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# INCREASING THE BEARING CAPACITY OF BEAMS WITH COMPOSITE ELEMENTS

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*The article considers the research findings on the operation of experimental samples and steel elements reinforced with composites. A comparative analysis of the control and reinforced elements is conducted,the recommendations for the use of this type of reinforcement are given.*

In recent years,much attention has been paid to the reconstruction of existing buildings and structures due to re-equipment of many industrial enterprises and in order to extend the service life of various construction facilities. Sometimes,after the reconstructionstructural elements do not meet the strength and stiffness requirements and need reinforcement.At present, composite materials based on carbon fibers are used to strengthen building structures.These materials are characterized by high strength, they are also comparable with structural steels at a much lower weight and have the same tensile-and-compression strength.Below are the results of the research on reinforcing steel beams with elements of composites, namely, carbon fiber tapes.

The studies were conducted in two stages.

1. Experimental studies of steel samples from the applied polymeric tapes.

2.Experimental studies of steel beams reinforced with polymer tapes.

In the first stage, mechanical tensile testing of the control and experienced samples.

Samples of the first stage.

Experimental and control samples were made of flat steel St.Z with a thickness of 8 mm and a width of the working part 50 mm Was tested 3 the steel control sample and 3 samples with glued composite tapes.Connection of composite tapes on the basis of carbon fibers and steel samples was made using epoxy glue with pre-treatment of contact surfaces. The mechanical characteristics of the material of composite tapes according to the manufacturer are presented in table 1 [1].

Table 1. – Mechanical characteristics of the material of composite tapes according to the manufacturer

| | |
|---|---|
| Elastic modulus | $1{,}65.10^{5}$ MPa |
| Tensile strength at break | 3050 MPa |

The mechanical characteristics of the composite obtained experimentally are presented in table 2.

Table 2. –-Mechanical properties of the composite obtained experimentally

| | |
|---|---|
| Elastic modulus | $1{,}62.10^{5}$MPa |
| Tensile strength at break | 2980 MPa |

Comparison of the data in tables 1 and 2 indicates a practical coincidence of mechanical properties.

The method of the experiment was as follows. The test and control specimens were stretched on a standard test machine under the same conditions: the strain rates of all specimens were the same, all specimens were loaded to failure of the steel and composite parts [1].

All control steel specimens under tension were deformed according to the classical scheme, typical for plastic materials, and collapsed in the middle zone with the formation of a pronounced neck. The defined yield strength and tensile strength correspond to the characteristics determined by the standard for the steel in question. The destruction of the test samples took place in stages: the first one broke before the destruction of the composite material in the form of rupture of the carbon fibers at the developed metal plasticity; the second one broke before the rupture of the steel sample with the formation of a neck. The tensile force at the end of the first stage was much greater than the tensile force of the reference metal. The deformation diagrams of test samples with glued composite material qualitatively repeat the diagrams for brittle materials, while the tensile strength was 22% higher than the tensile strength of the steel of the control samples. The brittle nature of the destruction of carbon fiber tensile involves careful and attentive approach to the use of such reinforcements.

Second stage samples.

I-beams of control samples are made of two channels by longitudinal seam welding with subsequent processing. Prototypes – the same beams with the polymer tape pasted in the stretched zone. Before gluing the surface of the steel beam is treated with degreasing liquids [1].

At the second stage, the bending deformation of steel beams made of two channels with polymer tapes(prototypes) and beams without reinforcement (control samples) glued in the stretched zone was carried out. In experimental studies of beams at each stage of loading measurements of deflections in the middle of the span beams, the relative deformations of steel, composite material gain.

The destruction of the "clean" steel control beam occurred in the middle of the span as a result of the steel reaching the yield point, which is typical for structural steels. The relative deformation of the steel in the stretched zone was 2.21%, the destruction occurred smoothly, the deflection increased without increasing the load. The bending moment corresponding to the breaking load is 10.6 kNm. The beam deflection in the middle of the span at the load corresponding to the operating value was 6.8 mm.

The test steel beams reinforced with composite had quasi-brittle fracture. Comparing the parameters of the test and control beams deformation, it should be noted that the best results of reinforcementare as follows: on deformations – 11%, on the destructive moment – 8%, on deflection – 12%.

On the basis of the research of the bent steel elements reinforced with composite materials it is possible to draw the following conclusions.

1. The use of composite material to strengthen steel structures is undoubtedly progressive.

2. The special aspects of the operation of the bent steel elements strengthened with composite materials on the basis of carbon fibers are established.

The aging of the polymer base of composites and the fragile nature of the destruction should be noted as negative factors in the application of this type of reinforcement. The most reasonable application of this reinforcement is for a short further service life of structures, i.e. temporary strengthening. Further long-term operation of the reinforced elements requires additional close monitoring [2].

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