Indian J.Sci.Res. 17(2): 68-71, 2018 ISSN: 0976-2876 (Print)
ISSN: 2250-0138(Online)

ENHANCING THE STRENGTH PROPERTIES OF CONCRETE BY THE INFLUENCE OF FLYASH AND NANOSILICA AS A PARTIAL REPLACEMENT OF CEMENT

[1] B.Joshna, [2]G.Yamini, [3]G.Anusha
[1] Department of Structural Engineering, Shree Rama College Of Engineering, Tirupati
[2,3] Department of Civil Engineering, SVCE, Tirupati

Abstract- In order to reduce the carbon dioxide emissions because of the manufacture of cement there is an emergence to find a solution for this problem. As a solution we will add fly ash and nano silica to regular Portland cement which reduces the environmental effect, and also improves the strength properties of concrete. Latest developments in nano-era and availability of nano-silica (nS) have made using such materials in improving concrete strength. It is possible because the silica(S) in the sand reacts with calcium hydrate (CH) within the cement at Nano scale to shape C-S-H gel and thereby it improves the strengthening element of concrete, which might be in turn useful within the accomplishing high Compressive power even in early days. This paper consists of state of the artwork of nS application in concrete, importance of nS, the nS manufacturing manner, the determination of compressive strength, split tensile strength, flexural strength and comparing the consequences to controlled concrete of M30 grade. In this experimental approach the cement is partly replaced via 20% and 30% of Fly Ash and Nano-Silica through 1.5%, 3.0% and 4.5% by using weight. The nature of mixed Fly Ash and Nano-Silica on compressive strength, Split tensile power, flexural energy of M30 grade of concrete is investigated. The variation of various test results of concrete organized with different proportions of Fly Ash and Nano-Silica shows the equal trend. It may bethat concrete organized with 20% Fly Ash and 3.0% Nano-Silica addition possesses enhanced characteristics compared to the control concrete. The boom in energy traits of concrete prepared using Fly Ash and Nano-Silica can be attributed to the effective particle packing.

Keywords— Fly-Ash, Nano-Silica, Partial substitute, Particle Packing and Calcium silicate Hydrate.

I. Introduction

New sorts of systems and new technology in constructing, structural and civil engineering created greater and tough requirements for concrete.In the recent years cement production has been increasing in a very fast manner. There's a need to reduce the CO_2 emissions in the environment. One of the treatments to overcome this problem is to reduce the cement content material and make use of Pozzolanic materials for the training of concrete. Some of them are Metakaoline, GGBS, Fly Ash, and Micro Silica and so on. After a long time a constituent in concrete is partially replaced by means of a nano material (Nano-Silica).

One of the great acknowledged Puzzolanic materials in the world is FLY ASH. Nano-silica particulates are too small which tends to mingle and mix uniformly with all the materials in a perfect manner which results in proper bonding. Fly ash while reacted in the presence of water produces better order hydrated products enhances strength and improves durability. The mechanism of mixed application of fly ash and nano-silica is to be determined out.

II. Objectives

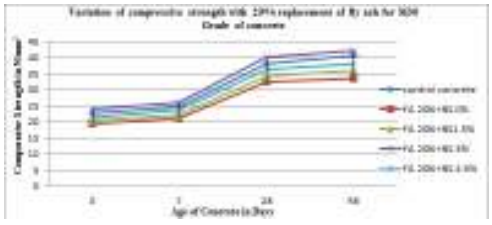
The objectives of the prevailing research work are to examine the impact of Fly ash content material on compressive strength, split tensile strength and flexural strength of concrete, combined effect of application of Nano-Silica and Fly ash on compressive strength, split tensile energy and flexural strength and assessment of the consequences of traditional Concrete, with the influence of Fly ash and Nano-Silica as substitute of Cement.

III. Experimental programme

150 mm × 150 mm × 150 mm cubes, cylinders of 150 mm diameter × 300 mm height and prisms of 100 mm × 100 mm × 500 mm were casted in this thesis. At extraordinary curing durations (3, 7, 28 and fifty six days) Concrete cubes had been examined for energy evaluation. At the age of 28 days cylindrical specimens had been examined for finding out the power of the concrete via distinctive tests like split tensile strength check, and compressive strength check. For determining the flexural strength of concrete prisms has been used.

IV. Effects and Considerations

A. Compressive strength



[1]Corresponding Author

Fig.1.Variation of compressive strength with20% replacement of flyash for M30 concrete

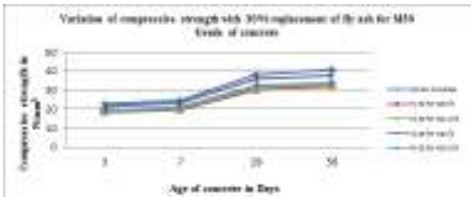


Fig.2.Variation of compressive strength with 30% replacement of flyash for M30 concrete

Table I. Cube Compressive Strengths of 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	22.8	24.67	38	40.53
FA 20 % + NS 0 %	20	0	19.46	21.11	32.49	33.40
FA 20 % + NS 1.5 %	20	1.5	20.52	22.23	34.20	35.98
FA 20 % + NS 3 %	20	3	24.06	26.06	40.10	42.10
FA 20 % + NS 4.5 %	20	4.5	21.50	23.68	36.40	38.10
FA 30% + NS 0 %	30	0	18.12	19.63	30.20	31.87
FA 30 % + NS 1.5 %	30	1.5	18.78	20.54	31.60	33.23
FA 30 % + NS 3 %	30	3	21.48	23.27	35.80	37.48
FA 30 % + NS 4.5 %	30	4.5	19.32	21.01	32.33	33.89

The results of compressive strength of M30 grade concrete with different proportions of fly ash and nano-silica is shown in Table1.

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% of nano-silica if the percentage of fly ash is 20% and with further increase in nano-silica the compressive strength decreases. But, if the percentage of fly ash is increased to 30% irrespective of the content of nano-silica the compressive strength is less than the control concrete.

B. Split tensile strength

The results of split tensile strength test of M30 grade concrete with different proportions of fly ash and nano-silica is shown in Table 2.

The split tensile strength of control concrete is 4.37 MPa. The split tensile strength of concrete initially increased up to 3% of nano silica for the given percentage of fly ash and beyond which the split tensile strength decreases with increase in the nano-silica. It can also be observed that at a combination of 3% of nano-silica and 20% fly ash combination maximum split tensile strength can be obtained. The increase in split tensile strength of concrete with 3% nano-silica and 20% fly ash content is 3%.

Table II. Split Tensile Strengths of M30 Grade of Concrete

Concrete Mix	FA (%)	Colloidal Nano Silica (%)	Split Tensile Strength (MPa) for 28 Days
Control Concrete	0	0	4.37
FA 20 % + NS 0 %	20	0	3.62
FA 20 % + NS 1.5 %	20	1.5	3.93
FA 20 % + NS 3 %	20	3	4.81
FA 20 % + NS 4.5 %	20	4.5	4.19
FA 30% + NS 0 %	30	0	3.47
FA 30 % + NS 1.5 %	30	1.5	3.50
FA 30% + NS 3%	30	3	4.29
FA 30% + NS 4.5 %	30	4.5	3.84

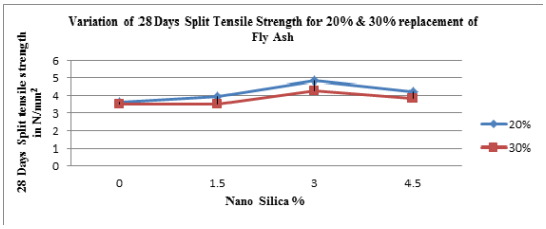


Fig.2. variation of 28 day split tensile strength for 20%&30% replacement of fly ash

C. Flexural strength

Table III. Flexural Strengths of M30 Grade of Concrete

Concrete Mix	FA (%)	Colloidal Nano	Flexural Strength (MPa)

		Silica (%)	for 28 Days
Control Concrete	0	0	5.89
FA 20 % + NS 0 %	20	0	4.87
FA 20 % + NS 1.5 %	20	1.5	5.13
FA 20 % + NS 3 %	20	3	6.23
FA 20 % + NS 4.5 %	20	4.5	5.46
FA 30% + NS 0 %	30	0	4.53
FA 30 % + NS 1.5 %	30	1.5	4.74
FA 30% + NS 3%	30	3	5.72
FA 30% + NS 4.5 %	30	4.5	4.84

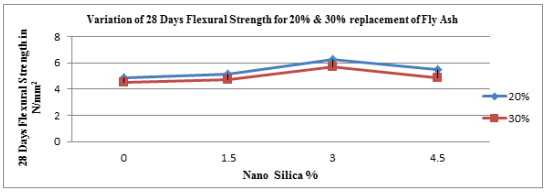


Fig.3.variation of 28 days flexural strength for 20% & 30% replacement of flyash

The flexural strength of control concrete is 5.89 MPa. The variation of flexural strength of concrete initially increases up to 3% percentage of nano-silica for different percentage of fly ash and then with further increase in the nano-silica the flexural strength decreases. The recommended combination for maximum split tensile strength is 3% of nano- silica and 20% fly ash. The increase in the flexural strength concrete with 3% nano-silica and 20% fly ash content compared to control concrete is 3.4%.

The alteration of flexural power of M30grade of concrete including diverse magnitudes of fly ash and nano-silica is seen in Fig.3. Normal concrete has its flexural energy as 5.89 N/mm2. Initial boom of flexural strength of concrete takes place until three% of Nano-Silica for wonderful percent of fly ash after which with similarly growth in the Nano-Silica the magnitude of flexure decreases. The endorsed mixture for maximum split tensile power is 3% of Nano-silica and 20% of fly ash. The growth in the flexural strength concrete with 3% nano-silica and 20% fly ash content is 3.4%.

V. Conclusion

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

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

It is very interesting to note that the variation of compressive strength, split tensile strength, flexural strength and modulus of elasticity of M30 grade fly ash concrete with various percentages of nano-silica indicates the similar trend.

The increase in various strength properties of concrete containing fly ash with increase in the nano-silica content can be dueto the availability of additional binder in the presence of nano-silica.The nano silica and fly ash reacts with the calcium hydroxide to form additional binder material. The availability of additional binder leads to increase in the paste-aggregate bond, results in improved strength properties of the concrete prepared with nano-silica and fly ash combination.

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

The various strength characteristics of concrete can be improved by the combined application of 3% nano-silica and 20% fly ash content. It can also be concluded that the cement content can be reduced without compromising the strength of concrete by the use of fly ash and nano-silica combination.

References

[1] Dr. D. V. Prasada Rao and K. Jayalakshmi, “Experimental Investigation on the Properties ofNano-Silica Concrete”, International Journal of Civil Engineering & Technology (IJCIET),Volume 5, Issue 6, 2014, pp. 116 - 124, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.

[2] IS: 10262-2009. Concrete Mix Proportioning – Guidelines (First Revision). Bureau of Indian Standards, New Delhi.

[3] Dr. D. V. Prasada Rao and G. V. Sai Sireesha, “A Study on the Effect of Addition of Silica Fume on Strength Properties of Partially used Recycled Coarse Aggregate Concrete”, International Journal of Civil Engineering & Technology (IJCIET), Volume 4, Issue 6, 2013,pp. 193 - 201, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.

[4] Dr. D. V. Prasada Rao and M.Pavan Kumar, “A Study On Influence Of Fly Ash And Nano- Silica On Strength Properties Of Concrete”, International Journal Of Advanced Research In Engineering And

Technology (IJARET), Volume 5, Issue 7, July (2014), pp. 94-102, ISSN 0976 - 6480 (Print) ISSN 0976 - 6499 (Online)

[5] P.A. Ganeshwaran, Suji and S. Deepashri, "Evaluation of Mechanical Properties of Self Compacting Concrete with Manufactured Sand and Fly Ash" International Journal of Civil Engineering & Technology (IJCIET), Volume 3, Issue 2, 2012, pp. 60 - 69, ISSN Print: 0976 – 6308, ISSN Online: 0976 – 6316.

[6] Chandra S, Bjornstrom J, 'Influence of cement and superplasticizers type and dosage on the fluidity of cement mortars – Part I, cement and Concrete Research, 32, (2002), 1605 – 1611.

[7] Balaguru, P. N. (2005), "Nanotechnology and Concrete: Background, Opportunities and Challenges." Proceedings of the International Conference – Application of Technology in Concrete Design

[8] Dr.S.Siddiraju and S. Reshma, "An Experimental Investigation on Concrete with Nano Silica and Partial Replacement of Cement with Flyash", International Journal of Science and Research, Volume 4 Issue 7, July 2015, (IJSR) ISSN (Online): 2319-7064

[9] www.aggregateresearch.com

[10] www.Nanoc.info/index.html

[11] www.nanoforum.org