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ABSTRACT

The influence of nano-silica (NS), carbon nano-tube (CNT) and fly ash (FA) as solo, binary or ternary combination on fresh and hardened properties of self-compacting concretes (SCC) were investigated in this study. These materials were replaced with the certain portion of the cement. In scope of this study, the eight groups of mixes categorized into two categories with and without FA so that each category possessed a reference group and three other groups with only NS, CNT or both. Based on different previous studies, the optimum substitution percentages selected 2%, 0.08% and 40% for NS, CNT and FA, respectively. The slump-flow, V-Funnel and L-Box properties of the produced fresh concretes were investigated. Besides, compressive strength and flexural toughness properties of hardened concretes were determined and were compared with typical properties of SCC.

Test results showed that NS worsened the fresh concrete properties due to its higher water demand, but in presence of FA, NS improved these properties significantly and removed segregation and bleeding effects of 40% FA. Also, the CNT substitution in concrete provided 20% increase in toughness index of SCC. According to test results, the mix with 2% NS, 0.02% CNT and 40% FA can be considered as the best SCC mix due to discussed specifications. Finally, besides all convenient fresh properties, by support of NS and CNT, the inclusion of high volume of FA enabled to sustainable construction and production of a more environment-friendly concrete with improved mechanical properties. Moreover, CNT resulted in more ductile concrete with higher energy-absorbing capacity.

Keywords: Self-compacting concrete, High volume fly ash, Nano-silica, Carbon nano-tubes, Flexural toughness.

Nomenclature

δ_0	First crack deflection
ASR	Alkali silica reaction
B	Binder
CNT	Carbon nano tube
CO_2	Carbon dioxide
C-S-H	Calcium silica hydrate
E	Module of elasticity
FA	Fly ash
F'c	Compressive Strength
GGBS	Ground granulated blast furnace slag
HP	Hyperplasticizer
HPC	High performance concrete
HVFA	High volume fly ash
HVFC	High volume fly ash concrete
I_N	Flexural toughness index
ITZ	Interfacial transition zone