Summary

Fiber Reinforced Polymers (FRP) composites are increasingly used in the construction industry. Currently, they are mainly used in three areas: as elements made entirely of composite materials (profiles, beams, bridges), materials used for suspension, reinforcement and prestressing of newly erected structures, and as materials used for repair, modernization and reinforcement of structures (meshes, tapes, mats, fittings glued to the reinforced surface with resin adhesive mortars). The main advantages of FRP composites are: resistance to chemically aggressive environments, high tensile strength, high fatigue strength, low volumetric density, the possibility of using elements of any length without making joints, easy transport of the material. Reinforcement of concrete elements with bars made of FRP composites is now considered an alternative reinforcement to steel reinforcement. FRP bars with glass fiber GFRP and, more recently, with basalt fiber BFRP are the most commonly used. FRP bars are made by pultrusion of continuous composite fibers (80% by weight) and resin (20% by weight), usually epoxy. In addition, a so-called braid is made to improve adhesion to concrete.

The purpose of the research and analysis presented in this dissertation was to determine the effect of modifying the composition of BFRP rebars on their resistance to alkaline environment exposure. Two variants of modification of the composition of BFRP bars were studied. In the first variant, part of the basalt fibers were replaced with carbon fibers while maintaining the assumed volume proportion of fibers in the bar (HFRP bars). In the second variant, the epoxy matrix was modified by adding nanosilica to it (nHFRP rods).

A detailed characterization of FRP rods is presented in Chapter 2. This includes a general description of all types of fiber-reinforced polymer composites, along with their areas of application. The growing interest in these materials in the construction industry is highlighted, particularly in areas where strength, stiffness and resistance to environmental factors play a decisive role. The next Chapter 3 focuses on the characteristics of basalt fiber reinforcing bars, while Chapter 4 discusses issues related to the durability of FRP composites. Chapters 5, 6, and 7, respectively, discuss the research concept, experimental results, and their analysis carried out to answer the research questions posed in the paper regarding the effect of modifying the composition of BFRP composites on their properties. Alkali resistance tests were conducted based on ACI 440.3R-04 B6 guidelines. The method consists of three procedures (A, B and C) of testing conducted at 60˚C, each for varying degrees of loading. The specimens in procedures A and B are immersed in an alkaline solution. In Procedure B, the

bars are additionally loaded to a strain of 2‰. In Procedure C, the specimens are loaded as in Procedure B, but the test bars are concreted into cylindrical specimens measuring 150 mm × 330 mm. After a period of 1, 2, 3, 4, and 6 months of seasoning in an alkaline environment, the change in weight and decrease in tensile strength were determined. Alkali resistance tests according to procedure B and C were carried out using an author's device built specifically to maintain constant strain during the seasoning of samples. At this stage, the seasoning of samples according to procedures B and C was carried out at room temperature.

On the basis of alkali resistance tests, it was found that modification of the composition of BFRP composite rods by their hybridization involving partial replacement of basalt fibers with carbon fibers (HFRP rods) increased the alkali resistance of the rods - the greatest stability and the smallest decrease in tensile strength during the period of seasoning the samples in an alkaline environment for 6 months. In contrast, additional modification of the composition of HFRP composite rods by adding nanosilica to the epoxy binder (nHFRP rods) did not provide the expected stability of tensile properties in alkaline solution at elevated temperatures. After 6 months of seasoning at 60ºC, the decrease in strength was significantly greater than the tensile strength of BFRP and HFRP bars.

Keywords: composite bards, basalt fiber, hybridisation, durability, alkali