Investigation of Strain-Stress State of Eccentric Compacted Concrete Elements Armored with Basalt-Plastic Reinforcement

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ABSTRACT

The present article is devoted to the experimental research of strength and crack resistance of reinforced concrete eccentric compacted elements with high eccentricity, armored with rhombic basalt-plastic reinforcement. All samples were fabricated and tested in compliance with a specially developed project. This project involves the investigation of two series of reinforced concrete samples. The first series of samples included armored with basalt-plastic non-metal reinforcement; the second series of samples included armored with steel reinforcement. The strength, crack resistance and stress-strain behavior of these samples were investigated. The comparative analysis of eccentric compacted elements armored with steel and basalt-plastic reinforcement under load was performed. The present article contains the results of obtained experimental data analysis.

KEY WORDS: FRP bar; basalt, reinforcement; crack; flexure; concrete, durability; test, analysis.

INTRODUCTION

The application of non-metal reinforcement in construction projects has the potential to increase significantly in the future. The mechanical properties of such reinforcement are notably increased; new technologies and new materials are being developed for its production. The technology of fabrication of basalt fiber was developed in Russia. (Osnos et al, 2010). This fact has prompted interest in its application. However, this is subject to the production of basalt-plastic reinforcement that is close to steel in terms of its properties.

Basalt-plastic bars consist of a polymer matrix and reinforcing elements. Reinforcing elements consist of continuous strong basalt fibers combined into a rod. The distinctive feature of this reinforcement is the high resistance to corrosive and hostile environments, in particular, chloride salts, carbon dioxide, sulphur dioxide, nitrogen oxides and others. Exposure to such environments significantly increases the need for repair of reinforced concrete structures.

Composite basalt-plastic reinforcement is a dielectric with a low coefficient of thermal conductivity. It is also radiotransparent, and magnetically indifferent, and as a result, in some cases, it can provide non-magnetic and dielectric properties to structures. The enhanced corrosion resistance of basalt reinforcement means that the risk of corrosion of the reinforcement is minimal. The life expectancy of structures reinforced with basalt-plastic reinforcement when exposed to corrosive environments such as sea water is approximately 80 years (STO 2.6.90-2013).

The main competitive advantage of basalt-plastic reinforcement subject to hydraulic construction is high resistance to the alkaline conditions. The closest analogue of basalt-plastic reinforcement with similar physical-mechanical properties is fiberglass bars. However, when subjected to humid conditions, fiberglass bars may deteriorate due to harmful influence of humidity penetrating into the microcracks of a polymer matrix. Moreover, the fiberglass may deteriorate due to the chemical influence of alkalies, see Figure 1. The diagram in Fig. 1 shows the dependence of residual reinforcement strength (%) on the Y axis with time of humid conditions on the X axis (day). The samples of reinforcement were embedded in the "body" of the concrete blocks made of portland cement. After holding under the humid conditions the blocks were cracked in order to take out the samples. Then the tensile tests were conducted.

The specified properties and necessary mechanical tensile and deformation features, provision of necessary contact with concrete, and the high strength of the basalt-plastic reinforcement subject to the humid alkaline conditions indicate that the most likely potential applications of basalt-plastic reinforcement are as follows: design of marine and port facilities, roads, foundations, design of engineering networks, transmission lines, heat-insulating enclosures, etc.