Abstract

The fiber-cement industry has progressively reduced its environmental footprint through the incorporation of supplementary cementitious materials, industrial by-products, and alternative reinforcement systems. Geopolymer binders represent a promising next step in this transition, offering the potential for clinker-free products with significantly lower CO_2 emissions while enabling the valorization of industrial and agricultural residues. Several manufacturing routes have been explored for natural-fiber-reinforced geopolymer composites, each presenting distinct advantages and limitations. Hand-layered composites reinforced with sisal and curauá fibers have achieved flexural strengths of approximately 17 MPa, benefiting from high fiber alignment and efficient stress transfer. Extruded composites reinforced with short bamboo fibers have reached flexural strengths of 9–10 MPa while offering improved dimensional control, greater production efficiency, and excellent resistance to wetting–drying cycles. These differences highlight the influence of fiber architecture, reinforcement morphology, and processing conditions on composite performance and durability. Despite these advances, the adaptation of geopolymer systems to the Hatschek process, the dominant manufacturing technology for commercial fiber-cement boards, remains largely unexplored. Unlike Portland cement-based formulations, geopolymer mixtures exhibit distinct rheological behavior and dewatering characteristics, creating challenges related to filtration efficiency, layer formation, and green strength development. Preliminary pilot-scale trials demonstrated the feasibility of producing geopolymer boards, while also revealing the need for modifications in mixture design and processing parameters. This work compares hand-layering, extrusion, and Hatschek manufacturing routes for natural-fiber-reinforced geopolymer composites, discussing their mechanical performance, durability, scalability, and technological maturity. The findings highlight key challenges and opportunities for transferring geopolymer composites from laboratory-scale production to industrial fiber-cement manufacturing.