EFFECT OF NANO SILICA IN FLY ASH CONCRETE

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Abstract : The aim of the experimental investigation is to find the influence of Nano silica and Fly ash on strength properties of concrete. Fly ash concrete is considered as a green building material. The use of fly ash in concrete improves the properties of concrete in fresh and hardened state. In this research, Fly Ash and Nano-Silica are used as partial replacement of cement. The cement is partially replaced by 30% of Fly Ash and Nano-Silica in different proportions. The influence on compressive strength, split tensile strength and permeability of M35 grade concrete is investigated. The concrete made with 30% fly ash and Nano-silica 3% by weight of cement possesses more strength and durability characteristics due to improved particle packing and additional binding action of NS.

IndexTerms - **Nano silica- NS, fly ash-FA, M35 grade concrete, compressive strength, tensile strength, permeability.**

I. INTRODUCTION

Concrete is used for various types of construction. Presently, more measures are taken to promote use of green building material to reduce the detrimental effects on the environment. Fly ash is the byproduct of burning coal in power plants. The use of fly ash in concrete reduces the early strength of concrete but improves the final strength and durability of concrete. The addition of NS is proved to be a feasible alternative to offset the loss of early strength (N. M. Garcia et.al., 2015).The study by Ahmad et al.,2017 demonstrated that the addition of NS accelerated the reactivity of early-age FA-based concrete and increased the compressive strength of cement paste and concrete over those without NS(A. M. Said et.al., 2012). The use of NS in concrete mix has shown results of increase in the compressive and tensile strength of concrete. It sets early and NS mixed cement can generate Nano crystals of C-S-H gel after hydration. These Nano crystals accommodate in the micro pores of the cement concrete, hence reducing the permeability and improving the strength of concrete. The use of NS increases the durability (H. Du et.al. 2014 and M. Nili et. al., 2010). In this study, concrete is made with 30%fly ash and NS in 0%, 1.5%, 3% and 4.5% by weight of cement. The cubes, cylinders are cast and tested for compressive strength, split tensile strength and water permeability. The use of NS in very minimal amount to fly ash concrete improved the compressive strength and split tensile strength of concrete. The concrete with fly ash and NS reduces the permeability enhancing durability.

II. MATERIALS AND METHODS

Cement: Ordinary Portland cement 53 grade
Maximum nominal size of aggregate: 20mm
Fine aggregate: standard sand conforming to grading zone II
Water: Tap water
Fly ash having specific gravity 2.54
NS having specific gravity 2.3
Mixing: Hand mixing
Compaction: Tamping rod
Curing: Ponding
Cube: 15cm x 15cm x 15cm
Cylinders: for split tensile strength -15cm diameter and 30cm length
Cylinders: for permeability test- 10cm diameter and 20cm length
Testing: compressive strength test of cubes after 7days, 14 days and 28days curing, split tensile strength of cylinders at 7days, 14days and 28 days curing, permeability test of small cylinders after 28 days of curing.

III. TESTING OF MATERIALS

Type 1:
M35 GRADE 0F FLY ASH CONCRETE AS PER IS CODE 10262:2009 (30%FA+0%NS)

Cement	= 16.8kg
Fly ash	= 7.2kg
Coarse aggregate	= 35kg
Fine aggregate	= 66kg
Water content	= 10.8 liter
Water-cement ratio	= 0.45

Type 2:
M35 GRADE 0F FLY ASH CONCRETE AS PER IS CODE 10262:2009 (30%FA+1.5%NS)

Cement	= 16.44kg
Fly ash	= 7.2kg

NS = 0.36kg
Coarse aggregate = 35kg
Fine aggregate = 66kg
Water content = 10.8 liter
Water-cement ratio = 0.45

Type 3:
M35 GRADE 0F FLY ASH CONCRETE AS PER IS CODE 10262:2009 (30%FA+3%NS)

Cement = 16.08kg
Fly ash = 7.2kg
NS = 0.72kg
Coarse aggregate = 35kg
Fine aggregate = 66kg
Water content = 10.8 liter
Water-cement ratio = 0.45

Type 4:
M35 GRADE 0F FLY ASH CONCRETE AS PER IS CODE 10262:2009 (30%FA+4.5%NS)

Cement = 15.72kg
Fly ash = 7.2kg
NS = 1.08kg
Coarse aggregate = 35kg
Fine aggregate = 66kg
Water content = 10.8 liter
Water-cement ratio = 0.45

Number of specimens cast in each type: 9 cubes, 3 big cylinders (15cm diameter and 30cm length), 1 small cylinder (10cm diameter and 20cm length)

IV. RESULTS AND DISCUSSION

Results are given in following tables:

4.1 Compressive strength of cubes

Table 4.1: Compressive strength values

	30%FA+0%NS	**30%FA+1.5%NS**	**30%FA+3%NS**	**30%FA+4.5%NS**
7 days	21.82	23.18	25.23	24.4
14 days	24.29	25.72	28.34	26.59
28 days	33.13	35.31	37.49	36.62

4.2 Split tensile strength of cylinders (MPa)

Table 4.2: Split tensile strength values

	7 days	14days	28days
30%FA+0%NS	1.38	1.80	2.35
30%FA+1.5%NS	1.59	2.10	2.56
30%FA+3%NS	1.87	2.28	2.91
30%FA+4.5%NS	1.73	2.08	2.7

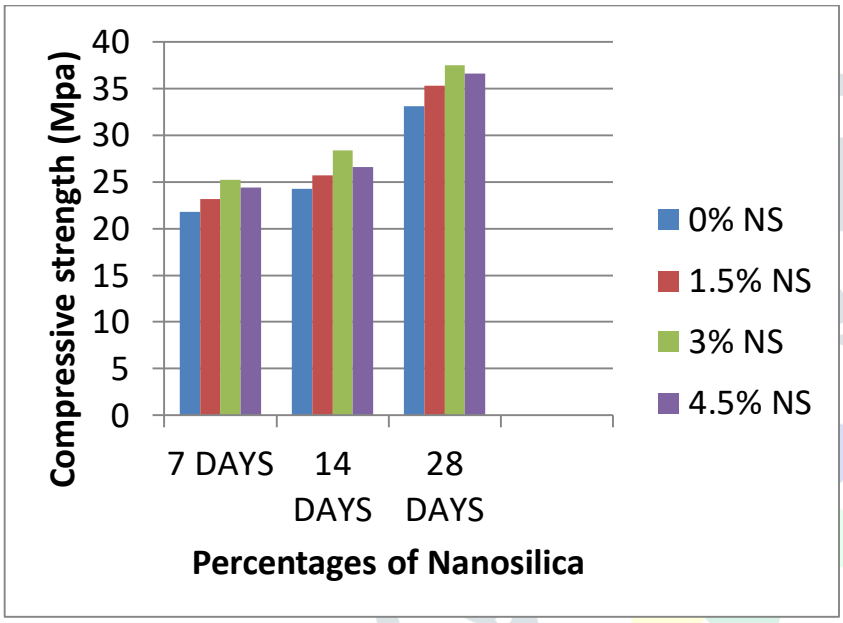
4.3 Permeability values

Table 4.3: Permeability values

% of NS	Permeability values (cm/s)
0% NS	0.0401
1.5% NS	0.0321
3% NS	0.0267
4.5% NS	0.0229

4.4 Graphs

Graph 1: Compressive strength test result



Graph 2: Split tensile strength test result

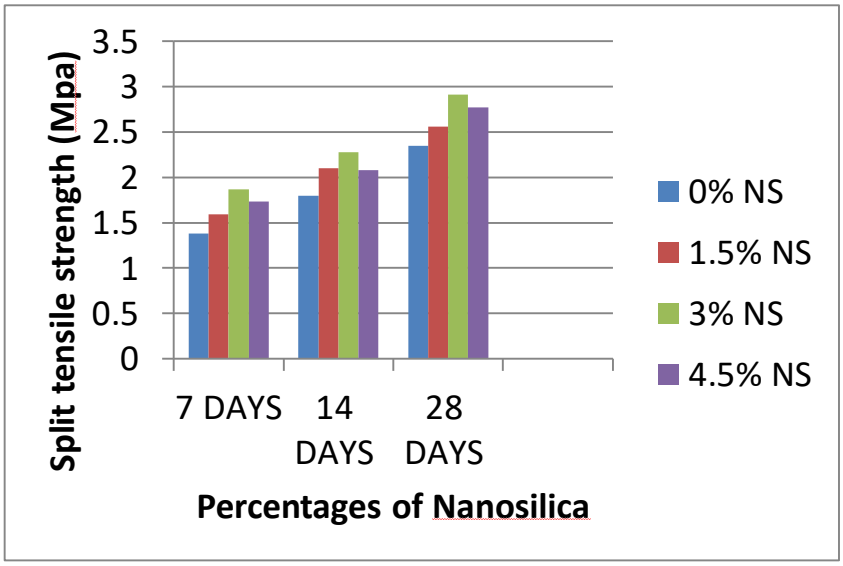


Figure 1: Cast specimens

Discussion

NS with fly ash concrete gives higher compressive strength than the conventional concrete. The addition of 1.5% NS to M35 grade fly ash concrete increased the compressive strength by 6.17% and split tensile strength by 8.20% compared to fly ash concrete with 0% NS. The addition of 3% NS increased the compressive strength by 11.62% and split tensile strength by 19.24%. The addition of 4.5% NS increased the compressive strength by 9.53% and split tensile strength by 15.16%. The addition of 3% NS showed more increase in compressive strength and split tensile strength. The permeability test result shows that with increase in NS %, permeability is getting reduced. This will enhance the durability of concrete.

4.5 Conclusion

The addition of NS is increasing the compressive strength and split tensile strength. The addition of NS more than 3% by weight is causing reduction in strength of concrete. Based on compressive strength result and split tensile strength result, maximum strength is attained for (3% NS + 30% fly ash + 67% cement) sample. The permeability value is also less for this sample. Therefore, the optimum percentage of NS to be added in the fly ash concrete (M35 grade) is 3% for attaining maximum strength and durability. The analysis of microstructure of the concrete samples with varying percentage of NS and FA is the future scope of this work.

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