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REVIEW ON THE EFFECT OF NANO SILICA IN M25 CONCRETE

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Abstract:- Nano-silica is the most efficient nanomaterial in replacing cement without compromising its strength and durability. Nano-silica also enhances the properties of cement when in conjugation with other supplementary cementitious materials. The objective of this study is to explore the effect of incorporating nano-silica to concrete on enhancing mechanical properties and durability. Nanomaterials can enable better utilization of natural resources and reaching required materials properties with minimal usage. Nano-cement and nano-silica are among the recently used materials in this regard.

Keywords*: concrete, nano silica,* durability*, compressive strength*

I INTRODUCTION

1.1 NANO SILICA

Nano-silica produced by this method is a very fine powder consisting of spherical particles or icrospheres with amain diameter of 150 nm with high specific surface area (15 to 25 m2/g). By means of this method, nano particles having a spherical shape with 88% process efficiency can be obtained. These particles were produced by feeding worms with rice husk, biological waste material that contain 22% of SiO2. Finally, nScan also be produced by precipitation method

1.2 CEMENT COMPOSITION AND HYDRATION

Cement can be described as a crystalline compound of calcium silicates and other calcium compounds having hydraulic properties (Intht). The four major compounds that constitute cement (Bogue's Compounds) are Tricalcium silicate, abbreviated as C3S, Dicalcium silicate (C2S), Tricalcium aluminates(C3A),Tetracalciumaluminoferrite (C4AF) where C stands for CaO, S stands for SiO2, A stands for Al2O3 and F for Fe2O3. Tricalcium silicate and declaim silicate are the major contributors to the strength of cement, together constituting about 70 % of cement. Dry or anhydrous cement does not have adhesive property and hence cannot bind the raw materials together to form concrete.

II LITERATURE REVIEW

2.1 APPLICATIONS OF NANOTECHNOLOGY IN CONSTRUCTION

There are many applications for building materials using nano-particles, some of which are currently utilized such as producing durable, antibacterial, purified air compound paint and green building materials

Richard et al. (1994) developed concrete by Reactive Powder Concretes (RPCs) which attained strength ranging from 200 to 800 MPa.

H. Li et. al. (2004) experimentally investigated the mechanical properties of nano-Fe2O3 and nanoSiO2 cement mortars and found that the 7 and 28 day strength was much higher than for plainconcrete. The microstructure analysis shows that the nanoparticles filled up the pores and thereduced amount of Ca(OH)2 due to the pozzolanic reaction.

Another experimental study by Li et al. (2004) proved that adding nano-particles to the cement mortar increases both compressive and flexural strength and enhances the mechanical properties in general. In addition, it was found in this study that the nano-particles are more effective than silica fume in increasing strength.

Porro et al. (2005) in a comparative study between nano-silica and micro silica reported that nano-silica is more effective than micro-silica in improving mechanical properties and increasing compressive strength when added to the cement paste because the portlandite consumption in the case of nano-silica is higher than that of silica fume. Moreover, they reached a conclusion that the reactivity and the production of C-S-H gel increases with the decrease in the nano-silica particle size and that colloidal nano-silica gives better results than agglomerated silica in increasing compressive strength because in the colloidal solution the nano-silica is purely nano and it is not agglomerated.

Tao Ji (2005) experimentally studied the effect of Nano SiO2 on the water permeabilityandmicrostructure of concrete. The findings show that incorporation of Nano

SiO2 can improve the resistance to water of concrete and the microstructure becomes more uniform and compact compared to normal concrete.

H. Li et.al. (2006) studied the abrasion resistance of concrete blended with nano particles of TiO2and SiO2 nano particles along with polypropylene (PP) fibers. It was observed that abrasionresistance can be improved considerably by addition of nano particles and PP fibers.

In another study by Green B. (2006) which concentrated on the production of rock matching grout, he discovered that adding nano-particles to the RMG increases its density and modify its viscosity without segregation for fine aggregate. He also proved that without adding nano-silica to the RMG mixture, it would not properly mix, pump or reach the desired mechanical properties.

Byung-Wan Jo**et. al. (2007)** studied the characteristics of cement mortar with Nano SiO2 particles experimentally and observed higher strength of these blended mortars for 7 and 28 days.

Li et al. (2007) in another study found that adding nano-titanium oxide to concrete (1% by weight of cement) drastically enhances the performance of flexural fatigue and increases fatigue life sensitivity to the change in the stress.

Jo et al. (2007) have noted that adding nano- SiO_2 to the cement paste raises the heat that evolves during setting and hardening time. That is why they concluded that adding nano-particles to the cement paste should be accompanied with large amount of super plasticizer to delay the early hydration and for heat treating to speed up the pozzolanic reaction. The quantitative analysis that they conducted for the remaining $Ca(OH)_2$ proved that adding nano-silica to the cement paste decreases its percentage in the paste which means more effective pozzolanic reaction, higher strength and smaller pore size distribution.

Blyszko et al. (2008) concluded that a small amount of cobalt and iron carbide in carbon nano-particles has a great effect on the mechanical and magnetic properties of concrete due to their size and magnetic interaction.

(Jain et al. (2009) proved experimentally that small amount of nano-silica enhances the leaching resistance of cement pastes when exposed to low or neutral pH environments which are beneficial in decreasing the mass loss, ensuring chemical stability and reducing the adverse effects of leaching in cement paste. They also proved in another study the positive effect of nano-silica in reducing calcium ion leaching specially when subjected to accelerated leaching.

In examining fly ash concrete, it was deduced by Said et al. (2009) that adding colloidal nano-silica to fly ash concrete enhances its reactivity and early age strength to match conventional concrete. It was also proved that adding nano-silica to concrete enhances its mechanical properties and decreases its permeability. Within the scope of the same research work, the adiabatic temperature test that has been carried out showed that adding nano-silica to concrete allows it to reach its peak temperature earlier than the conventional concrete which indicates that adding nano-silica gives higher early age strength. The adiabatic test also showed that the peak temperature for conventional concrete and fly ash concrete with colloidal nano-silica were almost the same which means that both have the same reactivity level. Another test that has been conducted to confirm the previous results was the rapid chloride ion penetration test which revealed that adding nano-silica gives better micro structure for the concrete which means higher durability for the concrete.

Nikolaev et al. (2010) claimed that adding nano particles to polymer binder increases its fire and thermal resistance and improves its barrier properties.

lirzaNajiGivi et.al. (2010) studied the size effect of nanosilica particles. They replaced cement with nanosilica of size 15nm and 80nm with 0-5, 1, 1.5 & 2% b.w.c. An increase in the compressive strength was observed with 1.5% b.w.c showing maximum compressive strength.

Xiao et al. (2011) experimentally proved that adding nano-particles to the asphalt binder enhances its viscosity, failure temperature, complex modulus, and elastic modulus values as well as improves rutting resistance of the binder. They also noticed that a relative high percentage (>1.0% per weight of cement) of nano-particles gives better results in enhancing asphalt binder than low percentage.

Sekari and Razzaghi (2011) studies the effect of constant content of Nano ZrO2, Fe2O3, TiO2, and Al2O3 on the properties of concrete. The reults showed that all the nano particles have noticeable influence on improvement on durability properties of concrete but the contribution of nano Al2O3 on improvement of mechanical properties of HPC is more than the other nano particles.

AlirezaNajiGivi et.al. (2012) studied the effect of Nano SiO2 particles on water absorption of RHA blended concrete. It is concluded that cement could be replaced up to 20% by RHA in presence of Nano SiO2 particle up to 2% which improves physical and mechanical properties of concrete.

J.Comiletti et.al. (2012) investigated the effect of micro and nano CaCO3 on the early age properties of ultra-high performance concrete (UHPC) cured in cold and normal

field conditions. The micro CaCO3 was added from 0 to 15% b.w.c. and nano CaCO3 was added at the rate of 0, 2.5 and 5% b.w.c. Results show that by incorporating nano and micro CaCO3 the flow ability of UHPC is higher than the control mix which increases the cement replacement level. The mixture containing 5% nano CaCO3 and 15% micro CaCO3 gives shortest setting time at 10 °C and at 20°C the highest 24 hrs compressive strength is achieved by replacing cement with 2.5% nanoand 5% micro CaCO3 and highest compressive strength at 26 days was achieved at 0% nano and 2.5% micro CaCO3.

G. Dhinakaranet. al. (2014) analyzed the microstructure and strength properties of concrete with Nano SiO2. The silica was ground in the planetary ball mill till nano size reached and it was blended in concrete with 5%, 10% and 15% b.w.c.. The experimental results showed gain in compressive strength with maximum strength for 10% replacement. Maria C.G.Juenger2015 This paper investigates the Supplementary cementations materials (SCMs) are commonly used in concrete mixtures as a replacement of a portion of clinker in cement or as a replacement of a portion of cement in concrete. This practice is favorable to the industry, generally resulting in concrete with lower cost, lower environmental impact, higher long-term strength, and improved long-term durability.

Anwar M.Mohamed 2016 This paper investigates the effect of nano particles on the mechanical properties at different ages of concrete. Different mixtures have been studied including Nano-silica (NS), nano-clay (NC) or both NS and NC together with different percentages. Mechanical properties have been investigated such as compressive and flexure strength through testing concrete prisms 40, 40 and 160 mm at 7, 28 and 90 days in order to explore the influence of these nano particles on the mechanical properties of concrete.

M.S. MuhdNorhasriet ,2017 This review paper discussed on the nano materials in concrete. Nowadays, the application of nano materials has received numerous attentions to enhance the conventional concrete properties.

III CONCLUSION

By study various research paper related to Nano silica use in concrete ,following salient conclusion can be drawn

- On addition of Nano SiO2 there is a substantial increase in the early-age strength of concrete compared to the 28 day increase in strength.
- It is observed that Nano silica can be effectively used as cement in concrete mix.

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