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Evaluation of the Effectiveness of Microsilica-Modified Epoxy Adhesive

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Extended Abstract

Strengthening structural elements by gluing tapes and mats made of FRP (Fiber Reinforced Polymer) composites to them is currently a popular method of increasing their load-bearing capacity and durability [1,2]. These composites are characterized by very good strength parameters while at the same time their low weight and longitudinal deformation [3]. In the contact between the tape and the concrete surface, forces are transferred via an adhesive joint (made as an adhesive layer). Its effectiveness depends on the condition of the surface to which the adhesive is glued and the type and condition of the adhesive itself. Three main states of load of the adhesive layer are analyzed: shear, stretching and tearing. In practice, it rarely happens that these states occur alone. Most often, the adhesive layer in the joint is loaded in a complex state of stress, but usually one of them dominates.

The most commonly used adhesives include epoxy resins [3, 4]. Their excellent adhesion to building materials, such as concrete, steel, wood or ceramics, allows for the creation of a very durable joint. Nevertheless, research is being carried out to modify the adhesive so that it can create an even more durable layer connecting the tape and concrete. Thanks to such modifications, it is possible to ensure a greater depth of penetration, greater adhesion of the adhesive to the substrate and its greater durability over time [4, 5]. The last issue is related to the natural tendency of polymers to lose some of their properties due to oxidation during long periods of use.

The study concerns a research program aimed at demonstrating the effectiveness of modifying a selected epoxy adhesive using microsilica, which acted as a filler. The main goal was to obtain greater adhesion of the adhesive to the concrete substrate. For this purpose, in the first phase of the research, the initial parameters of the adhesive were determined before it hardened: viscosity and density. Then, microsilica was added to the adhesive in the amount of 0.5% in relation to the resin mass. The amount of microsilica was determined at the stage of preliminary research. In order to effectively mix the microsilica particles with the resin, ultrasonic mixing was used. A sonicator with power 400 W emitted sounds waves at a frequency of 24 kHz. After mixing the filler and resin, the viscosity was measured again. Then, after the adhesive hardened and stabilized, the following were determined successively: free surface energy, tensile strength and adhesion to the concrete substrate. In order to obtain a wider range of results, the concrete was prepared using three methods: cleaning, grinding and sandblasting. The surface profile parameters were determined. In the final stage of the research, the actual influence of the adhesive prepared in this way on increasing the load-bearing capacity of reinforced concrete beams reinforced with CFRP tapes was also determined. By optimizing the results of parameters influencing adhesive adhesion, it was possible to increase the load-bearing capacity of the beams by more than 10%.

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