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EXPERIMENTAL INVESTIGATION ON STRENGTH OF CONCRETE BY USING NANO- SILICA AND FLY ASH AS PARTIAL REPLACEMENT TO THE CEMENT

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ABSTRACT:- "Cement consumption is directly related to the structure sector of the country and thus its growth is of consummate significance in determining the country's development. With a current product capacity of around 366 million tons(MT), India is the second largest cement patron in the world. Environmental cement has a negative impact as it emits about a ton of hothouse gas(CO2 into the atmosphere for every ton of cement produced. Portland cement product not only releases 7 of the world's carbon dioxide, but also uses a large quantum of natural coffers, similar as limestone, complexion, petroleum, coal and other substances, to conserve natural coffers and reduce pollution due to cement product by limiting the cement content of concrete without compromising its strength. sweats have been made to incompletely replace cement in concrete with new composites and artificial by-products. The ideal of the present experimental disquisition is to determine the influence of the combined operation of Nano- Silica(NS) and Fly Ash(FA) on the strength parcels of the concrete. Fly Ash and Nano- Silica are used as a partial relief for cement. In the present experimental disquisition, cement is incompletely replaced by 20 and 30 by Fly Ash and Nano- Silica1.5, 3 and4.5 by weight. The effect of the combined operation of Fly Ash and Nano- Silica on the compressive strength, tensile strength, flexural strength and pliantness modulus of the concrete grade M20 is delved . The test results of the concrete prepared using the combination of the different proportions of Fly Ash and Nano- Silica are compared with the results of the controlled concrete. Variation of different test results of concrete set with different proportions of Fly Ash and Nano- Silica indicates the same trend. Grounded on the test results, it can be observed that 20-percent Fly Ash and 3- percent Nano- Silica- combined concrete has bettered strength parcels compared to the controlled concrete. The increase in the different strength characteristics of the concrete prepared using Fly Ash and Nano- Silica can be attributed to the effective flyspeck quilting and the vacuity of fresh binders in the presence of Fly- Ash and Nano- Silica ".

Keywords: Fly-Ash, Nano-Silica, Partial Replacement, Particle Packing and Concrete Strength.

INTRODUCTION

"Concrete can be considered to be the most widely used product in the construction industry. Concrete has been commonly used in buildings such as schools, highway bridges and airport terminals. In modern construction experience, the mechanical and durability properties of concrete have a similar meaning. Cement is the most commonly found concrete product. As a result, cement consumption is increasing. This absorbs a significant amount of energy in the manufacture of cement, which produces carbon dioxide and emits emissions into the atmosphere. The solution to this problem is therefore to reduce the use of cement and to use Pozzolanic products for the preparation of concrete. Previous studies have shown that the use of Fly-Ash (FA), Micro Silica (MS) and Ground Granulated Blast Furnace Slag (GGBS) as a partial replacement of cement that reduces cement consumption and also increases the strength and durability of concrete. Nano materials are currently used as additional materials for further improvement of concrete properties. Recent advances in nanotechnology and the use of Nano silica have allowed concrete materials to be used. Any type of mineral mixture in concrete can be used with a combination of Nano silica".

MATERIALS USED:- The materials used for the design of the M20 grade concrete mix are Cement , Sand, Coarse Aggregate, Water, Super Plasticizer and Nano Silica.

Cement:- Cement used in this study is 53 grade ordinary Portland cement in accordance with IS 12269:1987.

Table 1: Properties of Cement

PROPERTIES	TEST VALUE
Specific gravity	3.14
Initial Setting time	45mins
Final Setting time	230mins
Consistency	30%
Fineness modulus	6.5%

Table 2: Chemical Composition of Cement

PROPERTIES	TEST VALUE(%)
Silicon dioxide	21.1
Calcium oxide	62.4
Ferric oxide	2.49
Aluminum oxide	4.50
Loss on ignition	2.40

Aggregates:- "Aggregates are one of the main components of concrete and are generally classified into two categories, the fine aggregate and the gross aggregate. They make up 70-75 per cent of the aggregate volume, give concrete a rigid skeleton structure, and act as efficient space fillers. They added both the weight and the strength of the solid. Sand as fine aggregates is collected from the locally available river and an analysis of the samples is carried out. The sand collected was found to comply with IS: 383-2016. For the gross aggregate, the parent rock is crushed by a mini jaw crusher. During the crushing process, we tried to maintain the maximum aggregate size. Aggregate with grain sizes above 4.75 mm is referred to as a gross aggregate and less than 4.75 mm is referred to as a fine aggregate. The physical properties of the fine aggregate and the gross aggregate are assessed in accordance with IS: 2386 (Part III)-1963".

Table 3 : Properties of Fine Aggregate

PROPERTIES	TEST VALUE
Specific gravity	2.61
Water absorption	0.43%
Fineness modulus	2.72
Size of fine aggregate	Passing through 4.75mm

Table 4 : Properties of Coarse Aggregate

PROPERTIES	TESTVALUE
Specific gravity	2.69
Water absorption	1%
Max Size of aggregate	12.5mm

Water:- "Water is the key ingredient in the production of a concrete mixture of cement. The amount of water in the concrete controls many of the fresh and hardened properties of the concrete, including workability , compressive strength, permeability and water tightness, durability and weathering resistance, drying shrinkage and cracking potential. For these reasons, limiting and controlling the quantity of water in concrete is important for both construction and useful life. Reducing water Increases compressive strength tightness".

Mineral Admixtures:- They are added to concrete either as a filler or to enhance positively certain desired properties, such as solidity.

Fly Ash:- "Fly ash, a waste material of fine particulate matter and a product of a pulverized coal-fired thermal power station, is an environmental pollutant and has the potential to be a resource material. In this project, class F fly ash was used to replace cement in concrete and is acquired from a thermal power station near Vijayawada".

Table 5: Chemical Composition of Fly Ash

CHEMICAL COMPOSITION	VALUE (%)
SiO2	49.45
MgO	1.3
Al2O3	29.61
Fe2O3	10.72
Cao	3.47
K2O	0.54

Table 6 : Properties of Fly Ash

S. No.	PHYSICAL PROPERTY
1	color
2	Specific Gravity

Nano Silica:- The Nano Silica Use the investigation of the colloidal form. Acquired from beechms pvt.ltd, Kanpur.

PHYSICALPROPERTIES	RESULT
Physical state	Micronized powder
Appearance	White colour powder
Colour	White
Appearance Form	powder
pHat5%solution	5
Specific gravity	1.40
Particle size	40nm
Purity	99.5%

Figure 1 : Nano Silica Liquid

Chemical Admixtures:-"Admixtures are used to change the properties of new and hardened cement. Synthetic compounds are used as part of the development industry to build hard, strong and waterproof structures. A few chemicals are blended with solid components and spread throughout the cement assembly, adjusting the enhancement and setting properties of the solid mixture. A few chemicals are attached to the surface of the cement to secure it in or out of the middle of the cement. A few chemicals are attached to the surface of the moulds used to frame the cement to impact the simple form of discharge operation. A few chemicals are attached to the bond or repair of broken or chipped concrete".

Super Plasticizer:- "Glenium SKY 8233 is a new generation polycarboxylic ether blend. The product has been developed primarily for high-performance concrete applications, whereas maximum durability and performance is required. Glenium SKY 8233 does not contain chloride and low alkali. It's well suited for all types of cement".

Table 8 : Properties of Super Plasticizer

PHYSICALPROPERTIES	RESULT
Specific gravity	1.08
pH	≥6
Relative Density	±0.02@25°C
Chloride ion content	≤ 0.2%
Colour	Reddish brown liquid

METHODOLOGY :-The material selection, the work plan and the test procedure followed for this study. It discusses the testing of materials, trail mixtures, the replacement quantity of cement and its proportions for various mixtures, the mixing of concrete, the casting of specimens and the curing of specimens. The mechanical and durability properties of the concrete specimens are considered for this study.

Table 9 Stipulations for Proportioning of M20 grade Concrete

Type of Cement	OPC43Grade
Maximum Nominal size of Aggregate	20mm
Minimum content of Cement	300kg/m^3
Maximum Water Cement ratio	0.55
Specific Gravity of Cement	3.15
Specific Gravity of Fine aggregate	2.66
Specific Gravity of Coarse aggregate	2.71

RESULTS:-

Compressive Strength:

The results of the M20 grade concrete compressive strength test with varying proportions of fly ash and nano-silica are shown in Table 10. The cube compressive strength is the average of three test results. It can be

observed that the compressive strength of concrete prepared using fly ash and nano-silica exhibits more strength than the control concrete up to 3 per cent of nano-silica if the percentage of fly ash is 20 per cent and the compressive strength decreases further with nano-silica. But if the percentage of fly ash is increased to 30% regardless of the nano-silic content, the compressive strength is lower than the control concrete.

Table.10 Cube Compressive Strengths of M20 and M30 Grade Concrete

Concrete Mix	Fly Ash (%)	Colloidal Nano Silica (%)	Compressive Strength (MPa)			
			3 Days	7 Days	28 Days	56 Days
Control Concrete	0	0	18.76	20.96	27.83	28.72
FA 20 % + NS 0 %	20	0	15.92	17.55	23.67	25.14
FA 20 % + NS 1.5 %	20	1.5	16.46	18.97	25.46	26.18
FA 20 % + NS 3 %	20	3	19.43	22.68	29.81	30.57
FA 20 % + NS 4.5 %	20	4.5	17.54	19.45	26.60	27.20
FA 30% + NS 0 %	30	0	14.51	16.65	22.03	23.47
FA 30 % + NS 1.5 %	30	1.5	15.58	17.67	24.44	24.97
FA 30 % + NS 3 %	30	3	16.97	19.40	26.06	27.54
FA 30 % + NS 4.5 %	30	4.5	16.29	18.44	24.71	25.88

Table 11. Comparison of 28 days Compressive Strength of Cube and Cylinder with Fly Ash (FA) and Nano-Silica (NS).

S.N	Concrete	Cube Compressive Strength (MPa) 'σ' Cube	Cylinder Compressive Strength (MPa) σ Cylinder	σ Cylinder /σ Cube
1	Control Concrete	27.83	23.65	0.86
2	FA 20 % + NS 0 %	23.67	20.82	0.88
3	FA 20 % + NS 1.5 %	25.46	20.40	0.88
4	FA 20 % + NS 3 %	29.81	27.12	0.91
5	FA 20 % + NS 4.5 %	26.60	23.67	0.89
6	FA 30% + NS 0 %	22.03	18.97	0.86
7	FA 30 % + NS 1.5 %	24.44	21.26	0.87
8	FA 30% + NS 3%	26.06	22.67	0.89
9	FA 30% + NS 4.5 %	24.71	21.74	0.88

Variation of 7 days and 28 days of cube compressive strength:- The variation of the 7-day and 28-day cube compressive strength of the M20 grade of concrete with different nano-silic and fly ash proportions is shown in Fig 6.2. The compressive strength of concrete initially increases to 3 per cent of nano-silica and then the strength decreases with a further increase in nano-silica by 20 per cent and 30 per cent of the ash content. The 7-day and 28-day cube compressive strength of the control concrete is 22.37 MPa and 32.12 MPa respectively . The increase in the 7-day and 28-day cube compressive strength of the 3-percent nano-silica and 20-percent fly ash combination is 4.6 per cent and 6.1 per cent respectively.

SPLIT TENSILE STRENGTH:

Table No 12 Split Tensile Strengths of M20 Grade of Concrete

Concrete Mix	Split Tensile Strength (MPa)
	for28Days
Control Concrete	3.30
FA20%+NS0%	2.84
FA20%+NS1.5%	3.05
FA20%+NS3%	3.57
FA20%+NS4.5%	3.19
FA30%+NS0%	2.64
FA30%+NS1.5%	2.93
FA30%+NS3%	3.12
FA30%+NS4.5%	2.96

The disconnected tensile strength of the control concrete is 3.30 MPa. The split tensile strength of concrete initially increased by up to 3% of nano-silicate for a given percentage of fly ash and beyond which the split tensile strength decreased with an increase in nano-silicate. It can also be observed that a combination of 3 per cent nano-silica and 20 per cent fly ash combined maximum tensile strength can be obtained. The increase in the split tensile strength of 3 per cent of nano-silica and 20 per cent of fly ash is 3 per cent.

Flexural Strength: The Flexural Strength of the control concrete is 4.45 MPa. Initially, the variation in Flexural Strength of concrete increases by up to 3 per cent of nano-silica for different percentages of fly ash and then, with a further increase in nano-silica, the Flexural Strength decreases.

Concrete Mix	Flexural Strength (MPa) for28Days
Control Concrete	4.45
FA20%+NS0%	3.78
FA20%+NS1.5%	4.07
FA20%+NS3%	4.76
FA20%+NS4.5%	4.25
FA30%+NS0%	3.52
FA30%+NS1.5%	3.91
FA30%+NS3%	4.16
FA30%+NS4.5%	3.95

Modulus of Elasticity: It can be observed that the modulus of elasticity of concrete increases with nano-silica for a given content of fly ash. The maximum value is 3 percent nano-silica for the content of a fly ash. The M20 grade control concrete has a 21,42 GPa elasticity module. The presence of 20 percent fly ash the modulus of elasticity is reduced to 19.64 GPa and with 30 percent fly ash the value is further reduced to 18.94 GPa. The modulus of elasticity of fly ash concrete increases the presence of nano- silica. The M20 grade concrete modulus of elasticity achieves a maximum value in a combination of 3 per cent nano-silic and 20 per cent ash by weight of cement. The increase in the modulus of elasticity of 3 per cent of nano-silicate and 20 per cent of ash flies is 3.2 per cent.

CONCLUSIONS:- The results of the experimental investigation indicate that the combination of fly ash and nano-silica can be used as an ordinary replacement of Portland cement for concrete preparation.

1. Using the test results, it can be concluded that with an increase in the percentage of nano-silica for different percentages of fly ash, the different strength properties of concrete are increased by up to 3% of nano-silica and the properties of concrete are further reduced by nano-silica.

2. It is very interesting to note that the variation of the compressive strength, the split tensile strength, the flexural strength and the elasticity modulus of the M20 grade fly ash concrete with different percentages of nano-silica indicates a similar trend.

3. As a result of the availability of additional binders in the presence of nano-silica, the increase in the various strength properties of fly ash-containing concrete with an increase in nano-silica content may be possible. Nano silica and fly ash react with calcium hydroxide to form additional binder material. The availability of additional binders leads to an increase in the paste-aggregate bond, resulting in improved strength properties of nano-silic-prepared concrete and a fly ash combination.

4. The decrease in the strength characteristics of concrete with an increase in nano-silic content of more than 3% is due to the poor quality of the binder formed in the presence of high nano- silic and fly ash content.

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