Abstract

The reinforcement architecture is an important factor influencing the mechanical performance and post-cracking behavior of fiber-cement composites. This study evaluated the effect of sisal fiber alignment on the flexural behavior of cementitious plates reinforced with long sisal fibers. Two reinforcement configurations with the same fiber volume fraction (5%) were investigated: unidirectional and bidirectional, with fibers aligned in two orthogonal directions. Plates were manufactured using the same cementitious matrix, and flexural performance was evaluated through three-point bending tests under equilibrium and saturated conditions. The unidirectional configuration exhibited higher flexural tensile strength, reaching 22.31 ± 4.56 MPa under equilibrium conditions and 19.07 ± 2.68 MPa under saturated conditions, compared with 17.31 ± 1.77 MPa and 15.33 ± 1.81 MPa, respectively, for the bidirectional configuration. Despite having only half of the fibers aligned with the loading direction, the bidirectional configuration retained approximately 77.6% of the unidirectional strength under equilibrium conditions. The unidirectional plates also showed a more stable post-cracking response and greater stress retention at larger displacements, indicating enhanced energy absorption. Saturation reduced flexural tensile strength by 14.5% and 11.4% for the unidirectional and bidirectional configurations, respectively. Overall, reinforcement architecture significantly affected stress transfer and post-cracking behavior, demonstrating the potential to optimize fiber orientation without increasing fiber content.