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Impact of carbon Nano tubes on fresh and hardned properties of conventional concrete

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ABSTRACT

Carbon Nano Tubes are strongest known materials known till now which can be ideally used in conventional concrete to tailor its functionalities. As water cement ratio governs the strength, serviceability and durability of concrete so its important to know the effect of Carbon Nano Tubes on basic properties of concrete. In order to analyze fresh and hardened properties of conventional concrete 0.5% Carbon Nano Tubes by weight of cement was incorporated in concrete mixes having water cement ratio 0.40, 0.45, 0.48.0.50 and 0.50. It was observed at 0.45 water cement ratio compressive, split tensile and Moment of resistance was greater by 8.89%, 28.9% and 5.33% respectively in comparison to Reference mixes while workability diminued by 38.40% and water absorption decreased by 0.03%. Also Coefficient of relationship R^2 for water absorption and water-cement ratio of Carbon Nano Tube reinforced concrete was found as high as 0.97. Scanning electron microscopic analysis revealed dispersion of Carbon Nano Tubes and their bridging effect.

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1. Introduction

CNT is strongest material discovered and is considered to be perfect reinforcing nano material for concrete [1]. Carbon nanotubes were discovered in 1991 at the NEC Fundamental Research Laboratory in Japan and are byproduct of the fullerene synthesis [2]. CNTs are hollow cylinder of Graphite sheets in which carbon atoms are bonded in zigzag, chiral or armchair shape that on rolling can form a single-walled or multi-walled nanotubes [3]. They posses excellent mechanical properties having Youngs modulus equal to 1 TPa, tensile strength around 100 GPa and fracture when strained up to 15% [4–6]. CNTs exhibit thermal conductivity as high as 1700–3000 W/mk and electrical resistivity as low as 5×10^{-8} – 2×10^{-6} Ωm, similar to copper [7]. They have specific surface area of up to 1000 m^2g^{-1} [8]. CNTs agglomerate due to vander wall force which is strong between them and surface area is also high as a result of which dispersion techniques play governing role. Dispersion can either be achieved by mechanical or chemical methods. Mechanical methods comprises either ultra sonication or magnetic stirring, or even hand mixing, while chemical methods consists de agglomeration with surfactants and or by attaching functional groups like –COOH (i.e.functionalization) [9–11]. In cement based composites, they impart interfacial contact area without weight gain such as traditional fibers and stabilize concrete more effectively [12–14]. CNTs behave as nucleation spot for formation of Calcium-Silicate-Hydrate (C-S-H) gel thereby CNTs increase hydration rate of cement products [15].They effectively restrict the spread of nano cracks and avoid the initiation of cracks [16,17].

CNTs act as fillers and C-S-H nucleation sites. They also provide bridging effect in composites based on cement, therefore, reinforce concrete efficiently. Overall volumes of pores in sample remain same as the concentration of macro pores remain unaltered [18]. On adding 0.1 percent CNT having aspect ratio ~ 300, Carrico *et al.*, reported 12 percent decrease in water absorption. The water absorption diminuend with decrease in CNT quantity as a 9 percent decrease in water absorption was found when 0.05 percent pristine CNT having aspect ratio ~ 667 was integrated [19]. At normal conditions Mudasir *et al.*, Observed compressive strength, split tensile strength and moment of resistance enhanced by 7.20 percent, 25.75 percent and 3.87 percent respectively relative to comparison concrete, while workability declined significantly at 0.5 water cement ratio (W/C) and 1% MWCNT by weight of cement (wbc)

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