

STUDY OF THE MICROSTRUCTURE OF BAZALTOFIBROBETON AND MULTI-COMPONENT BINDING

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Abstract: *This article investigates the microstructure of cement systems dispersed with basalt fibers, their influence on strength and homogeneity properties. The mechanisms of chemisorption processes in the contact zones between the cement matrix and the basalt fiber, the formation of new crystalline phases, and the improvement of the material's mechanical properties were analyzed.*

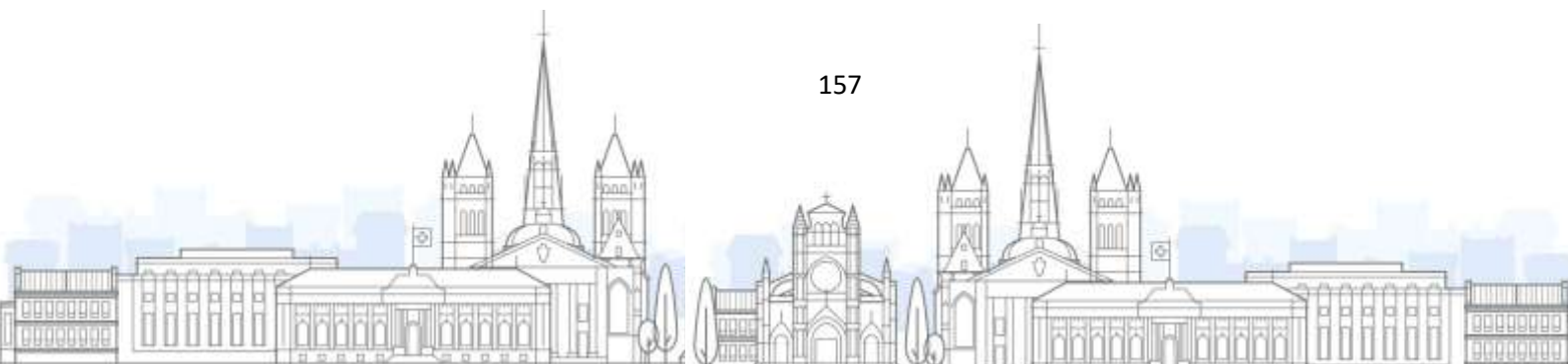
Keywords: *Basalt fiber, fibrous concrete, microstructure, cement stone, calcium hydrosilicates, chemisorption, dispersed reinforcement.*

Introduction. The increase in the strength and homogeneity of the concrete structure can be explained by the irregularly directed action of basalt fibers in the cement system, which inevitably leads to the intersection of pores and defects in the cement stone. As a result, the number of open pores decreases, and defects decrease due to the fact that basalt fiber serves as an additional base for the formation of hydration products of cement grains.

The interaction between the cement stone and the basalt fiber of the jointly operating contact zone is characterized by chemisorption processes occurring with the formation of new phases belonging to low-base calcium hydrosilicates.

Basalt fiber consists of a collection of ultra-thin fibers, on the surface of which crystallization occurs in the zone of micro-defects caused by mechanical influences. As a result, hexagonal plates and a network of needle-like crystals are formed, interconnected with the grains of the cement matrix. This enhances the dispersed reinforcement function of the fiber.

The porous structure of the fiber facilitates the penetration of hydration products into the outer parts of the fibers, where crystalline bonds are formed, which further enhances the strength properties of the cement stone. Thus, the basalt fiber integrates with the cement matrix, forming a single structure that significantly increases the strength of the composite.



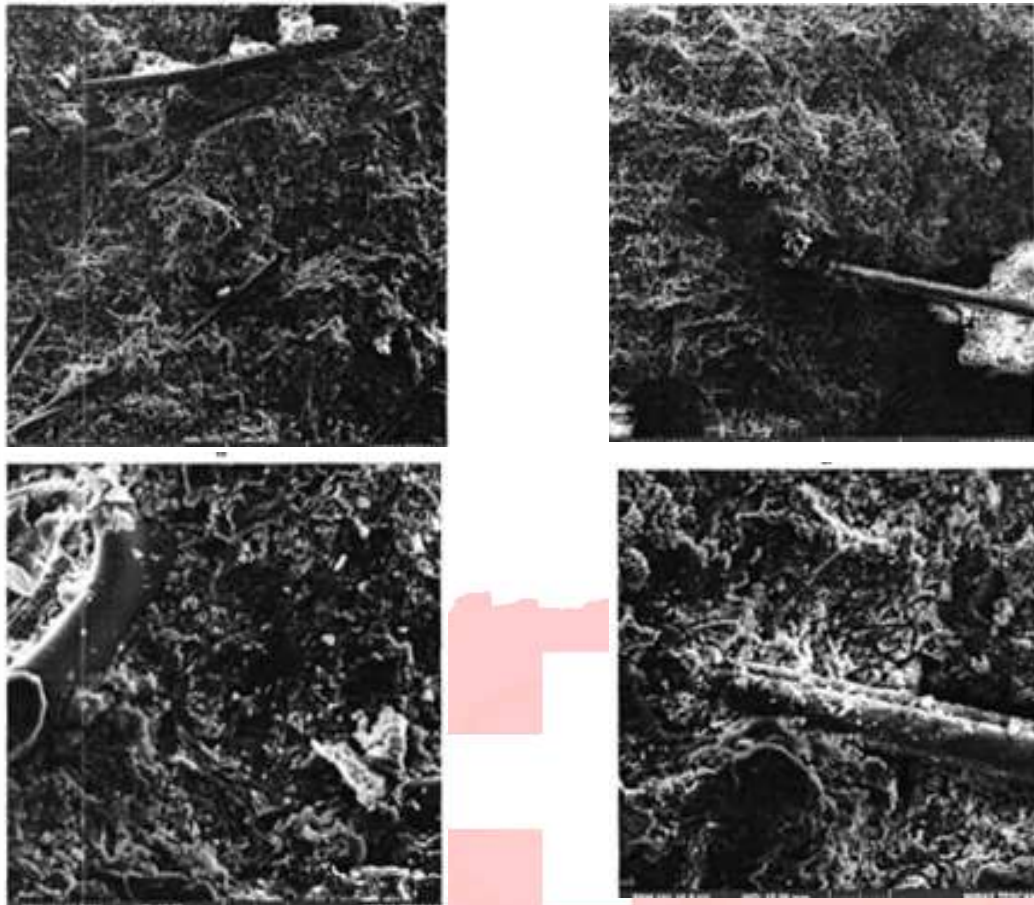


Figure 1. Microstructure of dispersed reinforced cement stone with basalt fiber:

The microstructural evolution and strengthening mechanisms of the modified cement stone were elucidated via Scanning Electron Microscopy (SEM) analysis, as illustrated in Figure 1. The micrographs clearly depict a highly homogeneous and chaotic three-dimensional dispersion of basalt fibers throughout the hydrated cement matrix (Fig. 1a). This multi-directional network spatial distribution is crucial for mitigating localized stress concentrations and enabling isotropic load transfer across the composite volume.

Furthermore, Fig. 1b directly visualizes the crack-arresting and "bridging" mechanisms of the basalt fiber within the porous cementitious skeleton. Upon the application of mechanical loads, the propagation of induced micro-cracking is effectively hindered as the high-modulus basalt fibers bridge the fissure flanks. This mechanism prevents catastrophic macro-fracture development and allows the composite to sustain substantial post-crack deformation. The close bonding observed at the interfacial transition zone (ITZ) between the fiber surface and the cement hydration products (such as C-S-H gel) further substantiates the enhanced tensile and flexural performance discussed herein.

The increase in the mechanical strength of the cement stone is fundamentally driven by the ability of basalt fibers to uniformly distribute internal structural stresses. Zones weakened by localized structural defects or elevated porosity are effectively stabilized by these fiber micro-reinforcements, thereby significantly enhancing the overall mechanical and operational properties of the composite material.

In this regard, it can be posited that basalt fiber-reinforced concrete (BFRC) operates on a mechanism fundamentally analogous to traditional concrete reinforced with steel mesh, yet substantially surpasses it in terms of strength characteristics. This superiority is primarily attributed to the exceptionally high dispersion (homogeneous three-dimensional distribution) of basalt fibers within the cement matrix, which induces a "bridging effect" that efficiently arrests micro-crack propagation.

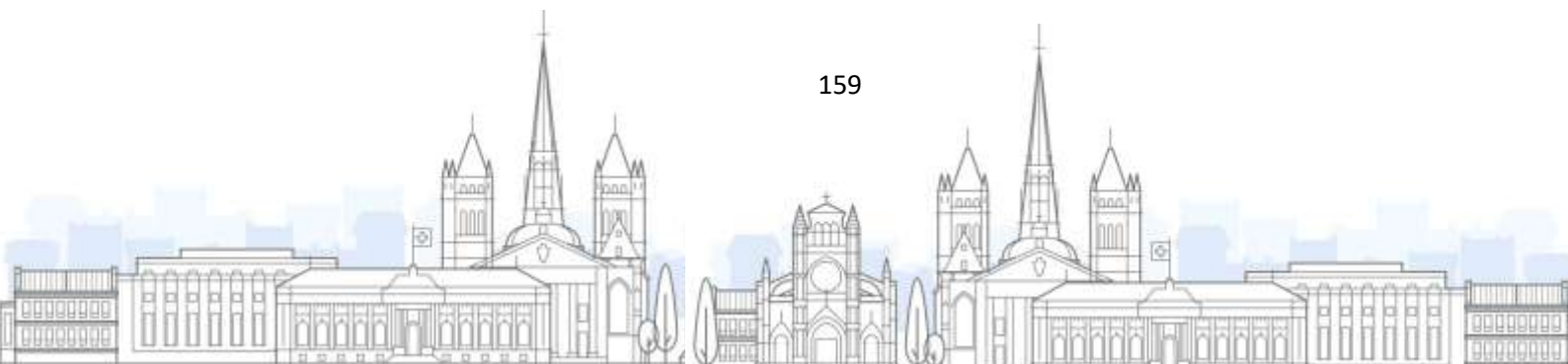
Consequently, basalt fiber-reinforced concrete exhibits superior resistance to significant deformational and dynamic stresses. This is due to the fact that basalt fibers possess a higher modulus of elasticity compared to steel and do not undergo irreversible plastic deformation under service loads. Nevertheless, the microstructure of the interfacial transition zone (ITZ) between the fiber and the cementitious matrix, as well as its long-term degradation kinetics under aggressive environments, remain critical areas that warrant further intensive research.

Conclusion

Basalt fiber does not merely mix with the cement matrix, but forms a unified composite structure integrated with it. The penetration of hydration products into the microporous structure of the fiber and the formation of crystalline bonds elevate the material's strength properties to a new level. This makes basalt fiber concrete a promising material for use in high-responsibility structures.

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