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IMPLEMENTATION OF NANO-SILICA INTO CONCRETE ROAD CONSTRUCTION

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Abstract: Concrete is the most common used material for construction and their design consumes almost the total cement production in the world. The use of large quantities of cement produces increasing CO_2 emissions, and as a consequence the green house effect. A method to reduce the cement content in concrete mixes for road construction is the use of silica fines. One of the silica fines with high potential as cement replacement and as concrete additive is nano-silica (NS). Furthermore, the application of NS and its effect in concrete is not fully understood yet in road construction. Nano-silica improves performance of concrete because of its pozzo-lanic reactivity besides the pore-filling effect. In a recent research project a new nano-silica is produced from olivine. This NS, as well as commercially available NS, will be applied and tested. This paper aims to present the state of the art of Ns application in concrete for pavements, focusing on the NS properties to render it suitable to be applicable in concrete roads. It includes the NS addition effect and its application in concrete Road construction. For this we will compare properties of conventional concrete and concrete with addition of 1%, 1.5% and 2% NS by its weight of conventional concrete. From these three proportions, we will use the suitable proportions (economy, strength, availability of material) for applying in concrete road. We will also carry out estimation work for particular area.

Keywords: Nano-Silica, Pozzo-lanic reactivity, Modulus of Elasticity, Compressive Strength, Splitting Tensile

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INTRODUCTION

Concrete is a porous material with pore sizes ranging from a few nano meters to a few millimetres. These pores are generally filled with a basic (pH > 12.5) pore solution of calcium dissolved in water. Therefore, environmental conditions with lower pH disturb equilibrium and are detrimental to concrete. During the degradation process, known as calcium leaching, caused by exposure to lower pH, cement hydrates progressively dissolve to re-establish the equilibrium concentration of the minerals contained in the pore solution. The dissolution rates of hydration products depend on the calcium-to-silicon ratio of the products, and rates are different for each of the hydrates. Furthermore, the response of each of the hydration products to the attack is also different. Although the phenomenon of calcium leaching has been widely studied, a suitable method to stop it is still unknown. Nano silica induces a pozzolanic reaction that results in a reduction of the amount of calcium hydroxide in concrete and improves the durability. Aim of this to study examines the elastic properties of nano mechanical properties of Nano-silica. Silicon Powder which means nano silica gives High hardness, low oil absorption rate, good dispensability, weathering corrosion resistance, thermal shock resistance, insulation, long shelf life, high temperature resistant, wear resistant, resistant to scratching, resistant to acid and alkali salt, etc. Hence, above existing properties of nano silica in concrete, it is concern to utilize for concrete roads.

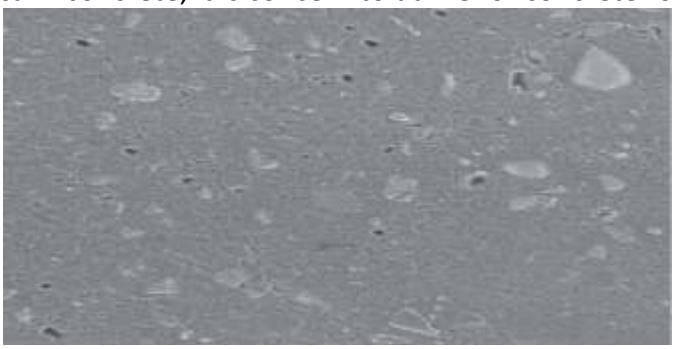

Figure 1 Microscope Image of Nano silica

Problem Statement

The Problem scouting of the Implementation nano silica into concrete road construction is given below:-

(1) Higher strength of the nano silicon cube.
(2) Higher durability of the nano silicon cube compound.
(3) Higher the compressibility factors that increases or not.
(4) Alkali rainfall adverse effect should affect to the nano silica or not.
(5) Problem related to the nano silicon compound use in powder form or jelly form.

Objectives & Scope

Objectives:-The Nano silica has the objective behind the road construction for the high strength of the material used complexity for the high strength concrete road construction. The work behind this should be the future expansion for the nano-silicon compound used for the road

construction. It is mainly using into building construction for the high strength concrete construction for the water-logging and as well as the high water resistive material for good compression efforts of the construction project. The water could not affect to the structure and construction. There should be a water resistive material with phenomenal strength of nano silica. To study the effect of nano-silica on the compressive strength of concrete. To study the microstructure of the hardened cement concrete. To explain the change in properties of concrete, if any, by explaining the microstructure. Comparison of the test results with Conventional Concrete and Nano Silica concrete.

Scope:- The present study incorporates mix design based on the guidelines as per Indian Standard code IS 10262-2009. The nano-silica used is imported from a supplier. The use of any kind of admixture is strictly prohibited in the mix design. The water content has been kept constant to facilitate a better comparison for different samples. The compressive strength measurements are carried out 4 for 7-day and 28-day and the FESEM analysis has been done for 28-day only. The size of the nano silica was identified using Particle Size Analyser. Adopt a multi-scale approach to crack bridging. An understanding of the mechanisms of how CNTs arrest cracks at the nano-scale of crack nucleation, how this is supported by crack control by aggregates and the presence of larger graph enable in fibres will provide a platform for larger-scale assessments. Investigate large-scale reinforced concrete (RC) beams undertaken to assess the mechanical behaviour under load, with-and without combinations of CNT, graphite fibres, and reinforcing steel in a laboratory setting. Develop “starting recipes” suitable for commercial trials in common construction applications to show the translational aspect of the project from pastes to construction applications. The purpose of this study is to investigate the compressive strength, modulus of elasticity and splitting tensile test of concrete by partial replacement of cement with nano-tube.

MATERIALS AND TEST

MATERIAL:-

The nano silica has the properties that it would make the concrete high strength and compatibility with the particles nano-silicon particles. The nano particles are usually not connect with the any form but the possibilities are available that these particles can easily make the bonding with air by just a simple flow. When any person is going to open that beg, the precaution that must taken is that do not open fan or any window. Make the atmosphere insulated. There must be no air flow. Nano silica has the properties that it easily flows with the air. From that, properties this situation must not be generate.

RAW MATERIALS AND TEST METHODS

Cement

42.5 ordinary Portland cement produced by Shandong cement plant, its quality qualified.

Aggregate

Fine aggregate is natural sand; quality of a material is good. Coarse aggregate is gravel, two kinds 5-20mm and 20-40mm, the ratio is 40%:60%.

Nano Silicon Powder

The high quality nano silica powder used in experiment produced by the AADINATH INDUSTRIES which is light gray, density 2.2 g/cm^3, average grain diameter is about 100nm.

Chemical admixture and Mixing Water

Using the water reducing agent FDN-1 that decrease water more than 10% and its amount is about 1.0% cement. The mixing and maintenance water is tap water in test room.

POZZOLANIC EFFFECT

The mineralogical composition, particle size distribution, and degree of without shape are the main factors affecting the pozzolanic activity of pozzolaninc clay. Nano-Silica(NS) possess pozzolanic nature since it chemically reacts with calcium hydroxide Ca(OH)2 (CH) released during cement hydration and convert it to calcium silicate hydrate (CSH) which is the strength responsible phase, therefore it has been used to increase strength, durability and sulphate resistance of cement pastes. NS particles uniformly distribute through cement matrix and act as nucleation centres for hydration products this in turn will accelerate the cement hydration rate. Due to its ultrafine size, NS causes packing i.e. act as filler into interstitial spaces inside the skeleton of hardened microstructure of cement paste and thus increasing the mechanical compressive strength. The small particles of pozzolanic silica fill the remaining voids in the young and partially hydrated cement paste, increasing its final density. NS can improve the microstructure and reduce the water permeability of hardened concrete. The NS particles fill the voids of the CSH-gel structure and act as nucleus to tightly bond with CSH-gel particles, this means that NS application reduces the calcium leaching rate of cement pastes and therefore increasing their durability. Finally the NS addition to cement increases density, strength, durability and decreases porosity of hardened blended cement and concrete. The aim of this work is to investigate the pozzolanic activity of nano-silica (NS) method and to study its application for improving physical, mechanical and structural properties of hardened blended cement.

LITERATURE REVIEW

G. Dhinakaran et. al. (2014) analysed 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. Nano-materials are very small sized materials with particle size in nanometres. These materials are very effective in changing the properties of concrete at the ultrafine level by the virtue of their very small size.

This kind of the nano silica having the properties with the silica flume and the thing the lower amount of the nano silica gives lower result.

Mukharjee and Barai (2014) the compressive strength and characteristics of Interfacial Transition Zone (ITZ) of concrete containing recycled aggregates and nano-silica. An improvement in the compressive strength and microstructure of concrete was observed with the incorporation of Nano-silica this incorporation effect gives the wrong method to develop the nano silica have the power to develop the maximum lower power of the nano silica infrastructure. Definitely, the high growth of the structural element of nano silica increases with amount of the percentage changes.

A.M. Said et. al. (2012) studied the effect of colloidal Nano silica on concrete by blending it with class F fly ash and observed that performance of concrete with or without fly ash was significantly improved with addition of variable amounts of nano silica. The mixture containing 30% FA and 6% CNS provides considerable increase in strength. Porosity and threshold pore diameter was significantly lower for mixture containing Nano silica. The RCPT test shows that passing charges and physical penetration depth significantly improved**.**

Alireza Naji Givi 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. If this concrete having different attribute with cement, that means the percentage of the cement and the percentage of nano silica may be affect to the all components. Where the percentage changes to nano silica than properties affects more.

Heidari and Tavakoli (2012) investigated the combined effect of replacement of cement by ground ceramic powder from 10% to 40% B.W.C. and nano SiO2 from 0.5 to 1%. A substantial decrease in water absorption capacity and increase in compressive strength was observed when 20% replacement is done with ground ceramic powder with 0.5 to 1% as the optimum dose of Nano SiO2 particles. If nano silica try to change the properties of the cement than it fails. But, there may be advantage that it changes the properties of powder. Basically, the properties of cement and nano silica comes near with the light bonding and the strength problem does affects to it than the probable conditions may effect to which from that or approximate answer to it.

Surya Abdul Rashid et. al. (2011) worked on the effect of Nano SiO2 particle on both mechanical properties (compressive, split tensile and flexural strength) and physical properties (water permeability, workability and setting time) of concrete which shows that binary blended concrete with nano SiO2 particles up to 2% has significantly higher compressive, split tensile and flexural strength compared to normal concrete. Another inference drawn was that partial

replacement of nano SiO2 particles decreases the workability and setting time of fresh concrete for samples cured in lime solution.

M.S. Morsy et. al. (2010) studied the effect of nano-clay on the mechanical properties and microstructure of Portland cement mortar and observed that the tensile and compressive strength increased by 49% and 7% respectively at 8% nano-met kaolin (NMK). But, this nano-clay is different with the nano silica. The size of particle does not matter with the main properties of clay. It is more important to check the silicon particle property. thus, this is related to nano size but it is not related to nano chemical bonding.

A. Sadrmotazi et.al. (2010), in another paper, have studied the effect of PP fiber along with nano SiO2 particles. The nanosilica was replaced up to 7% which improved the compressive strength of cement mortar by 6.49%. PP fiber amounts beyond 0.3% reduce the compressive strength but beyond 0.3% dose of PP fibre increases the flexural strength, showing the effectiveness of nano SiO2 particles. Also up to 0.5% PP fibres in mortar water absorption decreases which indicates pore refinement. Pore refinement sometimes they cannot obeisance the water to penetrate inside. Therefore, water bonding to surrounding of the nano- silica not possible. Compressive strength increases as per 0.5% but they never try to take strength that point to get compressive strength at 0.5%. It influences to the critical change of cement work.

M. Collepardi et.al. (2010) studied the effect of combination of silica fume, fly ash and ultrafine amorphous colloidal silica (UFACS) on concrete. The result shows that steam cured concrete containing SF and FA alone are much stronger than NC cured at room temperature at early age where as compressive strength at 28-90 days of steam cured concrete is less than NC cured at room temperature. So, author advised to use SF, FA &UFACS for the manufacturing of precast unit. It means SF,FA & UFACS are only the content whose additively inject to change the compressive strength for nano silica. If it does not work properly than the change in compressive strength will not more effective to other than normal concrete. For that, check the strength as similar as at normal concrete interval time. It may be gives positive answer.

M.Nill et.al. (2009) studied the combined effect of micro silica and colloidal nano silica on properties of concrete and found that concrete will attain maximum compressive strength when it contains 6% micro silica and 1.5% nano silica. The highest electrical resistivity of concrete was observed at 7.5% micro and nano silica. The capillary absorption rate is lowest for the combination of 3% micro silica and 1.5% nano silica. Also, Nano particles are combine the bonding with micro silica but it is neither reacts nor bind with each other but the physical properties doe's effect to main stream of the nano silica. It fully depends on the criteria of nano particles and as well as the physical characteristics with the micro particles. If it is not change the 1.5% after bonding than this the priority directly goes to Nano Particles.

H. Li et.al. (2007) studied the abrasion resistance of concrete blended with nano particles of TiO2 and SiO2 nano particles along with polypropylene (PP) fibres. It was observed that abrasion resistance can be improved considerably by addition of nano particles and PP fibres. Also the combined effect of PP fibre + Nano particles shows much higher abrasion resistance than with nano particles only. It was found that abrasion resistance of nano TiO2 particles is better than nano SiO2 particles. Also relationship between abrasion resistance and compressive strength is found to be linear.

B.-W Jo et. al. (2006) studied the characteristics of cement mortar with Nano SiO2 particles experimentally and observed higher strength of these blended mortars for 7 and 28 days. The microstructure analysis showed that SiO2 not only behaves as a filler to improve microstructure, but also as an activator to the pozzolanic reaction.

Tao Ji (2004) experimentally studied the effect of Nano SiO2 on the water permeability and microstructure 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.

CONCLUSION

These materials are very effective in changing the properties of concrete at the ultrafine level by the virtue of their very small size. This kind of the nano silica having the properties with the silica flume and the thing the lower amount of the nano silica give. An improvement in the compressive strength and microstructure of concrete was observed with the incorporation of Nano-silica this incorporation effect gives the wrong method to develop the nano silica have the power to develop the maximum lower power of the nano silica infrastructure.es lower result. A substantial decrease in water absorption capacity and increase in compressive strength was observed when 20% replacement is done with ground ceramic powder with 0.5 to 1% as the optimum dose of Nano SiO2 particles. But, this nano-clay is different with the nano silica. The size of particle does not matter with the main properties of clay. It is more important to check the silicon particle property. Thus, this is related to nano size but it is not related to nano chemical bonding. The result shows that steam cured concrete containing SF and FA alone are much stronger than NC cured at room temperature at early age where as compressive strength at 28-90 days of steam cured concrete is less than NC cured at room temperature.

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