FORMULATION OF STABLE NANOMETAKAOLINE DISPERSIONS FOR USE AS ADDITIVES IN CONCRETE

S.P. Makri[1,*], E. Papaioannou[1], K. Mavronasou, A. Zoikis Karathanasis[1]

D. Kosmidi[2], C. Panagiotopoulou[2], M. Taxiarchou[2]

[1]Creative Nano PC, 4 Leventi Street, Peristeri, 12132 Athens, Greece
[2]School of Mining and Metallurgical Engineering, National Technical University of Athens, 9 Heroon Polytechniou St, 15780 Athens, Greece
s.makri@creativenano.gr*

ABSTRACT

Concrete remains the most extensively used material for the construction industry due to its significant advantages in durability, availability, and workability. However, concerns have lately been raised about the high CO_2 footprint of Portland cement, the main component of concrete. To overcome this problem, various mineral additives have been investigated to partially replace portland cement.[1] Metakaolin (MK) and especially nanometakaolin (NMK) have gained much attention as pozzolanic materials since they can enhance concrete's early compressive strength, chemical resistance, toughness and durability.[2] Nevertheless, the potential use of nanometric powders such as NMK as additives must initially address challenges related to nanoparticles agglomeration, difficulty in transportation, as well as health and environmental hazards.[1] To this end, many studies have suggested different methodologies for the preparation of stable and "ready to use" NMK water suspensions.[3]

In the context of the LightCoce EC research project,[4] Creative Nano in collaboration with the National Technical University of Athens have developed a new method that combines ultrasonication and chemical functionalization with polycarboxylate superplasticizers (SPs) to produce stable NMK aqueous dispersions. An experimental procedure based on two Taguchi orthogonal arrays (L25 and L16) with NMK particle size distribution (PSD) and zeta potential (ZP) as reference measurements furnished an optimal composition of 4.5% NMK - 1.6% SP that exhibited a NMK particle size reduction from 650 nm (raw material) to 424 nm and a high negative ZP value of -28.6 mV. In addition, significantly more concentrated NMK aqueous dispersions were prepared (i.e. 20, 40 and 60% less water added) via our new method. The concentrated suspensions were stable and exhibited similar NMK particle size and zeta potential with the diluted ones, enabling their addition in concrete mixtures to partially replace cement.

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KEYWORDS: Nanometakaolin, colloidal suspension, nanoparticles, superplasticizer, concrete

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