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## CHARACTERIZATION OF CALCIUM SILICATE HYDRATE AND CALCIUM HYDROXIDE IN NANOSILICA BINDER COMPOSITES

I. Yakub, N. M. Sutan, C. S. Kiong

University Malaysia Sarawak  
Sarawak, Malaysia  
yibrahim@feng.unimas.my

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### 1. Introduction

Pozzolanic reaction is the reaction of vitreous silica with calcium hydroxide (C-H), which is formed during the hydration of the ordinary Portland cement (OPC) binder producing additional calcium silicate hydrate (C-S-H) that resembles tobermorite or jennite structure, which is the main constituent for the strength and density in the harden binder paste. The pozzolanic activity includes two parameters; the amount of lime (CaOH) that pozzolan can react with and the rate of reaction. The rate of the pozzolanic activity is related to the surface area of pozzolan particles where higher surface area of pozzolan particle (or finer particle) gives more pozzolanic reactivity [1].

One of the synthetic nanomaterials that has been gaining attention and has been applied in binder material due to its pozzolanic characteristic is nanosilica. This material normally consists of very fine vitreous particles approximately 1000 times smaller than the average binder particles. It is based on silica particles of 5 – 50 nm and is much smaller than those of silica fume (microsilica) which contains particles of 0.1 – 1  $\mu\text{m}$ . Previous studies have shown that due to the very high specific surface area ( $\sim 1000 \text{ m}^2 / \text{g}$ ) and the spherical shape of silica particles, it can potentially enhance the performance of binder mainly due to its reaction with C-H to develop more of the strength-carrying compound in binder structure: C-S-H [2 – 4].

The factor that affects nanosilica reactivity in binder is its high surface area where the precipitation of C-S-H gel works in the nucleation. Besides, it has been found in several studies that if nanosilica particles are uniformly dispersed in the binder paste it will accelerate the hydration rate due to its high activity [5 – 9]. Previous studies have shown that the pozzolanic activity of the nanosilica is higher than the silica fume [10 – 13]. The addition of nanosilica to binder (cement) based materials can control the degradation of C-S-H reaction caused by calcium leaching in water, block water penetration, increase the compressive strength and reduce the overall permeability of hardened concrete which results in finer hydrated phases of C-S-H gel and densified microstructure [1].

To date there are limited knowledge on the effects of nanosilica as a binder replacement on the pozzolanic reaction. Therefore this study aimed to investigate the extents of pozzolanic reaction of nanosilica binder composites (nSBC) by the characterization of calcium silicate hydrate gel (C-S-H) and calcium hydroxide (C-H) crystal using X-ray diffraction technique (XRD) and scanning electron microscopy / energy dispersive X-ray spectroscopy (SEM/EDX).