Abstract

Fiber cement products, with their outstanding physical properties and economic efficiency, are widely used in the construction sector. As the construction industry transitions toward low-carbon solutions, its environmental impact is also receiving increasing attention. This study proposes a method for developing low-carbon and sustainable fiber cement composites, targeting two typical production pathways: air curing and autoclaving. By optimizing material formulation design, it achieves a significant reduction in the carbon footprint of existing products while ensuring processability, dimensional stability, mechanical properties, and durability. For air-cured products, the study considered how reactive mineral additives and particle fillers support strength development and efficient cement hydration under ambient curing conditions. For autoclave products, the effects of silica reactivity and CaO/SiO_2 balance in promoting beneficial calcium silicate hydrate while reducing cement content were studied.

The results show that when material selection is combined with curing path-specific design principles, meaningful carbon footprint reductions can be achieved without compromising product performance. Detailed foundational data and feasible solutions are provided for the formulation design of fiber cement products.