Abstract

Magnesium-based cements have emerged as promising alternatives for construction applications due to their satisfactory mechanical performance, reduced alkalinity, and favorable thermal properties. Their lower pH makes these binders particularly attractive for fiber cement production, as the high alkalinity of Portland cement matrices contributes to the degradation of natural fibers. Among magnesium-based systems, magnesium aluminosilicate hydrate (M-A-S-H) cements have attracted considerable attention because the M-A-S-H gel formed during hydration is the primary phase responsible for strength development in the hardened matrix. This study investigated the influence of the Mg/(Si+Al) molar ratio (0.25, 0.50, 0.75, 1.00, and 1.25) on the reactivity of M-A-S-H binders, hydration product formation, and the performance of natural fiber-reinforced composites. The objective was to determine the optimal proportion between the magnesium source and the silicoaluminous material to improve composite performance. Cementitious pastes were produced with different Mg/(Si+Al) ratios and characterized using Fourier-transform infrared spectroscopy (FTIR), isothermal calorimetry, and thermogravimetric analysis (TGA). Based on these binders, natural fiber-reinforced composites were manufactured and evaluated in terms of bulk density, water absorption, apparent porosity, and mechanical performance through four-point bending tests at 7 and 28 days. The results demonstrated that the Mg/(Si+Al) molar ratio significantly influences binder reactivity, hydration product formation, and the physical and mechanical properties of the composites. These findings highlight the importance of controlling the chemical composition of M-A-S-H matrices for fiber-reinforced applications. Among the compositions investigated, the Mg/(Si+Al) ratio of 0.75 exhibited the most promising overall performance.