Effect of Carbon Black on Epoxide Resin ED-20 Properties

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Abstract. This article describes the effect of carbon black P505 on the bending strength of epoxy resin ED-20. Studies of the effect of the filler concentration of carbon black P505 on the bending characteristics of the epoxy resin composite ED-20 were carried out at temperatures of +23 and -60 °C. Three times decrease in flexural strength and four times in deformability has been observed. When test temperature drops to -60°C, indicators of strength and deformation at failure remain unchanged.

1. Introduction
Epoxy polymers, due to the modification possibility, caused by presence of reactive hydroxyl and epoxy groups, with obtaining materials with high physical and mechanical properties, are still the most promising among other organic high-molecular substances [1-3]. Composite materials based on epoxy oligomers are widely used in practice due to high adhesion, high heat resistance, low brittleness, low shrinkage during curing, stability of technological properties and several other properties. Due to such properties, materials based on epoxy resins are widely used in various industries: as film-forming substances in the refining industry, shipbuilding, construction, etc. [4,5].

2. Theoretical part
However, the characteristics of these materials do not always meet the requirements of modern technology, therefore, obtaining materials with improved performance is of great scientific and technical importance. In practice, in order to expand the areas of application, epoxy resins often undergo modifications. Obtaining polymer composite materials with the required performance characteristics can be achieved by modifying the original epoxy polymer, during which purposeful regulation of the structure occurs. Production of epoxy polymer composites for construction purposes with predetermined properties is usually associated with the use of physicochemical modification methods: the introduction of solid insoluble fillers and aggregates, surfactants, inert plasticizers and diluents [6-8].

3. Practical part
GOST 4648-2014 “Test method for static bending” was chosen for control tests of samples. Tests were carried out on universal testing machine UTS-20K. Distance between supports is 64mm, traverse speed is 2mm / min. Load F (N) and deflection s (mm) of sample destruction was measured. Samples were made by casting with dimensions of 4 mm thickness, 10 mm width and 100 mm length. Samples after casting were kept for 24 hours at a normal temperature of 296K, and after that they were kept at a temperature of 333K for 150 minutes and cooled in the chamber to a normal temperature.
With an insufficient amount of hardener in the volume of the composite, unpolymerized part of the epoxy resin remains, which can be considered as a separate dispersed inclusion in the structure of the material \([9,10]\). With hardener content of up to 16\%, the crosslinking degree of epoxy resin increases. Further increase in the amount of hardener leads to the fact that in the structure of the material in the form of a separate phase stands out the residue of non-interacting hardener, which leads to decrease in the strength characteristics \([11,12]\). Thus, for the manufacture of samples at room temperature, an optimal ratio of ED-20 and hardener TETA was chosen as 100:16.

As a filler used carbon black brand P505 Fig. 1. Carbon black is a highly dispersed carbon material that is formed during incomplete combustion or thermal decomposition of hydrocarbons contained in natural or industrial gases, as well as in liquid products of petroleum or coal origin.

![Figure 1. Carbon black P505 (an increase of 10,000 times).](image)

Studies of the effect of the filler concentration of carbon black P505 on the bending characteristics of the epoxy resin composite ED-20 were carried out at temperatures of +23 and -60 °C. The tests were carried out with each batch of 5 samples, the flexural strength at fracture (σ, MPa) and the fracture deformation (ε, %) were calculated, then the average value was found and graph depending on filling degree was plotted in Fig.2 and Fig. 3.

![Figure 2. Dependence of ED-20 bending strength on carbon black P505 filling degree.](image)
4. Conclusion
Tests of composite samples, that are based on ED-20 and carbon black P505, showed that with increase in mass content of filler leads to decrease in flexural and fracture deformation strength by 3 and 4 times, respectively. With decrease in test temperature to -60°C, strength and fracture deformation indicators remained unchanged.

Thus, the use of P505 carbon black filler for ED-20 epoxy resin reduces deformation and strength characteristics of the composite, but the resulting composite is not sensitive to temperature drops to -60°C.

5. References
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