ABSTRACT

This paper presents the study of the flexural concrete elements behavior with modified basalt FRP bars "ANK-BM" with rhombic relief (non-spinneret technology) "Plaintrusion". The comparative analysis of the flexural elements behavior strengthened by steel and composite reinforcement was carried out. The resistance of flexural composite-concrete elements in standard cross-sections was studied within the area of peak bending moment at all stress and strain states down to rapture. The comparison was made of test and theoretical results.

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

INTRODUCTION

Basalt FRP bar reinforcement consists of a matrix and reinforcing elements with fibers combined into a rod through polymer matrix. The relief of rhombic type is most effective. The distinctive feature of this rebar is the high resistance to corrosive impacts of offshore environment, of chloride salts, carbon dioxide and sulphur dioxide, nitrogen oxides. FRP reinforcement has a low coefficient of thermal conductivity, is the dielectric, radiotransparent and magnetic indifferent. These properties define the futures of application of FRP bars in design of the marine structures. The many countries such as United States (American Concrete Institute, 2003), Canada, Japan, Germany, Italy have adopted the regulations for designing, testing and application of FRP reinforcement have been developed.

Uralskaya Reinforcing Co. produces the modified basalt FRP bars "ANK-B" by the new non-spinneret technology "Plaintrusion". This technology allows to increase the productive capacity almost 10 times compared to spinneret method, reducing the product cost. Modulus of elasticity of "ANC-BM" reinforcement on 35% higher than previous kinds of reinforcement. The paper presents the results of determination of nature of changes of stressed-strained state of concrete and FRP reinforcement in the complex deformation processes. The comparison with steel reinforcement was made.

EXPERIMENTAL STUDIES

Concrete beams of square cross section 100*100*960 mm in length with longitudinal basalt FRP and steel reinforcement were used. Two series were conducted: 5 beams with FRP bars located only in tension zone; 5 beams FRP bars located in tensile and compressive zones. For the first series reinforcement ratio of tension zone was 0.66% (2Ø8 ANC-B), for the second -1.06% (2Ø8 A-III). Beams were tested as free-ended, and loaded by two concentrated forces on the third of the span (classic beams test on the 4-point bending, in order to obtain bending in 1/3 section of the span). Beam was mounted on a support cross frames, at that one of these support was hinged movable, and the second - hinged immovable. The strains were measured of bearing stress on supports, vertical deflections of beams in the middle of the span and crack width.

The compressive strength of concrete was $R=47.4$ MPa was in the first series. The "ANC-BM" bars have tensile strength $R_{sf}=1450$ MPa; elasticity modulus $E_f=78000$ MPa; density 13 kN/m$^3$. For a compressive zone and transverse reinforcement steel wire "Bp-1" are tensile strength $R_{sc}=500$ MPa; elasticity modulus $E_c=170$ GPa; density 78.5 kN/m$^3$.

The compressive strength of concrete was $R=48.1$ MPa was in the