About the influence of fiber on the deformation of compressed flanges at 3.6 h'_f, 4.8 h'_f, 8 h'_f overhangs of reinforced rubber concrete t-beams with reinforcement of 2.50%

Aleksei E. Polikutin[1], *Sergey* A. Pinaev[1], *Pavel* A. Zyabukhin[1*], and *Theophilus* O. Oforkaja[1],

[1]Voronezh state technical university, 20-letia Oktyabrya 84, 394006, Voronezh, Russia

Abstract. The aim of this study is to determine the effect of fiber reinforcement on deformations arising from the applied load in the compressed flanges of reinforced rubber concrete beams of a T-section.This article presents the results of testing prototypes of rubber concrete and fiber rubber concrete beams of a T-section, tested to a pure bending. The strain curves for compressed flanges (3.6h'_f, 4.8h'_f, 8h'_f overhangs) of reinforced rubber concrete beams of T-section are obtained.

1 Introduction

Composite material - rubber concrete (rubcon), obtained on the basis of liquid rubbers, has a high, almost universal chemical resistance and high physical and mechanical properties. Component composition and coefficients of chemical resistance of this polymer concrete are given in tables 1 and 2.

Table 1. Component composition of reinforced rubber concrete

Name of components	The content of components, mass. %
Cis-polybutadiene low molecular weight rubber SKDN-N	8.0
Industrial sulphur	4.0
Tiuram-D	0.4
zinc oxide	1.6
calcium oxide	0.5
Fly ash	7.0
Quartz sand	24.0
Crushed stone	54.5

* Corresponding author: aypavel@mail.ru

Table 2. Chemical resistance coefficients of rubcon

Type of aggressive environment	Chemical resistance coefficient	
	after 1 year of exposure	Projected after 10 years
20% sulphuric acid solution	0.95	0.95
3% nitric acid solution	0.8	0.7
10% citric acid solution	0.9	0.8
20% sodium hydroxide solution	0.95	0.95
10% potassium hydroxide solution	0.8	0.65
Saturated Sodium Chloride solution	0.9	0.8
Diesel fuel	0.95	0.95
Water	1	0.99

An analysis of previous studies [9,10,12,14-16] shows that based on rubcons, it is possible to create highly efficient reinforced structures for various purposes, including flexural ones of various cross sections [1 – 7,11,13].

The T- section, in comparison with the rectangular, is more effective from the point of view of profitability, because from the tensile zone, poorly resilient to tension, a part of the material that was practically not involved in the work was removed.

It has been established that the type of reinforcing fiber and its amount affect the deformation-strength properties of fiber rubber concrete. The most effective is dispersed reinforcement of rubcon with fibers made from steel cord waste [8].

2 Methods of experimental research

In order to conduct experimental studies, T-beams of cross-section were made of rubcon and fiber rubcon. A500C class reinforcing bars were used as longitudinal reinforcement, and Bp500 with a diameter of 5 mm and a step of 50 mm as transverse reinforcement. Fiber reinforcement is represented by steel fibers with a diameter of 0.3 mm and a length of 30 mm (i.e., the ratio of the diameter to the length of the fiber is 1/100) located randomly throughout the volume of the experimental beams. Dimensions of experimental samples of the beams:
Length (l) – 1400 mm; web height (h-h'_f) – 95 mm; web width (b)– 60 mm;
flange height (h'_f) - 25 mm; flange width (b'_f) – 240, 300 и 460 mm; diameter of the longitudinal reinforcing bar –2Ø10; which corresponds to the percentage of longitudinal reinforcement (μ) – 2,50 %. The reinforcement scheme and the location of the T-beam on the supporting elements is shown in fig. 1.

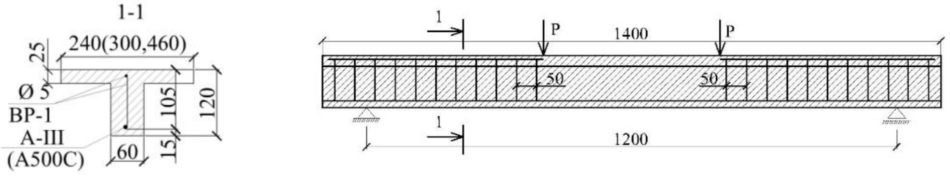

Fig. 1. Reinforcement scheme and location of T-beams on supporting elements

Experimental studies were carried out according to the following procedure. The beams were tested for bending by two forces applied in the third span, increasing up to failure. The calculated span of the samples was 1200 mm, the length of the samples was 1400 mm, which ensured reliable anchoring of the reinforcing bar. Flange sizes were assigned for the following reasons: flange height (h'_f=25 mm) was chosen in such a way as to provide, if necessary, the possibility of placing reinforcing bar in it. The width of the flange was 240, 300 and 460 mm. The arrangement of strain gauges is shown in fig. 2. The type of beam before and after the test is shown in fig. 3. The tests were carried out at the Center for Collective Use named after Professor Yu.M. Borisov of VSTU, the following devices were used: Universal floor-mounted hydraulic testing system model 600KN from INSTRON (USA), a set of equipment for monitoring the stress-strain and technical state of structures and their elements (Germany).

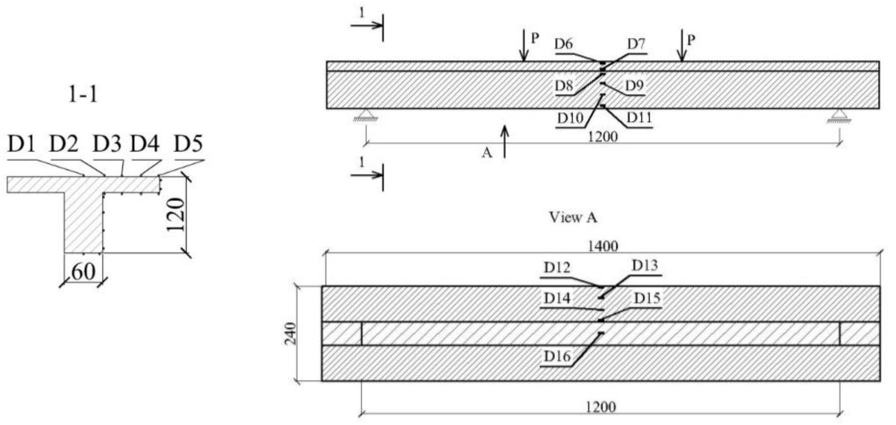

Fig. 2 - Layout of strain gauges.

Before the experiment After the experiment

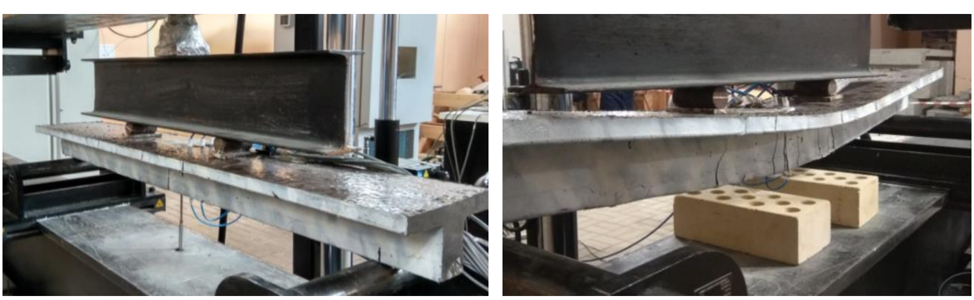

Fig. 3. Fiber rubber concrete T-beam (BFRT), flange width 240 mm

3 Experimental results

As a result of testing the experimental beams, curves of changes in deformations were obtained in the compressed flange of a bent reinforced rubber concrete element as shown in fig. 4,5,6. The distribution of deformations in the flange is almost linear in nature, reducing the inclusion of flange in the work as it moves away from the web in the initial stage of work, gradually distorting as the bearing capacity is exhausted by the design. Figures 4,5,6 show only the last stages of beam loading.

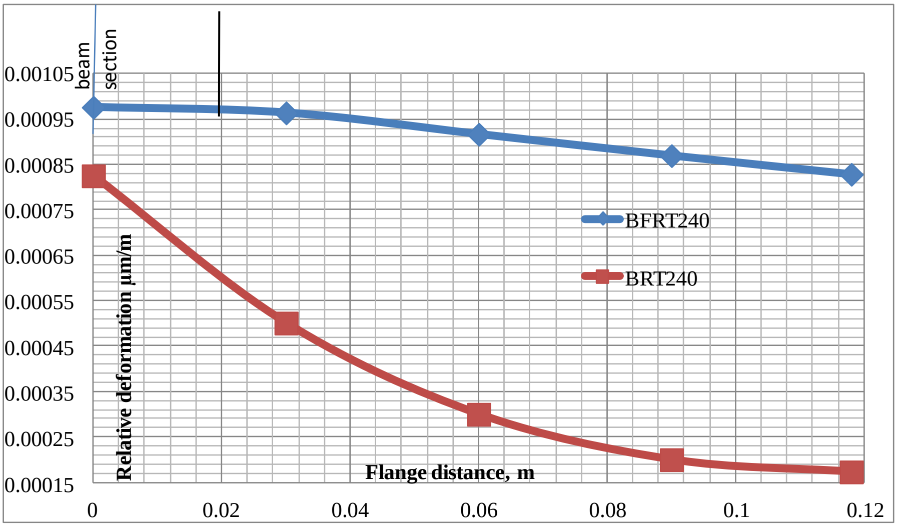

Fig. 4 Distribution of strains in extreme compressed fiber along the width of the flange of the upper zone of reinforced rubber concrete beams, BFRT240 and BRT240, µ=2.50% at 90% Mu.
Note: cipher decryption of BRT240: B - type of element, in our case, a beam; R - material of which the bent element is made (FR- fiber rubber concrete, R-rubber concrete); T – cross-sectional view, in our case, T-section; 240 - flange width in mm.

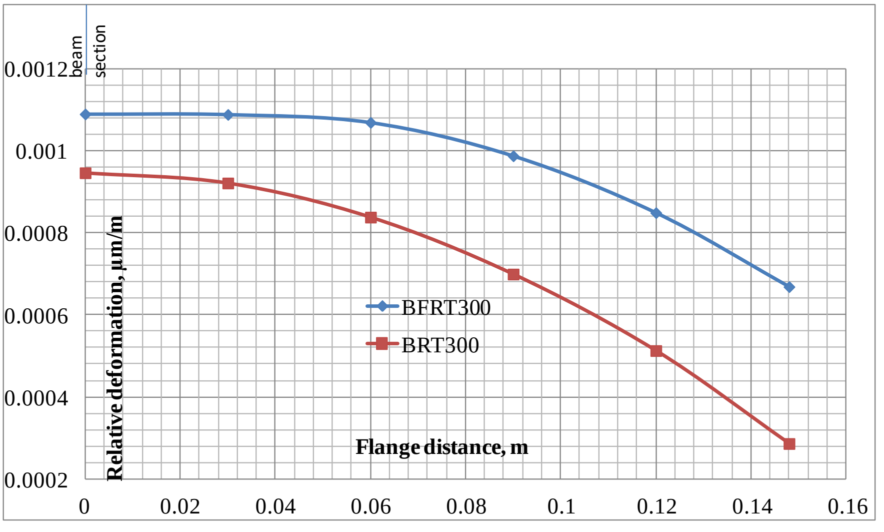

Fig. 5. Distribution of strains in extreme compressed fiber along the width of the flange of the upper zone of reinforced rubber concrete beams, BFRT300 and BRT300, µ = 2.50% at 90% Mu

The difference in the relative deformations for the BFRT240 and BRT240 beams of the wall and at the farthest portion from the wall at the construction stage close to critical for the BFRT is 652.10 * 10^{-6}, in BRT- 148.20 * 10^{-6}.
The difference in the relative deformations for the BFRT300 and BRT300 beams of the wall and at the farthest portion from the wall at the construction stage close to critical for the BFRT is 661.71 * 10^{-6}, in BRT- 421.91 * 10^{-6}.

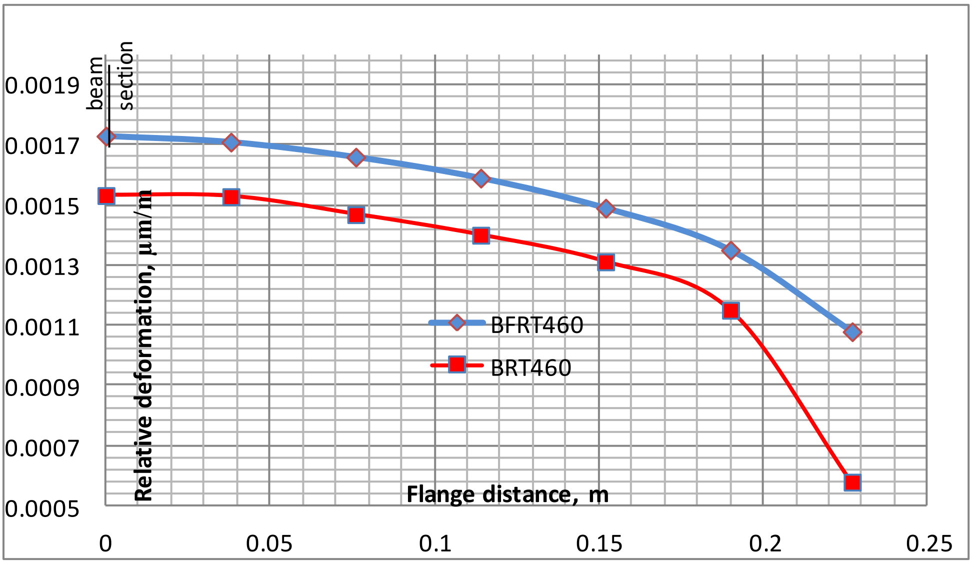

Fig. 6. Distribution of strains in extreme compressed fiberalong the width of the flange of the upper zone of reinforced rubber concrete beams BFRT460 and BRT460, µ = 2.50% at 90% Mu

The difference in the relative deformations for the BFRT460 and BRT460 beams of the wall and at the farthest portion from the wall at the construction stage close to critical for the BFRT is 652.32 * 10^{-6}, in BKT- 651.54 * 10^{-6}.

In BFRT240 mm, an increase in the strain value at the farthest portion from the wall is 4.78 times in comparison with BRT240, the value of wall deformation in BFRT240 is 1.18 times higher than in BRT240.

In BFRT300 mm there is an increase in deformations in the farthest portion from the wall by 2.33 times in comparison with BRT300, the value of wall deformation in BFRT300 is 1.15 times higher than in BKT300.

In BFRT460 mm, an increase in deformations at the farthest portion from the wall is 1.86 times in comparison with BRT460, the value of wall deformation in BFRT460 is 1.13 times higher than in BRT460.

Conclusions

1. An analysis of experimental data showed that with the addition of fiber filaments, the strain values in the compressed flange of a rubber concrete beam of T-section increase.
2. The greatest difference in deformations, when fiber is added to the walls and at the farthest portion from the wall, is observed in a beam with a flange width of 240 mm.

3. An increase in the width of the flange most significantly affects the change in deformations (with the addition of fiber) at the farthest portion from the wall, at the portion near the wall, deformations are more stable.

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