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STRENGTHENING AND DEFORMATION OF GLASS COMPOSITE ARMATURES MANUFACTURED IN UZBEKISTAN

Abstract: *The article describes the results of experimental studies of beams reinforced with composite reinforcement, and provides information on the development of stresses and deformations in elongated and compressible parts of concrete under the influence of beam load.*
Key words: *composite reinforcement, load, bending moment, transverse force, deformation.*
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Introduction

With the rapid development of modern construction practices in the world, the share of the use of composite materials in the reinforced concrete structures of buildings and structures is growing. In this regard, one of the priorities of the construction and design industry is the development, application, durability, and modernization of production technologies, reduction of production costs and their widespread use, using local raw materials as an alternative to steel reinforcement in flexible reinforced concrete structures. Much attention is paid to ensuring its application.

In our country, special attention is paid to the development of the construction industry and the use of innovative composite materials in construction, simplification of structures, saving metal ore reserves, ensuring the reliability of buildings and structures, the development of new constructive solutions.

The main part.

Existing standards and recommendations for testing fiberglass composite reinforcement and calculation of structures are often considered as a modification of the standard for calculation of steel reinforcement structures. The changes are related to the standardization of the physical and mechanical properties of the reinforcement and a number of empirical ratios based on.

The principles of calculation of constructions by the method of boundary conditions are considered to be common to all norms. There are limit states for the first limit state ULS (in terms of robustness) and the second limit state SLS (in terms of normal serviceability).

There are two approaches:

The European approach - the design condition for boundary conditions is written in the form R ≥ S, where the calculated resistance of the section as a function of the calculated characteristics of R-materials (normative values R - divided by the coefficients of reliability of the material), S - external design influences and loads lar [6-14].

The North American approach is that the design condition for boundary conditions is written in the form phR_n≥S, where R-materials are the nominal resistance of the cut as a function of the normative (with a given assurance) characteristics; ph is the generalized coefficient of reliability depending on the type of failure; S is the stress generated in the section from external computational influences and loads.

Thus, the main difference of the existing normative documents in the field of calculation of composite polymer reinforcement structures is the principles of ensuring this reliability.

The calculated value of strength (deformation) classifications is generally determined by the following formula.

$$R = \eta R_n/\gamma_R$$

where R_n is the normative value of strength or deformation (with a guarantee of 0.95); g_n - reliability coefficient on the material; ē is the product of the coefficients of working conditions (coefficient taking into account the long duration of loads, multi-cycle, external conditions) [19-25].

The material reliability coefficient for composite polymer reinforcement is set only in European standards. [6] Italian standards set a coefficient value of g = 1.5 for calculations on the first boundary condition and a value of 1.0 for calculations on the second boundary condition. In the bulletin [5] and [9] it is proposed to adopt a value of the reliability coefficient g for the first boundary condition at a value of not less than 1.25. In [7], the g_R coefficient does not boil, but the normative (manufacturer-guaranteed) value is determined by 0.9986 (3s), with the total (reserve) reliability coefficient φ =0,5-0,7 being taken into account in addition.

The coefficient of working conditions is provided to take into account the external conditions that affect the strength and deformation properties of fiberglass composite reinforcement (these coefficients are defined differently in different normative documents). In [7] it is accepted to distinguish only two types of external conditions: exploitation in dry and humid environments. Similar requirements are included in Italian standards. [8] Japanese standards and many European recommendations provide for a generalized coefficient of working conditions. Canadian standards also provide for class consideration in terms of quality. A number of standards also provide for operating conditions related to the loading nature of the elements. The summarized data on the magnitudes of the coefficients of operating conditions are given in the table below.

Table 1. Coefficients of operating conditions for fiberglass composite fittings

Factor to be taken into account	ACI 440.1R-06	NS 3473 (Norway)	CSA-S6-00 (Canada)	JSCE (Japan)	CNR-DT203 (Italy)
External conditions (first and second boundary condition)	**Dry: СП – 0,8 ОП – 0,9 УП – 1,0 Name: СП – 0,7 ОП – 0,8 УП – 0,9**	**СП – 0,5 ОП – 0,6 УП– 1,0**	**СП-0,5 ОП-0,6 УП-0,75**	**СП-0,77 ОП-0,87 УП-0,87**	**Dry: СП-0,8 ОП-0,9 УП-1,0 Name: СП – 0,7 ОП – 0,8 УП – 0,9**
Symbols: SP - glass, OP - organic plastic, UP - carbon fiber					

The following operating conditions coefficients are included for fiberglass composite reinforcement, which take into account the possibility of incomplete use of strength properties of fiberglass composite reinforcement in relation to the continuous effect of stresses, uneven distribution of stresses across the cross-section, anchoring conditions, operating conditions:

m_{ad} = 0.65 is the coefficient taking into account the long-term effects applied to all calculated sums of loads.

m_{at} = 0.9 - coefficient taking into account the effects of high temperatures (short-term heating in production up to 100 °C, long-term effect of temperature at 80ºC, evaporation at 60 °C).

m_{ak} = 0.7-0.8 - coefficient taking into account the impact on structures during the operation of structures in aggressive environments.

The following calculation ratio is set to determine the compressive strength of fiberglass composite reinforcement:

$$f_{fds}=0.2f_{fd}$$

where f_fds is the compressive strength of the composite polymer reinforcement, f_fd is the compressive strength of the composite polymer reinforcement.

Results and discussions.

To determine the true strength of the glass composite reinforcement used in the sample beams, 6 special samples of each type of longitudinal working reinforcement diameter (Ø10,12,16mm) were prepared in accordance with GOST 31938 and tested for elongation (Fig. 1,2). The results of elongation tests of reinforcement samples are given in Table 2.

The physical and mechanical properties of concrete and glass composite reinforcement determined from experiments were used in the theoretical calculations of sample beams, in particular, M^x_{crc}, Q^x_{crc}, M^x_{ult}, Q^x_{ult},, to determine the width of cracks, the slope of the beams.

Figure 1. Samples of fittings prepared for elongation testing

Figure 2. The process of elongation testing of a sample of glass composite reinforcement

Table 2. Results of determination of strength, modulus of elasticity and relative elongation of glass composite reinforcement in axial elongation:

№	Sample cipher	Cross-sectional area, A,мм^2	Maximum load,P,кН	Consistency limit, σв, МПа		Elasticity module, E_f , МПа		Relative elongation , $\varepsilon_в$, %	
				amount	average value	amount	average value	amount	average value
1	ShKA - 10-1	50,24	44,00	876	871	51200	50967	2,0	1,63
2	ShKA - 10-2		45,66	909		50900		1,6	
3	ShKA - 10-3		46,39	923		51300		1,7	
4	ShKA - 10-4		42,45	845		50700		1,4	
5	ShKA - 10-5		42,73	850		50500		1,6	
6	ShKA - 10-6		41,18	820		51200		1,5	
7	ShKA - 12-1	113,1	66,36	753	752	50600	50550	1,6	1,65
8	ShKA - 12-2		62,60	774		51100		1,8	
9	ShKA - 12-3		64,90	779		50200		1,9	
10	ShKA - 12-4		65,45	740		51000		1,8	

11	**ShKA - 12-5**		**61,10**	**733**		**50100**		**1,5**	
12	**ShKA - 12-6**		**60,32**	**734**		**50300**		**1,3**	
13	**ShKA - 16-1**	**201,1**	**82,63**	**811**	**810**	**50300**	**50580**	**1,8**	**1,68**
14	**ShKA - 16-2**		**85,67**	**826**		**50200**		**1,8**	
15	**ShKA - 16-3**		**86,39**	**830**		**51200**		**1,7**	
16	**ShKA - 16-4**		**80,65**	**801**		**50400**		**1,5**	
17	**ShKA - 16-5**		**79,62**	**896**		**50600**		**1,4**	
18	**ShKA - 16-6**		**79,77**	**897**		**50800**		**1,9**	

The glass composite fittings used for the pattern beams are elongated the results of these studies are shown in Figure 2.26-2.29. The tensile strength of the samples was 752 ÷ 871 MPa, the modulus of elasticity was 50550 ÷ 50967 MPa, and the relative elongation was 1.63 ÷ 1.68%.

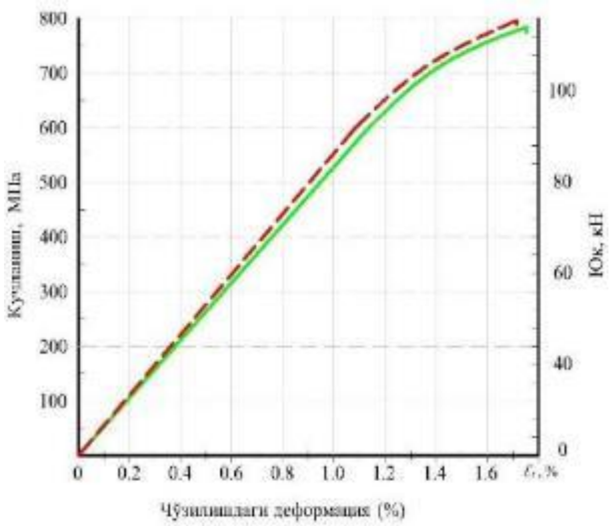

Figure 3. Axial elongation diagram of armature model ShKA-14 "Stress / Load-deformation"

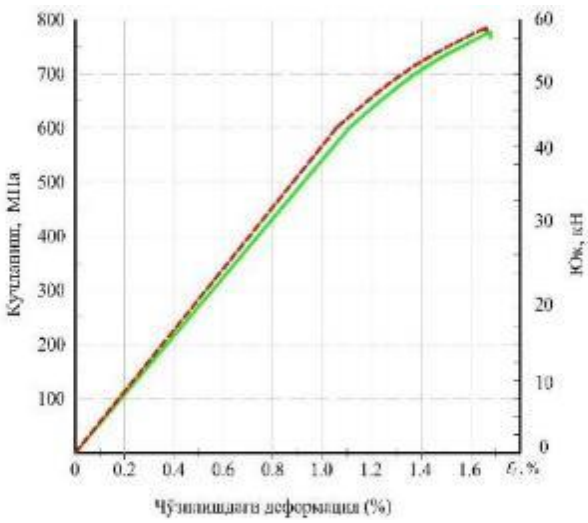

Figure 4. Axial elongation diagram of armature model ShKA-12 "Stress / Load-deformation"

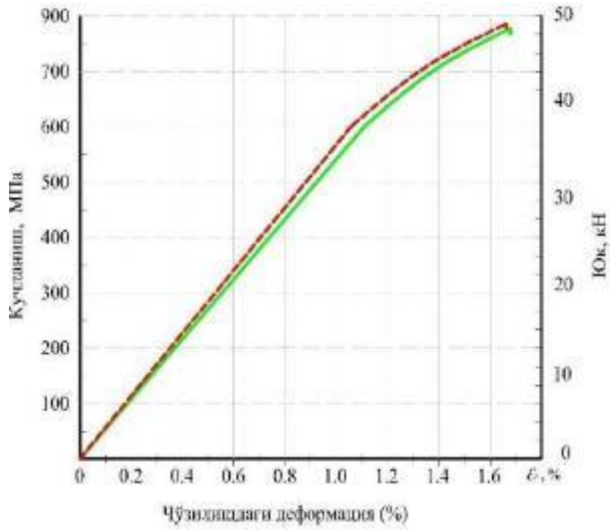

Figure 5. Axial elongation diagram of armature model SHKA-10 "Stress / Load-deformation"

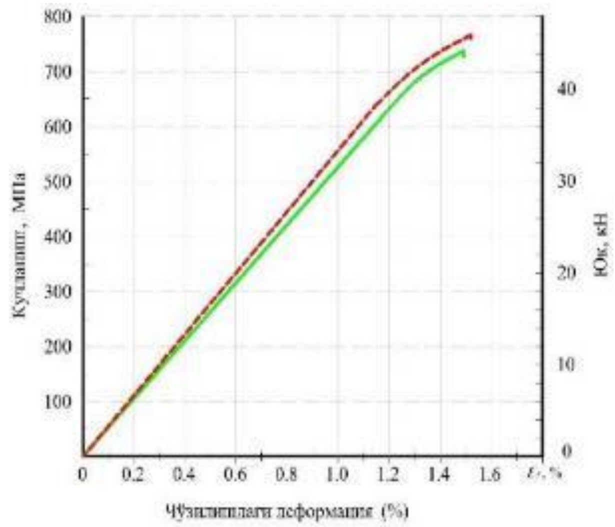

Figure 6. Axial elongation diagram of armature model ShKA-8 "Stress / Load-deformation"

Conclusion

1. The maximum deformations formed in the longitudinal elongated reinforcement showed that they formed elongated stresses in quantities that reach the calculated resistance of the composite reinforcement. Deformations in the compressive longitudinal reinforcement reached values (100-150) 10^{-4}.

2. Experiments have shown that the calculation of glass-composite reinforced concrete structures is based on the method of boundary conditions developed for steel-reinforced concrete structures, which is the right approach in all respects. At the same time, it would be expedient to periodically make appropriate changes to the empirical connections based on the results of new experimental studies.

3. Physical and mechanical properties of glass composite fittings used for sample beams were tested according to standard methods and quantitative values were determined. Based on them, all the main parameters of the test samples were calculated according to the requirements and rules of SHNQ[1].

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