Abstract

Fiber cement products are widely used in the construction industry because of their favourable physical properties, durability and cost-effectiveness. As the industry moves towards low-carbon development, reducing the carbon footprint of these products while maintaining their technical performance remains a significant challenge. This study investigates formulation strategies for low-carbon fiber cement in air-cured and autoclaved systems. Three sets of experiments assessed the feasibility of using Microsilica independently and in combination with low-carbon raw materials to reduce the carbon footprint of fiber cement products. The formulation-level embodied carbon was estimated using a raw-material-based cradle-to-gate screening approach. Mineral-addition screening showed that 5% Microsilica achieved the highest flexural strength among the additives evaluated while also producing a lower theoretical carbon footprint. Experiments combining Microsilica with industrial by-product gypsum showed that reducing the cement content and incorporating industrial by-product gypsum could effectively lower the carbon footprint, although these modifications also affected product performance. Microsilica compensated for the performance loss and further improved flexural strength and other physical properties while maintaining or further reducing the formulation carbon footprint. These findings indicate that Microsilica can be used either independently as an alternative ingredient or in combination with suitable low-carbon raw materials to support the design of low-carbon fiber cement.