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A STUDY ON THE VARIATION OF PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT USING NANO-SILICA (NS) AND FLY ASH (FS)

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Abstract: *This paper studies the current examinations and advancement of combined utilization of Pozzolanic additions- Nano-Silica (NS)and Fly Ash (FA) on the properties of concrete for sub consecutive development of concrete industry. This examination saves the natural resources as well as controls the ecological contamination by use of wastes. The restricted work is done on partial replacement of Fly Ash and Nano-Silica in cement paste, mortar and cement. In the present investigation the concrete is mostly substituted by 20% and 30% of Fly Ash and Nano-Silica 1.0%,2.0%,3.0%, 4.0%,5.0%by weight. To comprehend the use of Fly Ash and Nano-Silica different literary works have been explored and their effect on Compressive Strength, RCPT of M25 review of cement is examined. The exploratory examination consequences of concrete are classified utilizing the mix of different extents of Fly Ash and Nano-Silica are group with that of Controlled Concrete. The mechanical strength advancement and durability properties of cement are significantly impacted due to this joined use of Nano-Silica and Fly Ash compared with the Controlled Concrete properties. The feasible increment in the different strength attributes of concrete arranged utilizing Nano-Silica and Fly Ash can be authorize to the viable packing of colloidal particles and the need of extra binders in the use of Fly-Ash and Nano-Silica.*

KEY WORDS: **Nano silica, fly ash, cement, concrete, aggregates, compressive strengthen Etc..**

1. GENERAL

Concrete has been recommended as a construction material in wide range. At present in construction, prior to strength, the durability of concrete also has importance. The minimum cement content to satisfy the strength and durability requirements. The Indian standard code of IS 456:2000 for plain concrete design is used. This results in usage of cement in huge content. The cement production results in evolution of lots of carbon dioxide resulting in environment mortification. By usage of additive Pozzolanic alternative materials instead of cement upto certain proportion will be another solution for this problem. Earlier studies show that the usage of Fly-Ash (FA), Micro Silica (MS), Ground Granulated Blast Furnace Slag and Kaolinite as replaced materials which results in increases in strength and durability. By introducing Nano sized materials as a partial replacement of cement which improves the performance of cement.

Because of many experimental researches on Nano particles, Nano-Silica is available as replacing material of cement in making concrete. Nano-Silica (NS) is a Nano-sized, highly reactive nebulous silica. Because of Nano-Silica particle is as small as other particles and also having very large surface area as the substitute materials, its usage comparatively intensify the concrete performance upto extensive range. This amalgamation of Nano-Silica and fly ash as a substitute material for cement has to be scrutinized. These particles are very tiny and generally allow forming a group of mass due to its large surface influence, consistent dispersion of these fine particles is a predominant thing to get results upto serviceable or advantageous results.

2. MATERILAS

2.1.1 Cement

In this experimental study, Ordinary Portland Cement 53 grade, conforming to IS: 8112-1989 was used. The different laboratory tests were conducted on cement to determine the physical and mechanical properties of the cement used are shown in.

Table 1.

Properties	Values
water absorption	**0.2 to 0.4 %**
Fineness modulus	**3.43**
Specific gravity	**4.05**
bulk density (gm/cc)	**2.20**

2.1.2 Aggregates

Locally available natural sand with 4.75 mm maximum size confirming to class II- IS 383 was used as fine aggregate, having specific gravity, fineness modulus and unit weight as given in Table 3 and crushed stone with 16mm maximum size having specific gravity, fineness modulus and unit weight as given in Table 3 was used as coarse aggregate. Table 2 gives the physical properties of the coarse and fine aggregates

Table 2: Physical Properties of coarse aggregate and fine aggregate

property	Fine aggregate	Coarse aggregate
Specific gravity	2.66	2.95
Fineness modulus	3.1	7.96
Surface texture	Smooth	--
Practical shape	rounded	angular

Table 2.3 Physical properties of Coarse Aggregate

Physical properties	Results
Fineness	8%
Normal consistency	31.5%
Vicat initial setting time(minutes)	43mins
Vicat final setting time (minutes)	256min
Specific gravity	3.15
7-days compressive strength	39.65
28-days compressive strength	54.86

2.1.3 Water

Ordinary potable water available in the laboratory has been used.

NANO SILICA:

In the present days the micro-level does not provide enough insight into the building materials. Therefore, all around the world, the research is being diverted into the nano level, which is claimed to have tremendous potential for the future. The fundamental processes that govern the properties of concrete are affected by the performance of the material on a nano scale. The main hydration product of cement-based materials, the C-S-H gel, is a natural nano-structured material. For the creation of huge materials a technology based on the usage of minute particles which are nano sized are used by manipulating them. It is important to check whether the particle size usually in the order of ≤100nm because the particle size i.e., nano (10^{-9}) may affects the properties of materials.

3. Testing Procedures.

3.1Compression Strength Test

A standout amongst the most essential properties of cement is the estimation of its capacity to withstand compressive burdens. This is alluded to as a compressive quality and is communicated as load per unit range. One technique for deciding the compressive quality of cement is to apply a heap at a steady rate on a block (150×150×150 mm), until the point that the specimen comes up short. The pressure tests performed in this venture were finished as per IS standard 516 "Strategies for Tests for Strength of Concrete". The device used to decide the compressive quality of cements in this exploratory work was an all-inclusive testing machine (UTM). For this investigation tests were tried for pressure testing at 28, 56,90 days of curing. The compressive quality of the solid regarding weight was then ascertained utilizing the Equation

$$fc=P/A$$

Where,
fc = Compressive Strength of Concrete, (Kpa or psi)
P = Maximum load applied (KN or lb), and
A = The cross-sectional area of sample (mm2 or in2)

3.2 Rapid Chloride Permeability Test(Test Procedure (ASTM C 1202)

*Rapid chloride permeability test According to ASTM C1202 test, water-saturated, 50 mm thick, 100 mm thick diameter concrete specimen is subjected to applied DC voltage of 60 V for 6 hours.
*In one container 3.0% NaC1 solution and in the other container 0.3 M NaOH solution.

4.RESULTS

Compressive strength of concrete in N/mm2at different curing periods

Concrete Mix	Fly Ash (%)	Colloidal Nano Silica (%)	Compressive Strength (MPa)				
			3 Days	7 Days	28 Days	56 Days	90days
Control Concrete	0	0	18.17	28.55	43.25	45.50	46.20
FA 20 % + NS 0 %	20	0	19.53	30.90	45.42	48.35	49.12
FA 20 % + NS 1.0%	20	1.0	21.03	34.22	48.92	50.78	49.98
FA 20 % + NS 2.0%	20	2.0	24.25	39.70	55.13	57.14	57.65
FA 20 % + NS 3.0 %	20	3.0	20.26	31.85	48.25	50.30	53.21
FA 20 % + NS 4.0 %	20	4.0	19.98	30.54	45.32	48.12	50.17
FA 20 % + NS 5.0 %	20	5.0	17.31	27.55	40.12	40.78	42.22
FA 30% + NS 0 %	30	0	19.22	33.14	44.19	47.66	49.77
FA 30 % + NS 1.0 %	30	1.0	21.23	34.02	47.25	50.32	52.09
FA 30 % + NS 2.0 %	30	2.0	21.54	34.26	48.94	51.85	52.10
FA 30 % + NS 3.0%	30	3.0	20.39	31.72	45.32	47.62	49.86
FA 30 % + NS 4.0%	30	4.0	19.10	32.12	43.15	46.55	47.45
FA 30 % + NS 5.0%	30	5.0	17.97	29.86	41.32	44.69	46.59

Durability property

Rapid chloride permeability Test results

Concrete Mix	FA (%)	Nano Silica (%)	RCPT values	RCPT ratings as per ASTM C1202.
			for 28 Days	
Control Concrete	0	0	2998	Moderate
FA 20 % + NS 0 %	20	0	3214	Moderate
FA 20 % + NS 1.0 %	20	1.0	3225	Moderate
FA 20 % + NS 2.0%	20	2.0	3365	Moderate
FA 20 % + NS 3.0 %	20	3.0	3543	Moderate
FA 20 % + NS 4.0 %	20	4.0	3215	Moderate
FA 20 % + NS 5.0 %	20	5.0	3123	Moderate
FA 30% + NS 0 %	30	0	3151	Moderate
FA 30 % + NS 1.0 %	30	1.0	3215	Moderate
FA 30% + NS 2.0%	30	2.0	3212	Moderate
FA 30% + NS 3.0 %	30	3.0	3110	Moderate
FA 30% + NS 4.0 %	30	4.0	2986	Moderate
FA 30% + NS 5.0 %	30	5.0	2798	Moderate

5. CONCLUSION

- From the investigation results i.e., a partial replacement of cement with Fly Ash and Nano-Silica it is studied that various strength properties of concrete mix increases upto 4% application of Nano-Silica content and decreases with further increment.
- Because of additional binder formed in concrete due to the Pozzolanic additives tends to form a paste-aggregate bond which leads to increment in the strength properties of concrete.
- The partial replacement of Fly ash and Nano-Silica tends to give maximum increment in strength properties at Fly ash content 20% and Nano-Silica content 4%.
- But the decrement in the strength properties with increase in Nano-Silica content is due to the formation of poor quality binder.
- The Rapid Chloride Permeability Test esteems an are appeared as direct and qualities were diminishes with increment in nano silica.

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