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Effect of Nano oxide on the Compressive Strength of Concrete

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ABSTRACT

The application of engineering science in concrete has else a replacement dimension to the efforts to enhance its properties. Nano materials, by virtue of their terribly little particle size will have an effect on the concrete properties by sterilization the microstructure. This study considerations with the employment of nano oxide of size 236 nm to enhance the compressive strength of concrete. Associate experimental investigation has been administrated by commutation the cement with nano oxide of zero.3%, 0.6% and one hundred and twenty fifth b.w.c. The tests conducted on that shows a substantial increase in early-age compressive strength and a little increase within the overall compressive strength of concrete. The strength increase was discovered with the rise within the share of nano oxide.

Keywords: concrete, nano silica, compressive strength, microstructure.

INTRODUCTION

Concrete is that the material of gift additionally as future. The wide use of it in structures, from buildings to factories, from bridges to airports, makes it one among the foremost investigated material of the twenty first century. Thanks to the speedy population explosion and therefore the technology boom to cater to those wants, there's associate pressing ought to improve the strength and sturdiness of concrete. Out of the varied materials utilized in the assembly of concrete, cement plays a serious role due its size and adhesive property. So, to provide concrete with improved properties, the mechanism of cement association needs to be studied properly and higher substitutes to that need to be instructed.

Totally different materials called supplementary building material materials or SCMs area unit additional to concrete improve its properties. A number of these area unit ash, furnace scoria, rice husk, oxide fumes and even microorganism. Of the varied technologies in use, nano-technology appearance to be a promising approach in up the properties of concrete.

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 aluminate (C3A), Tetracalciumaluminoferrite (C4AF) where C stands for CaO, S stands for SiO2, A stands for Al2O3 and F for Fe2O3. Tricalcium silicate and dicalcium silicate are the major contributers 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. When mixed with water chemical reaction takes place and is referred to1as 'hydration of cement'. The products of this exothermic reaction are C-S-H gel and Ca(OH)2. Calcium hydroxide has lower surface area and hence does not contribute much to the strength of concrete. On hydration of cement aluminates a product is formed known as ettringite, which has needle like morphology and contributes to some early strength of concrete. C-S-H gel refers to calcium silicate hydrates, making up about 60 % of the volume of solids in a completely hydrated cement paste. It has a structure of short fibers which vary from crystalline to amorphous form. Owing to its gelatinous

structure it can bound various inert materials by virtue of Van der Waal forces. It is the primary strength giving phase in cement concrete.

NANOMATERIALS- Use in Concrete

Nanomaterials Are Terribly Little Sized Materials With Particle Size In Nanometers. These Materials Are Terribly Effective In Ever-Changing The Properties Of Concrete At The Ultrafine Level By The Virtue Of Their Terribly Little Size. The Tiny Size Of The Particles Additionally Means That A Larger Extent (Alirezanajigivi, 2010). Since The Speed Of A Pozzolanic Reaction Is Proportional To The Extent Obtainable, A Quicker Reaction Will Be Achieved . Solely Tiny Low Proportion Of Cement Will Be Replaced To Realize The Specified Results. These Nanomaterials Improve The Strength And Permeableness Of Concrete By Filling Up The Minute Voids And Ores With In The Microstructure. The Use Of Nanosilica In Concrete Combine Has Shown Results Of Increase Within The Compressive, Tensile And Flexural Strength Of Concrete. It Sets Early And Thus Usually Needs Admixtures Throughout Combine Style. Nano-Silica Mixed Cement Will Generate Nano-Crystals Of C-S-H Gel Once Association. These Nano-Crystals Accommodate Within The Small Pores Of The Cement Concrete, Thus Up The Permeableness And Strength of Concrete.

Motivation of the Study

The increased use of cement is essential in attaining a higher compressive strength. But, cement is a major source of pollution. The use of nanomaterials by replacement of a proportion of cement can lead to a rise in the compressive strength of the concrete as well as a check to pollution. Since the use of a very small proportion of Nano SiO2 can affect the properties of concrete largely, a proper study of its microstructure is essential in understanding the reactions and the effect of the nanoparticles. The existing papers show the use of admixtures in concrete mix. In the present study, no admixture has been used in order to prevent the effect of any foreign material on the strength of the concrete. This study is an attempt to explain the impact of a nano-silica on the compressive strength of concrete by explaining its microstructure.

Objective of the Study

The main objectives of the present study are as mentioned below:

- 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.

Scope of Work

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.

MATERIAL PROPERTIES

The materials used to design the mix for M25 grade of concrete are cement, sand, coarse aggregate, water and Nano SiO2. The properties of these materials are presented below.

Properties of Cement

Portland slag cement of 43 grade conforming to IS: 455-1989 is used for preparing concrete specimens.

Properties of fine and coarse aggregate

Sand as fine aggregates are collected from locally available river and the sieve analysis of the samples are done. It is found that the sand collected is conforming to IS: 383-1970. For coarse aggregate, the parent concrete is crushed through mini jaw crusher. During crushing it is tried to maintain to produce the maximum size of aggregate in between 20mm to 4.75mm. The coarse aggregate particle size distribution curve is presented in table 1. The physical properties of both fine aggregate and recycled coarse.

Table 1: Properties of Portland slag cement

Specific Gravity	Fineness by sieve analysis	Normal consistency
3.014	2.01%	33%

aggregate particle size distribution curve is presented in.1. The physical properties of both fine aggregate and recycled coarse aggregate are evaluated as per IS: 2386 (Part III)-1963 and given in Table 2.

Table 2: Properties of coarse aggregate and fine aggregate

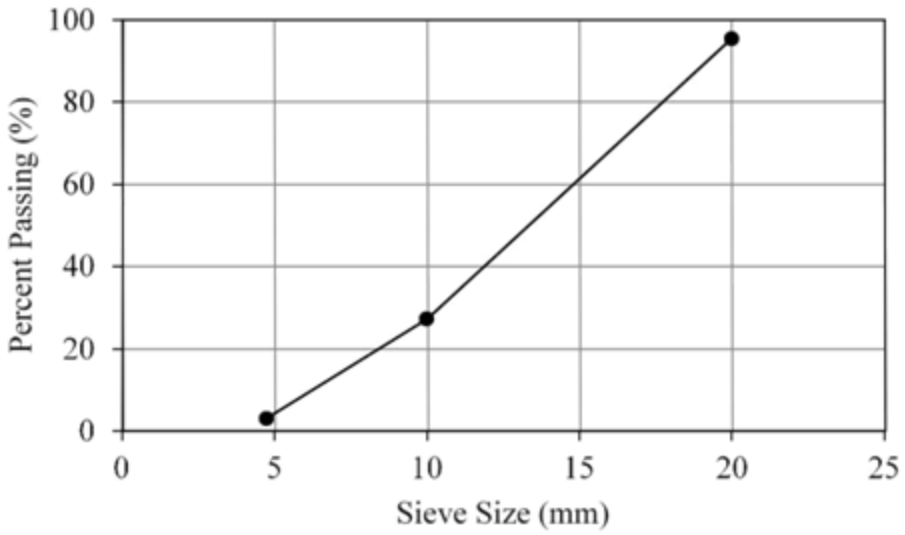
Property	Coarse Aggregate	Fine Aggregate
Specific Gravity	2.72	2.65
Bulk Density (kg/L)	1.408	-
Loose Bulk Density (kg/L)	1.25	-
Water Absorption (%)	4.469	0.0651
Impact Value	26.910	-
Crushing Value	26.514	-
Fineness Modulus	3.38	2.84

Properties of Water

Tap water was used in this experiment. The properties are assumed to be same as that of normal water. Specific gravity is taken as 1.00.

Properties of Nano SiO2

The average size of nano silica was found to be 236 nm from Particle Size Analyzer, the report of which has been presented in the Appendix. The properties of the material are shown in Table 2.3.. Shows the nano silica used in the experiment.



Graph.1: Size distribution curve for coarse aggregate

Properties of Nano SiO2

The average size of nano silica was found to be 236 nm from Particle Size Analyzer, the report of which has been presented in the Appendix. The properties of the material are shown in Table .Fig.1 . Shows the nano silica used in the experiment.

Image of the Nano SiO2used

RESULT

Target Strength For Mix Proportioning:

Characteristic compressive strength at 28 days: fck = 25 MPa

Assumed standard deviation (Table 1 of IS 10262:1982): sd = 4 MPa

Target average compressive strength at 28 days: ftarget = fck + 1.65sd =31.6 MPa

Selection of Water Content:

Maximum water content per cubic metre of concrete (refer Table 2 of IS: 10262-1982): Wmax = 186L (for 50 mm slump). Since, the slump was less than 50 mm, no adjustment was required.

Calculation of Cement Content:

Mass of water selected per cubic metre of concrete = 186 kg. Mass of cement per cubic metre of concrete = 186/0.43 = 433 kg.

Minimum cement content = 300 kg/m^3 (for moderate exposure condition, Table 5 of IS 456:2000)

Maximum cement content = 450 kg/m^3 (Cl. 8.2.4.2 of IS 456:2000)

So, the selected cement content is alright.

Proportion of Volume of Coarse Aggregate and Fine Aggregate Content:

Volume of coarse aggregate per unit volume of total aggregate (Table 3 of IS: 10262-1982) = 0.64

(This is corresponding to 20 mm size aggregate and Zone III fine aggregate for water-cement ratio of 0.50)

As the water-cement ratio is lowered by 0.05, the proportion of volume of coarse aggregate is increased by 0.01 (ref. Table 6 of IS: 10262-1982)
Corrected volume of coarse aggregate per unit volume of total aggregate = (0.64+0.014) = 0.654

Volume of fine aggregate per unit volume of total aggregate = 1-0.654 =0.346

Mix Calculations

i. Volume of concrete = 1 m^3

ii. Volume of cement = 433/(3.01×1000) = 0.144 m^3

iii. Volume of water = 186/1000 = 0.186 m^3

iv. Volume of all aggregates = 1-0.144-0.186 = 0.67 m^3

v. Mass of coarse aggregate = 0.654×0.67×2.72×1000 = 1192 kg

vi. Mass of fine aggregate = 0.346×0.67×2.65×1000 = 614 kg

Mix Proportion

For a batch of 6 cubes of 150mm side, the volume of concrete required = $(0.15)^3$×6×1.2 = 0.024 m^3

(taking into account 20 % extra for losses)

Cement required	= 0.024x433	= 10.4 kg
Fine aggregate required	= 0.024x614	= 14.7 kg
Coarse aggregate required	= 0.024x1192	= 28.6 kg
Water required	= 0.024x186	= 4.5 kg

From the test results, the SEM micrographs and the relative chemical composition of the specimen a number of conclusions can be drawn. These conclusions are justified in the next section. The conclusions drawn are:

i. From the compressive strength results, it can be observed that increase in compressive strength of concrete is observed on addition of a certain minimum quantity of Nano SiO2. The increase in strength is maximum for NS 1% b.w.c and least for NS 0.3% b.w.c.

ii. 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.

iii. The UPV test results show that the quality of concrete gets slightly affected on addition of Nano SiO2 but the overall quality of concrete is preserved.

iv. The FESEM micrograph shows a uniform and compact microstructure on addition of Nano-SiO2.

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