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FULL LENGTH ARTICLE

Pozzolanic and hydraulic activity of nano-metakaolin

S.A. Abo-El-Enein [a,*], M.S. Amin [a], F.I. El-Hosiny [a], S. Hanafi [a], T.M. ElSokkary [b], M.M. Hazem [a]

[a] *Faculty of Science, Ain Shams University, Cairo, Egypt*
[b] *Housing & Building National Research Center, HBRC, Giza, Egypt*

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KEYWORDS

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Abstract Nano-metakaolin (NMK) was prepared by firing of Nano-kaolin (NK) at different temperatures (750–825 °C) for 2 h. The pozzolanic activities of NMK samples were studied using hydrated lime as an activator. The optimum firing temperature of metakaolin (MK) was established from the results of hydration kinetics and differential scanning calorimetry (DSC) and found to be 750 °C; NMK, thus produced, is designated as NMK(750). This was based on the marked consumption of free calcium hydroxide by NMK fired at 750 °C as well as the highest values of chemically combined water at all ages of hydration. Therefore, NMK(750) was used for partial replacement of OPC and studying the physico–mechanical properties of OPC–NMK blended cement pastes. The optimum substitution of OPC by NMK was found to be 8–10%. This was based on the development of compressive strength of the various hardened OPC–NMK blended cement pastes having different NMK contents (0–16%), where the strength increases with NMK content up to 10% and then decreases. In addition, the SEM micrographs obtained for the hardened OPC (93%)–NMK (7%) blended cement paste displayed the formation of amorphous and microcrystalline CSH which fill the pores leading to a more dense structure with higher hydraulic activity as compared to neat OPC paste.
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Introduction

The utilization of calcined clay as a pozzolanic material for mortar and concrete has received considerable attention in recent years. The effect of nano-clay on the mechanical properties and microstructure of Portland cement mortar was investigated [1]. The results showed that the compressive strength of the cement mortars with NMK was higher than the plain cement mortar with the same water/binder ratio.

Metakaolin (MK) which is a pozzolanic material, is a thermally activated aluminosilicate material obtained by firing kaolinite clay within the temperature range of 700–800 °C

* Corresponding author.
E-mail address: saaboelenein@yahoo.com (S.A. Abo-El-Enein).
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Table 1 Mix composition of OPC–NMK(750) dry mixtures.

Sample	OPC	NMK
Mo	100	0
M2	98	2
M4	96	4
M6	94	6
M8	92	8
M10	90	10
M12	88	12
M14	86	14
M16	84	16

[2,3]. It was concluded that the replacement of cement by 5–20% MK increases the compressive strength for concretes and mortars at 28 days [4]. MK has been widely studied due to its high pozzolanic properties [5,6].

By-pass cement kiln dust (CKD) was used as an alkaline activator for burnt clay (B.C.), obtained by firing Libyan clay at 600, 700 and 800 °C, as an artificial pozzolana [7]. The effect of calcination temperature on Belbeis clay and Sammlout limestone as well as hydration characteristics of calcined products was investigated. Three mixes 50/50, 60/40, 70/30 wt.% clay-limestone were calcined at 700, 800, 900, and 1000 °C for 2 h, then hydrated for up to 90 days. The degree of calcination was investigated from the free lime content and the ignition loss for each mixture. Also, the mineralogical composition of the fired mixes was investigated with the aid of X-ray diffractometry. The results revealed that the free lime of each mix increased up to 800 °C then decreased gradually up to 1000 °C. Mix 60/40 clay-limestone fired at 800 °C shows the presence of $Ca(OH)_2$ with quartz. As the firing temperature increased gehlenite appeared and increased up to 1000 °C with the disappearance of free lime. Mix 50/50 gave the highest hydration

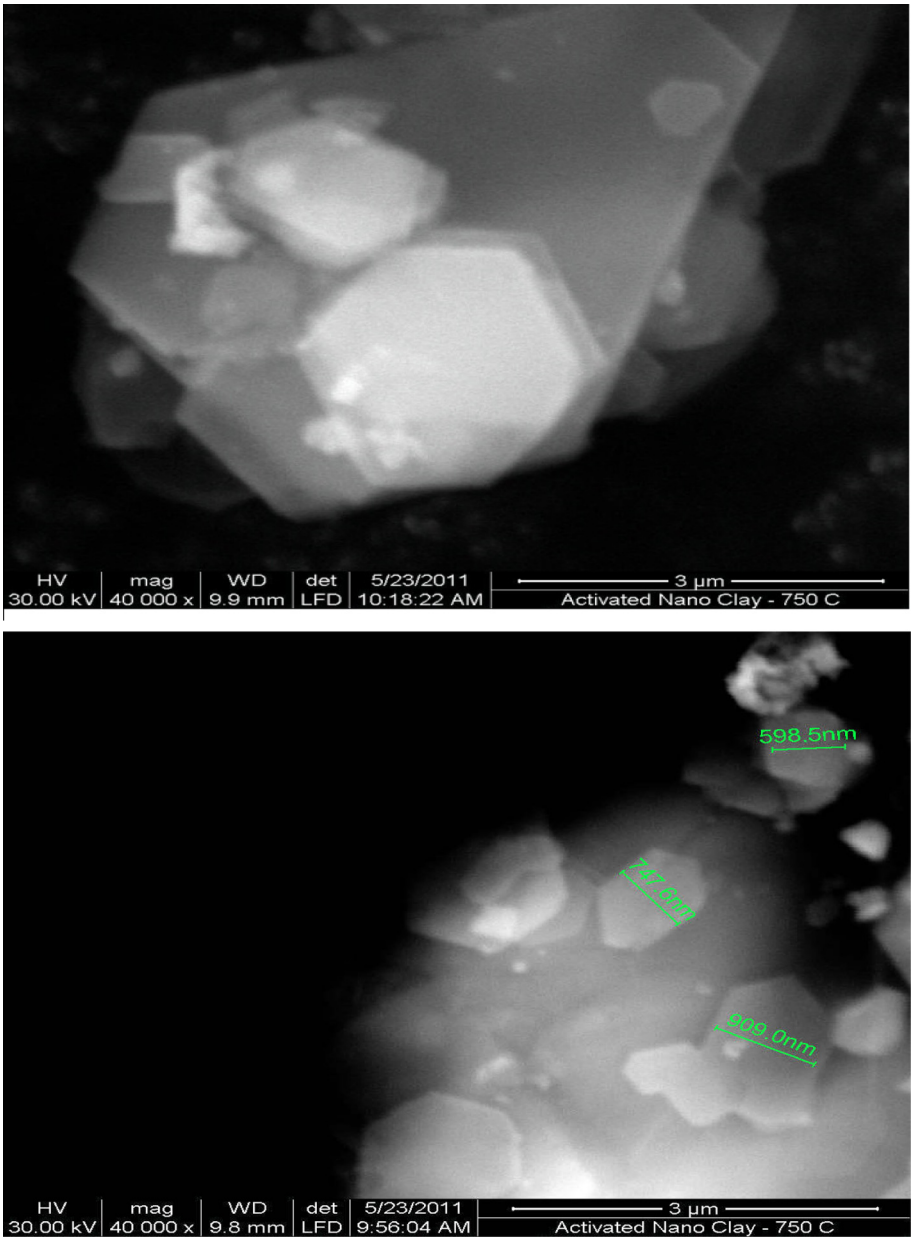

Fig. 1 SEM micrographs of NMK(750).

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