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Properties of High Strength Concrete Using Nano Silica and Micro Silica

A.Ayesha[1]
[1](Student & Department of civil Engineering & *Siddhartha Institute Of Technology & Sciences)*

Abstract: *Concrete is the most versatile material. Due to the persistent and continuous demands made on concrete to meet the various difficult requirements, extensive and wide spread research work is being carried out in the area of concrete technology. Engineers are continually pushing the limits to improve its performance with the help of innovative chemical admixtures and supplementary cementitious materials like fly ash, silica fume, and granulated blast furnace slag, steel slag etc. Nano material concrete is new generation concrete; the composition of nano material concrete consists of cement, nano silica grain of the size of 10 nm - 140 nm, water, fine aggregate and coarse aggregate. Nano materials like nano silica, nano titanium oxide, carbon nano tubes, nano alumina etc… which are presently used in concrete to modify its strength properties. Nano materials have properties or functions different from similar materials of large size. Nano materials have a larger value of the ratio between surface area and volume than other similar particles in larger size, making the nano materials more reactive. Nano silica will react with C_3S and C_2S in the cement and produce CSH-2 that will form a strong and solid bond of gel. In the present study strength properties such as Compressive strength, split tensile strength and flexural strength of M_{40} and M_{50} grades of concrete with the use of micro silica (5%, 7.5%, 10%, 15%) and nano silica (1%, 1.5%, 2%, 2.5%) as partial replacement of cement were studied. It was found from the experimental study that concrete composites with superior properties can be produced using micro silica, nano silica and combination of micro silica and nano silica.*

Keywords *- concrete, nano material, c_3s, c_2s, csh-2*

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I. Introduction

Concrete will be stuff composed primarily of cement, combination and water. It is a wide used construction material for varied types of structures [1]ascribable to its structural stability and strength. Increasing the event challenges in combos with the new innovations in materials and production techniques have give new basis for manufacturing high performance concrete structures. Presently concrete is obtaining used for wide[1] styles of functions to make it applicable in varied conditions. In these conditions commonplace concrete could fail to exhibit the desired quality performance or strength. In such cases, pozzolanic or mineral admixtures ar accustomed modify the properties of traditional concrete.

II. NANO Technology

One of the foremost and extremely important helpful uses of technology in technology is to use in concrete. It's utilized in regarding of all construction fields like roads, bridges, buildings and varied construction works. Concrete unit of measurement typically changed in varied ways; one in every of that is to feature nano particles to that. Researchers are aiming for how higher [2]understanding of the delicate structure of cement-based materials at nano levels. This could ends up in new generation of stronger and additional sturdy concrete with desired behaviors and properties. Association of cement produces a rigid, heterogeneous microstructure. As water is introduced to cement to make a paste that hardens over time the[3] foremost little structural phases within the hydrous cement[4] paste are

- Calcium salt hydrate gel (C-S-H)
- Calcium hydroxide (C-H)
- Ettringite (a Sulfo matter hydrate)
- Monosulphate
- Unhydrated cement particles and
- Air voids

These tiny structural phases govern the gross properties of artefact materials like strength.

III. Need For Present Work

Mortar and concrete are composite materials whose over all mechanical properties are suffering from properties and arrangement of every constituent (cement, aggregate) in it. By incorporating nano materials in to matrix to enhance mechanical properties, emerged as a promising analysis field of nano composite. When put next with dense structure matrix like polymer, the case is kind of different within the area of cement matrix composites. As a result of cement matrix has relative loose structure. Between the cement and mixture there are nano sized air voids which can have vital impact on the nano composite's chemical properties. There exists a lot of space for improvement of cement composites by incorporating nano materials in to the cement matrix.The requirement of gift work is to check the standard of nano construction materials and to seek out the mechanical properties of nano silicon dioxide concrete i.e. compressive strength, flexural strength and split tensile strength.properties of the cement paste, however the small and nano scale structure of C-S-H continues to be not well established. The pozzolanic supplementary building material materials like atomic number 14 oxide fume, ash react with CH at intervals the presence of wet to build C-S-H. Researchers have taken this to the nano scale by mistreatment mixture silicon oxide within the concrete combine to achieve identical properties in handiest manner. It is additionally being used to management the cracks in concrete due to alkalis in cement.

Most of the researchers have done with nano particles with nano-silica, nano clay, nano-titanium oxide, nano-alumina and nano-iron. These "nano particles will act as nuclei for cement phases, further promoting cement hydration owing to their high reactivity, as nano reinforcement, and as filler, densifying the microstructure". durability, physical property and flow ability. Determination of the behavior of megascopic properties provides a radical data of the structure of these phases at the tiniest size level. Among the varied phases, the primary one, C-S-H, is that the most vital product of association and accounts for fifty to seventieth of the full paste volume. This main binding part governs the microscopic

IV. Experimental Investigation

The experimental programme was administrated to check the mechanical properties like. compressive strength, split durability, and flexural strength of high strength concrete with relevance M40 and M50 grade of concrete, with different replacement levels of ordinary hydraulic cement (ultra tech cement 53 grade) with silica fume (5%, 7.5%, 100 percent and 15%) and nano oxide (1%, 1.5%, 2% and 2.5%). Strength properties of M40 and M50 grade concretes were additionally studied for combination of optimum replacement levels of SF (7.5%) and NS (2%).

V. Materials Used And Their Properties

The materials used in the present investigation are as fallows

a) Cement
b) Aggregates
c) Water
d) Super plasticizer
e) Silica Fume
f) Nano silica

TABLE I: Physical Properties of Ultra Tech 53 grade (OPC) cement

S.NO	PHYSICAL TESTS	OBTAINED RESULTS	REQUIREMENTS AS PER IS CODES
1	Fineness	4%	Not>10% as per IS 4031 part 1
2	Standard Consistency	31%	IS 4031 part 4
3	Initial Setting time	120 min	Not less than 30 minutes as per IS 4031 part 5
4	Final setting time	250 min	Not more than 600 minutes as per IS 4031 part 5
5	Soundness	3mm	Not>10mm as per IS 4031 part 3
6	Specific gravity	3.11	IS 2720 part 3 (3.15)

Aggregates are the important ingredient materials in concrete. They impart bulk volume to the concrete and scale back the shrinkage result. They occupy seventy to eighty % of the overall volume of concrete.

VI. Sieve Analysis Of Fine Aggregate (FA)

The sieve analysis of fine mixture is as shown within the Table-2. And from this take a look at the sand utilized in gift study was conformed to zone-II Semi log graph premeditated for sieve analysis of fine mixture.

TABLE II: Sieve Analysis of Fine Aggregate

S.NO	Sieve size in mm	Weight retained in gm	% weight retained	Cumulative % weight retained (f)	% passing (100-f)
1	4.75	25	2.5	0.25	99.75
2	2.36	20	2	2.25	97.75
3	1.18	130	13	15.25	84.75

4	0.60	570	57	72.25	27.75
5	0.35	225	22.5	94.75	5.25
6	0.15	15	1.5	96.25	3.75
	PAN	15	1.5		100
	Total	1000	100	281	

Fineness modulus = Sum of cumulative percentage retained on standard sieves/100
= 281/100
= 2.81

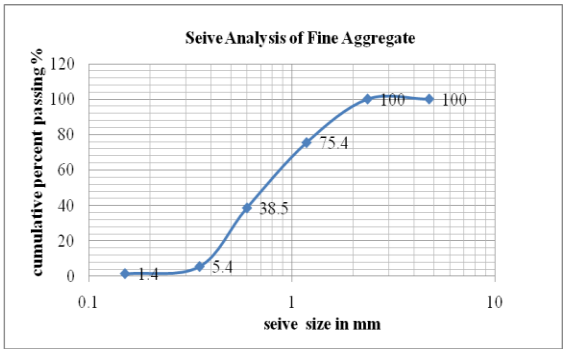

Fig. 1 Sieve Analyses of Fine Aggregate

VII. Results & Discussion

Testing of concrete plays a crucial role in dominant and conformist the standard of cement concrete works. Regular testing of raw materials of contemporary concrete and hardened concrete are plays a crucial half to manage the standard of the concrete that helps to attain higher performance of concrete with relevance each strength and sturdiness. The most purpose of testing hardened concrete is to substantiate that the concrete attains target mean strength.

Fresh concrete or plastic concrete may be a freshly mixed concrete which may be moulded into any form. Strength of concrete primarily depends upon the strength of cement past

Compaction factor test:

Compaction issue take a look at is adopted to work out the workability of concrete. The workability is that the property of the concrete that determines the quantity of labor needed to provide full compaction. To seek out the workability of freshly ready concrete, the take a look at is distributed as per specifications of IS: 1199-1959. It provides a concept of the capability of being worked, i.e., plan to manage the number of water in cement concrete combine to urge uniform strength. It was observed that increasing of silica fume and nano silica in the concrete shows the decreasing order of workability. The results of compaction factor for different mixes are shown in Table III

TABLE III: Compaction Factor Values for Different Mixes

S.No	% Addition of silica fume to concrete	% Addition of nano silica to concrete	Compaction Factor Value	
			M 40	M 50
1	0%	0%	0.96	0.94
2	5%	0	0.94	0.92
3	7.5%	0	0.902	0.895
4	10%	0	0.88	0.87
5	15%	0	0.86	0.86
6	0	1%	0.94	0.95
7	0	1.5%	0.91	0.89
8	0	2%	0.88	0.87
9	0	2.5%	0.86	0.84
10	7.5%	2%	0.85	0.82

∴ Compressive strength = $\frac{P}{A}$, in N/mm2

Where,

P = most applied load in KN

A = space of Specimen over that load applied.

Sample calculation of compressive strength of concrete is as shown in Table IV

Table IV: Calculation of cube compressive strength of plain mixture of M35 grade concrete

S.No	Load in KN	Strength in N/mm^2	Average Strength in N/mm^2
1	1045	46.44	49.56
2	1100	48.88	
3	1200	53.33	

VIII. Conclusion

Compressive strength, split tensile strength and flexural strength of both mixes M40 and M50 grades were increased gradually up to replacement level 7.5% SF and up to replacement level 2% NS and then decreased.

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