Morphological characteristics of hardened cement pastes incorporating nanopalm oil fuel ash

Abstract

Recently, nano-sized additives and supplementary cementing materials (SCM) have shown to improve the mechanical and durability of mortars and concretes. This study investigates the incorporation of nano-POFA (nPOFA) into cement paste so as to observe its effect towards the microstructure development of cement. Additionally, the effect of micro-sized POFA (mPOFA) was also carried out for comparison. The mPOFA were subjected to milling for the generation of nPOFA. The prepared nPOFA exhibited a BET specific surface area of 145.35 m^2/g with an average particle size ranging between 20 nm to 90 nm. Cement pastes were prepared with 10% - 50% replacement of nPOFA and 10% - 30% replacement of mPOFA. The morphological analysis of hardened cement paste (hcp) containing nPOFA (nPOFA-hcp), mPOFA (mPOFA-hcp) at the curing ages of 7, 28 and 90 days were conducted and compared with Ordinary Portland cement paste. At 7 days curing, the nPOFA particles acted as fillers and nucleation sites to accelerate cement hydration. The nPOFA particles reduced the appearance of lime crystals in the nPOFA-hcp at later curing ages due to the occurrence of pozzolanic reactions which formed secondary calcium-silicate-hydrates gel, resulting in a compact microstructure. The study concluded that the nPOFA particles created a dense and closely-packed microstructure of the hardened cement pastes due to the filling effect and pozzolanic reactions in the pastes.