stretching area, Ø10 BPA in the compression area, Ø4, Ø8 BPAs were placed as clamps, with a step of 15 (10)cm.

The strength of flexural concrete beams with basalt reinforcement was determined depending on the distance between the element supports, the amount of load, the strength of the concrete and the reinforcement of the beams.

RESULTS AND DISCUSSION

According to the results of the conducted test studies, it was found that the flexural concrete beam structures reinforced with basalt reinforcements tested under the influence of external forces are almost qualitatively similar to the flexural structures with steel reinforcement.

According to the values of deformations in concrete and reinforcement during the test research, it was determined that cracks are formed in the sample beams. At the same time, the surfaces and side surfaces of the beams were carefully monitored during loading. In this case, the fact that the load has a relatively small value (~ 0.05Fult) during the observation and loading stages, allowed to determine the amount of the load during the crack formation during the test.

In all tested beams, initially vertical cracks were formed in the pure bending region, and as the amount of load in the loading stages increased, cracks inclined to the longitudinal axis of the beam were also formed in the load span (shear span).

It was observed that the value of the bending moments Mcrc during the formation of cracks in the sample beams depends on the value of the distance "a" (shear interval) between the load and the support.

When the distance between the supports is a=70cm in the beams of the series sample, $(\frac{a}{h} = 2{,}59)$ vertical cracks were formed at bending moments equal to $M^{\text{т}}_{crc} = 9{,}2 - 9{,}7$ кНм. In this case, the ratio of the crack forming moment to the breaking moment was $\frac{M^{\text{т}}_{crc}}{M^{\text{т}}_{ult}} = 0{,}209$. In the BPPA I-3 beam of the I-series, when the distance between the supports is a=40 cm, $(\frac{a}{h} = 1{,}48)$the vertical crack $M^{\text{т}}_{crc}$ nng value is $M^{\text{т}}_{crc} = 7{,}9$ кНм, $\frac{M^{\text{т}}_{crc}}{M^{\text{т}}_{ult}} = 0{,}28$.

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The distance between the supports in the II-series sample beams is a=70cm. When the distance between the supports in the II-series sample beams is a=70cm, $(\frac{a}{h} = 2{,}59)$ vertical cracks are $M_{crc}^{т} = 8{,}9 - 9{,}1$ кНм,, equal to in bending moments was equal to $\frac{M_{crc}^{т}}{M_{ult}^{т}} = 0{,}224$.

Due to the low strength of the concrete of sample beams of the III-series compared to other sample beams, vertical cracks were formed earlier, that is, the amount of moments in the formation of cracks was 7-11% less. In this case, when the distance between the supports is a=70cm, $(\frac{a}{h} = 2{,}59)$ vertical cracks $M_{crc}^{т} = 7{,}9 - 8{,}3$ кНм, the ratio decreases at equal bending moments, $\frac{M_{crc}^{т}}{M_{ult}^{т}} = 0{,}173$.

In sample beams of series IV, the distance between the supports was tested at values of a=40см $(\frac{a}{h_0} = 1{,}48)$.

The first vertical cracks were formed in sample beams of the IV-series at values of $M_{crc}^{т} = 12{,}7 - 13{,}03$ кНм. The corresponding value was $\frac{M_{crc}^{т}}{M_{ult}^{т}} = 0{,}33$.

The ratio of the experimental values of the cracking moments to the calculated values for sample beams of I, II and III-series had values less than 1 and ranged from 0.67 to 0.92, their average value was equal to 0.73. According to the analysis of calculated and experimental values, vertical cracks are formed at loads 25-30% lower than the calculated values. For IV-series specimen beams, values greater than 1 were obtained, and the ratio of experimental and calculated cracking moments was between 1.05 and 1.07 (Fig. 1).

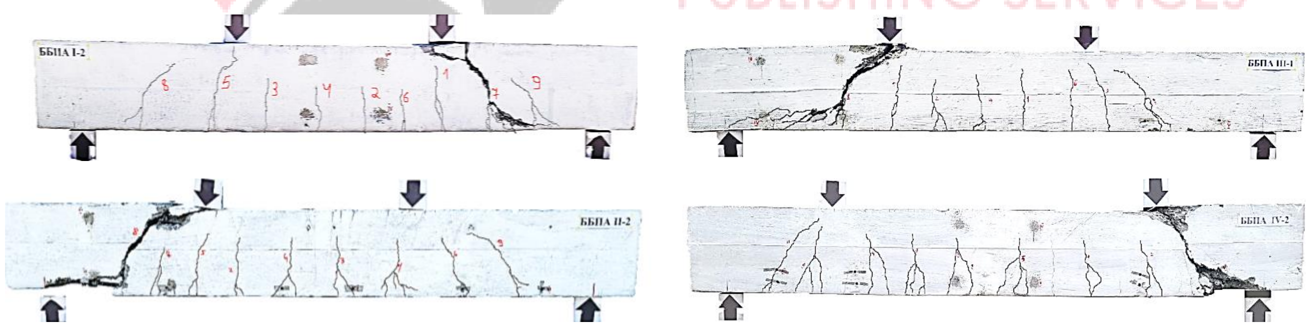

Figure 1. Formation and development of cracks in sample beams

The values of the experimental M_crc^т and calculated M_crc^ҳbending moments perpendicular to the element's longitudinal axis in the sample beams are presented in Table 1.

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Formation of vertical cracks in sample beams

A sample beam cipher	The distance between the forces, cm	Bending moment in the formation of vertical 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}			
BBPA I-1	70	9,7	12,95	25,34	0,383	0,75
BBPA I-2	70	9,2	12,60	25,06	0,367	0,73
BBPA I-3	40	7,9	10,50	19,20	0,411	0,752
BBPA II-1	70	9,1	12,60	25,34	0,36	0,72
BBPA II-2	70	9,0	13,06	23,38	0,384	0,69
BBPA II-3	70	8,9	13,30	22,26	0,40	0,67
BBPA III-1	70	7,9	10,56	21,18	0,373	0,75
BBPA III-2	70	9,3	10,09	22,42	0,414	0,922
BBPA III-3	70	8,3	9,91	20,09	0,413	0,837
BBPA IV-1	40	11,5	10,94	27,08	0,424	1,051
BBPA IV-2	40	12,7	11,87	29,80	0,426	1,069
BBPA IV-3	40	13,03	12,27	29,68	0,44	1,061

When the load was applied to the beams of the tested sample, 1.2 vertical cracks first appeared in the beams in the area of pure bending of the element at II and subsequent stages of loading, and new vertical cracks were formed as the load increased. The opening width of the initially formed cracks was 0.03-0.05 mm. As the loads increased, vertical cracks developed, the crack tips were observed to grow towards the compressive zone of the member, and at the same time, the crack opening width also increased.

When the destructive load in the loading stages reached about half, the opening width of the vertical cracks was asrc=0.25-0.35mm, the increase of the load in the later stages caused the rapid development of the vertical cracks and the significant increase in the opening width.

The values of M^{x}_{crc}range from 9.91 kN·m to 13.30 kN·m based on theoretical calculations. The average value of Mcrch was equal to 11.60 kN·m. The difference between the average value of $M^{x}_{crc}$and the smallest and largest values is 2.01 kN·m (0.85%) and 1.72 kN·m

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(1.18%), respectively. Almost constant values were obtained for the values of M_{crc}^{X} in the calculations.

In the values of the bending moments M_{crc}^{T} in the formation of a vertical crack, there were big differences. In the experiments, the values of M_{crc}^{T} of the sample beams of the III series were 7.5-9.3 kN·m, and the values of the sample beams of the IV series were 12.7-13.03 kN·m.

During the tests, the opening width and length of the vertical cracks formed in all sample beams were measured. The obtained results were processed and summarized and graphs were developed. (Figure 2).

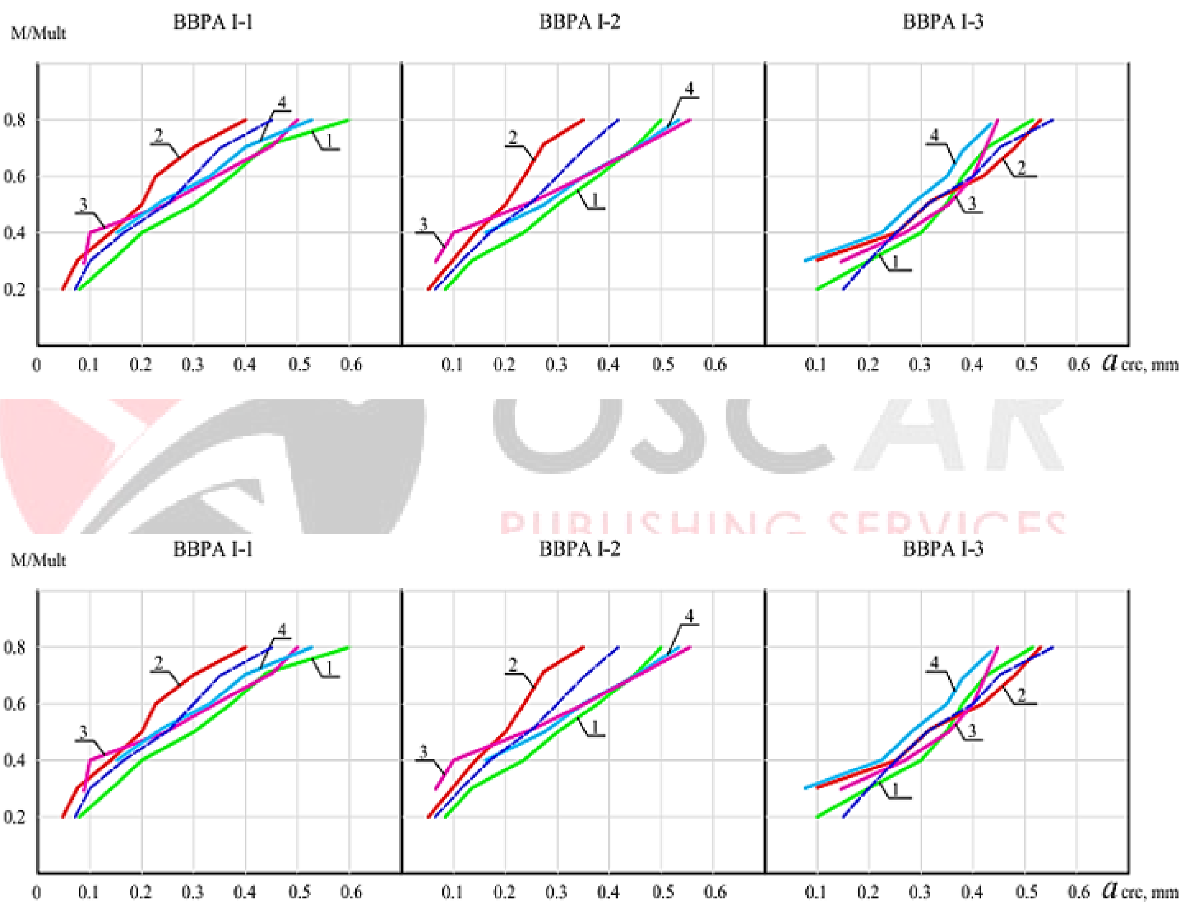

Figure 2. Vertical crack opening width in sample beams. 1,2,3,4 is the order number of cracks. ___________ - experimental, computational

CONCLUSIONS

1) According to the results of the test experiment, it was observed that the values of M_crc^t change in accordance with the values of the tensile strength of

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concrete R_(bt,ser). As an example, we can cite sample beams of the III series. Accordingly, since the concrete of the sample beams of this series is made of low-strength concrete, it was determined that the moment of cracking is 1.74 times smaller than that of the beams of other series tested under the same conditions.

2) The ratio of the experimental M_crc^T to the calculated M_crc^h was 1.21 on average, except for the samples of the III series. For samples of the III series, this ratio was 0.833. It was found that the average value of the experimental crack-inducing moments in samples other than the III-series is equal to 20.0% of the breaking moments. In the samples of this series, cracks occurred at loads equal to 10.0% of the breaking load.

3) It was found that the results of calculation of the opening width of vertical cracks in relation to the longitudinal axis of the element according to the method given in ShNQ 2.03.14.18 "Concrete constructions with composite polymer reinforcement" satisfactorily agree with the laws and quantities of changes obtained in the experiments.

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