International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)
Impact Factor: 5.22 (SJIF-2017), e-ISSN: 2455-2585
Volume 4, Issue 11, November-2018

Mechanical performance of M30 Grade concrete utilizing NFA and NRHA

Y.Veera Kishore[1], P.Prathap[2], Y.Saritha[3]

[1]*Department of Civil Engineering, SDES, Ibrahim Patnam*
[2]*Department of Civil Engineering, AITS, Rajampet*
[3]*Department of Civil Engineering, SDES, Ibrahim Patnam*

Abstract— The largest man made material used in the world is Portland cement concrete. No other material except water is being used in such huge quantities. Portland cement concrete structures exposed to aggressive chemicals, high temperatures, humidity extremes i.e., severe environments tend to deteriorate and the intended service life of the concrete goes down. The production of one tone of OPC consumes 1.5 tonnes of raw material, 80 units of power apart from abatement of about one tonne of CO2 gas into the atmosphere. The production of Portland cement contributes about 7% of world's total, greenhouse gas" CO2 emissions. The deterioration of concrete results in wastage of natural resources used in concrete apart from the monetary loss. In light of the facts that the production of OPC not only cause environmental pollution but also causes depletion of natural resources quickly becoming hindrance for sustainability, there is every need to reduce the OPC content in concrete and use the so called waste material like Rice Husk Ash, fly ash etc., into the concrete to make concrete, greener'. The Rayalaseema Thermal Power Plant (RTPP) located at Muddanur in Kadapa district produces about one million tonnes of fly ash every year, about 25 million tons of rice husk ash is produced in India every year. Many researchers have investigated the characteristics of concrete using fly ash and rice husk ash. But very few of researches have attempted to find the properties of concrete using Nano Rice husk ash and Nano Fly ash. The present investigation results reveal that the uses of Nano fly ash and Nano rice husk ash improve the properties of OPC concrete. It is also observed that the use of Nano fly ash and Nano rice husk ash is effective in improving the mechanical properties like compressive strength, split tensile strength and flexural strength when compared to the micro/ordinary fly ash and rice husk ash. The Nano fly ash and Nano rice husk ash concretes can be used effectively to improve the mechanical properties of M30 grade concrete

Keywords— Ordinary Portland cement (OPC), Nano Fly Ash (NFA), Nano Rice Husk Ash (NRH)

I. INTRODUCTION

The production of one tonne of cement consumes about 1.5 tonnes of raw materials, 80 units of electric power apart from one tone of CO_2 released into the atmosphere. Out of the total CO_2 emissions worldwide, cement industry contributes about 7 percent of CO_2 emissions. Annual cement production rate of the world is increasing very much. The production can be reduced if demand is reduced. Demand can be reduced by using supplementary cementing materials and other material which reduce Portland cement content of concrete. The properties of concrete can also be increased by using by-products and natural wastes as supplementary cementing material. Lot of energy and cost can also be saved by using these natural wastes and industrial by-products as partial replacements to OPC. India stands second among various countries in paddy (rice) cultivation and its production of fly ash is nearly equal to the production of cement. For effective utilization of fly ash(FA) and rice husk ash(RHA) in cement in India, using rice husk ash and fly ash in Nano form as partial replacements to cement is very important than other usage of these supplementary cementing materials. There are both technical advantages and social benefits in using rice husk ash and fly ash in concrete. After the selection of supplementary cementing materials for making of concrete, the other ingredients such as the aggregates were collected from the nearby quarries, 53 Grade Portland cement was used in all concrete mixtures. The mechanical properties of the concrete were examined by the replacement of OPC with Nano FA and Nano RHA...

II. LITERATURE REVIEW

This chapter presents the literature on a short review of the terminology and also the past studies on rice husk ash (RHA) and fly ash. A comprehensive review of the work of earlier investigators on using ordinary Portland cements; studies on the activation of low-calcium and high-calcium fly ashes and natural pozzolans; studies on the RHA addition of properties of concrete, namely workability and mechanical properties; and some of the literature used to study the partially replaced by RHA and FA combination to find out the properties of concrete have also been presented. The literature review mainly focusses on the studies of mix proportioning methods; effect of elevated temperature; mechanical and durability properties and influence of RHA in concrete.

III. MATERIALS AND EXPERIMENTATION

a) General

In this chapter, various materials used in the present investigation and method of conducting the tests are discussed in detail and detailed methodology of the work is presented.

b) Materials Used

1. Cement
2. Aggregates: Fine aggregate and Coarse aggregate
3. Water
4. Nano Rice Husk Ash
5. Nano Fly Ash

1 Cement

Cement is the most important material in concrete and it acts as a binding material. Ordinary Portland cement 53 grade manufactured by Zuari Cement Company confirming to IS 12269-1987 is used in this investigation. The physical properties of cement are presented in table 1.

Table 1: Physical properties of cement

Sl.No	Particulars	Results
1	Specific Gravity	3.14
2	Initial setting time	31min
3	Final setting time	512min
4	Fineness	225m^2/kg

2 Nano Rice Husk Ash

In the present experiment cement is partially replaced by Nano RHA, Nano RHA is made with rice husk ash material in which particle size range is from one Nanometer to 100 micro meter. The particle size of Nano RHA is calculated by using X-Ray Diffraction (XRD) analysis.

Table 2: Physical properties of nanorice husk ash

Sl.no	Particulars	Properties
1	Colour	Gray
2	Specific gravity	2.2
3	Mineralogy	Crystallite size
4	Particle size	26.8nm

***3** Nano Fly Ash*

The other supplementary cementing material used in this investigation is Nano Fly ash used in this study contains more silica content and less calcium.

IV. EXPERIMENTAL INVESTIGATION

1 General

The concrete mix proportions were determined for M_{25} grade concrete as per the guide lines given in IS 10626 – 2009. In the present investigation cement, has been replaced with different percentages of Nano fly ash i.e., by 20%, 30%, 40%, 50% and 60% and Nano RHA by 5%, 10%, and 15% and combination of both materials. For study of various properties, concrete specimens were casted and tested. Constant water-cement ratio of 0.5 has been adopted. The experimental investigation started with selection of materials and followed by their testing, casting of specimens and curing, and finally by testing the specimens.

***2** Compressive Strength Test*

Concrete cubes of sizes 150mm×150mm×150mm were tested for crushing strength. Compressive strength depends on many factors such as w/c ratio, cement strength, quality of concrete material and quality control during production of concrete.

Compression test on cube was conducted with 2000KN capacity compression testing machine available in concrete technology laboratory at AITS, Rajampet. The experimental arrangement is shown in figure no 2. The specimens were placed centrally on the base plate of the machine and the load was applied gradually at the constant rate of 140 kg/cm^2/min till the specimen failed. The maximum load applied was noted for each test. The specimen results were calculated at 7days, 14days, 28days and 60days and tabulated. The cube compressive strengths of various concrete mixtures are presented in graphical form. The crushing strength is the ratio of failure load to the area of cross section of specimen. The cube compressive strength can be calculated as follows:

If f_c is the cube compressive strength,

Then f_c= N/mm^2,

Where P is an ultimate load in Newtons.

A is a cross sectional area of cube in mm^2.

3 Split Tensile Strength

Split tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. Spilt tensile strength test was conducted by using the method prescribed by IS 5816 - 1999. Cylinders of 150mm diameter × 300mm height were used for this test. The test specimen was placed in machine between two strips of 3mm thick and approximately 12cm wide placed on the top and bottom of the specimens.

The spilt tensile strength was conducted on compression testing machine. The specimens were tested for 7, 14, 28 and 60days. The cylinder specimen was placed in horizontal direction on the testing machine. The load was applied uniformly at a constant rate of 1.5 N/mm^{2}until the failure by splitting along the vertical axis took place. Loads at which specimen failed were recorded and tabulated. Then split tensile strength was calculated. The splitting of cylinder is shown in figure no 3. The following relation is used to find out the spilt tensile strength of cylinder $F_t = 2P/\pi LD$

Where F_t is split tensile strength

P= Ultimate load in Newton.

L = Length of the cylinder in mm.

D = Diameter of the cylinder in mm.

4 Flexural Strength

Flexural strength test was conducted by using the method prescribed by IS 516 – 1959.Beams of 700mm × 150mm × 150mm were used for this test. The test specimen is placed in the machine at the bearing surfaces of the supporting and loading rollers. The load was applied without shock and increased continuously at a rate of loading of 400 kg/min for the 150mm specimens. The load was increased until the specimen failed, and the maximum load applied to the specimen during the test was recorded.

The flexural strength is calculated using the formula $f = PL/Bd^2$

Where P is the load in N

L and B are the length and breadth in mm.

d is depth in mm.

f is the flexure strength in N/mm^2

Table 3:Mix Designations of Concrete used in the Study

S.No	Mix designations	Binding materials
1	A1,B1,C1,D1 and E1	Conventional OPC concrete.
2	A2	5% replacement of OPC with Nano RHA.
3	A3	10% replacement of OPC with Nano RHA
4	A4	15% replacement of OPC with Nano RHA
5	B2	20% replacement of OPC with Nano FA.
6	B3	30% replacement of OPC with Nano FA.
7	B4	40% replacement of OPC with Nano FA.
8	B5	50% replacement of OPC with Nano FA.
9	B6	60% replacement of OPC with Nano FA.
10	C2	20% replacement of OPC with Nano FA+5% of Nano RHA.
11	C3	30% replacement of OPC with Nano FA+5% of Nano RHA.
12	C4	40% replacement of OPC with Nano FA+5% of Nano RHA.
13	C5	50% replacement of OPC with Nano FA+5% of Nano RHA.
14	C6	60% replacement of OPC with Nano FA+5% of Nano RHA.
15	D2	20% replacement of OPC with Nano FA+10% of Nano RHA.
16	D3	30% replacement of OPC with Nano FA+10% of Nano RHA.
17	D4	40% replacement of OPC with Nano FA+10% of Nano RHA.
18	D5	50% replacement of OPC with Nano FA+10% of Nano RHA.
19	D6	60% replacement of OPC with Nano FA+10% of Nano RHA.
20	E2	20% replacement of OPC with Nano FA+15% of Nano RHA.
21	E3	30% replacement of OPC with Nano FA+15% of Nano RHA.
22	E4	40% replacement of OPC with Nano FA+15% of Nano RHA.
23	E5	50% replacement of OPC with Nano FA+15% of Nano RHA.
24	E6	60% replacement of OPC with Nano FA+15% of Nano RHA.

V. RESULTS AND DISCUSSION

This chapter explains the mechanical strength properties like compressive strength, split tensile strength and flexural strength of various concrete mixtures with Nano Rice Husk Ash (RHA) and Nano Fly Ash (FA) and (Nano RHA+ Nano FA), and the discussions on the variation of the properties.

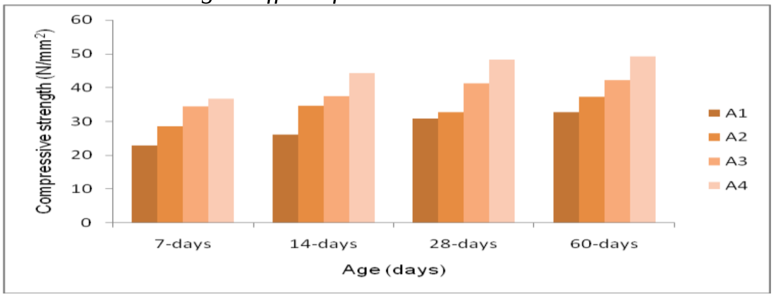
1. Compressive Strength Test

a) Effect of Nano RHA on Compressive Strength of Concrete

Table 4: Compressive strength test results for Nano RHA

Mix Designation	Proportions of Binding Materials	Compressive strength N/mm^2			
		7-Days	14-Days	28-Days	60-Days
A1	100% cement	22.9	28.6	34.4	36.7
A2	95% cement + 5% Nano RHA	26.1	34.7	37.4	44.3
A3	90% cement + 10% Nano RHA	30.9	36.8	41.3	48.2
A4	85% cement + 15% Nano RHA	32.8	37.3	42.3	49.2

Fig 1: Effect of Nano RHA on concrete

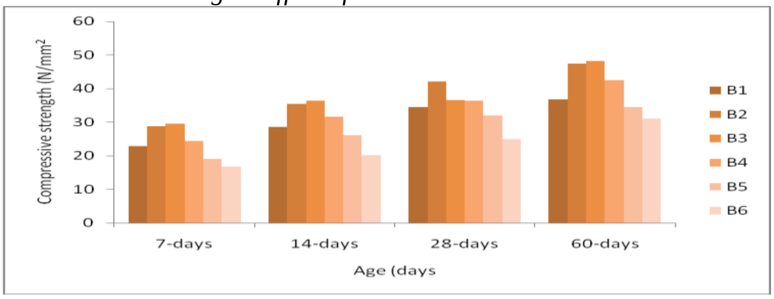


b) *Effect of Nano FA on Compressive Strength of Concrete*

Table 5: Compressive strength test results for Nano FA

Mix designation	Proportion of binding material	Compressive strength N/mm^2			
		7-Days	14-Days	28-Days	60-Days
B1	100% Cement	22.9	28.6	34.4	36.7
B2	80% Cement+20% Nano FA	28.8	35.5	42.1	47.4
B3	70% Cement+30% Nano FA	29.6	36.3	36.6	48.2
B4	60% Cement+40% Nano FA	24.4	31.6	36.4	42.4
B5	50% Cement+50% Nano FA	19.1	25.2	32.0	34.4
B6	35% Cement+60% Nano FA	16.7	20.1	24.9	31.0

Fig 2: Effect of Nano FA on concrete



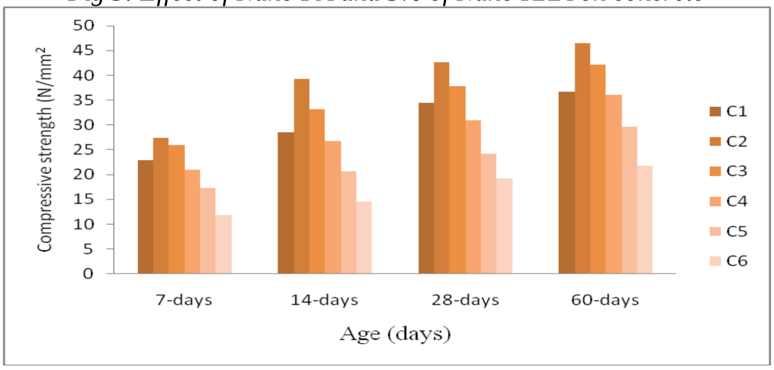
c) *Effect of Nano FA + Nano RHA on Compressive Strength of Concrete*

✓ Effect of 20% to 60% of Nano FA + 5% of Nano RHA on Compressive Strength of Concrete

Table 6: Compressive strength results for 5% of Nano RHA + 20% to 60% of Nano FA

Mix Designation	Proportions of binding materials	Compressive strength N/mm^2			
		7-Days	14-Days	28-Days	60-Days
C1	100% cement	22.9	28.6	34.4	36.7
C2	20% Nano FA+ 5% Nano RHA+75% cement	27.4	39.2	42.7	46.4
C3	30% Nano FA+ 5% Nano RHA+60% cement	26.2	33.1	37.8	42.1
C4	40% Nano FA+ 5% Nano RHA+55% cement	21	26.7	30.9	36.1
C5	50% Nano FA+ 5% Nano RHA+45% cement	17.3	20.6	24.2	29.6
C6	60% Nano FA+ 5% Nano RHA+30% cement	11.9	14.6	19.3	21.8

Fig 3: Effect of Nano FA and 5% of Nano RHA on concrete

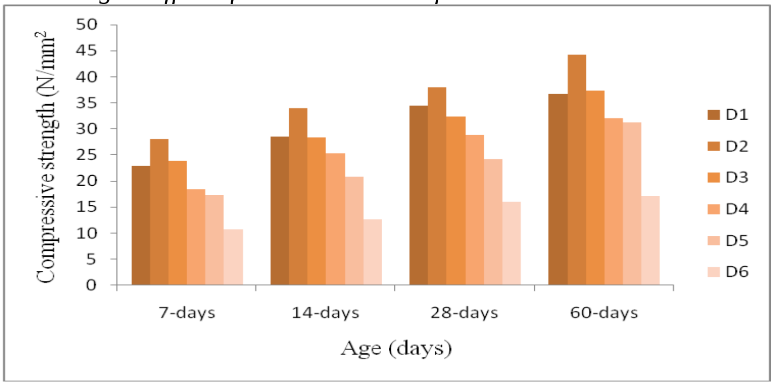


✓ Effect f 20% to 60% of Nano FA +10% of Nano RHA on Compressive Strength of Concrete

Table 7: Effect f 20% to 60% of Nano FA +10% of Nano RHA on Compressive Strength of Concrete

Mix designation	Proportions of binding materials	Compressive strength(N/mm²)			
		7 days	14 days	28 days	60 days
D1	100% cement	22.9	28.6	34.4	36.7
D2	20% Nano FA+10%Nano RHA + 70% cement	28	33.9	38	44.2
D3	30% Nano FA+10%Nano RHA + 60% cement	23.9	28.3	32.4	37.3
D4	40% Nano FA+10%Nano RHA + 50% cement	18.5	25.4	28.8	32.0
D5	50% Nano FA+10%Nano RHA + 40% cement	17.3	20.9	24.2	31.2
D6	60% Nano FA+10%Nano RHA + 25% cement	10.7	12.6	16.1	17.2

Fig 4: Effect of Nano FA +10% of Nano RHA on concrete

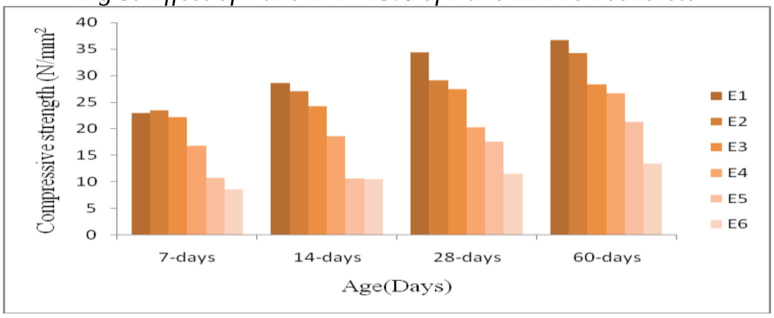


✓ Effect of 20% to 60% of Nano FA+ 15% of Nano RHA on Compressive Strength of Concrete

Table 8: Effect of 20% to 60% of Nano FA+ 15% of Nano RHA on Compressive Strength of Concrete

Mix designation	Proportions of binding materials	Compressive strength(N/mm²)			
		7days	14days	28days	60 days
E1	100% cement	22.9	28.6	34.4	36.7
E2	20% Nano FA+ 15% Nano RHA+60% cement	23.4	27	29.1	34.2
E3	30% Nano FA+15% Nano RHA+55% cement	22.2	24.2	27.4	28.3
E4	40% NanoFA+15% Nano RHA+45% cement	16.8	18.6	20.3	21.3
E5	50% Nano FA+15% Nano RHA+35% cement	10.8	10.6	17.6	13.5
E6	60% Nano FA+ 15% Nano RHA+20% cement	8.6	10.5	11.3	11.16

Fig 5: Effect of Nano FA+ 15% of Nano RHA on concrete



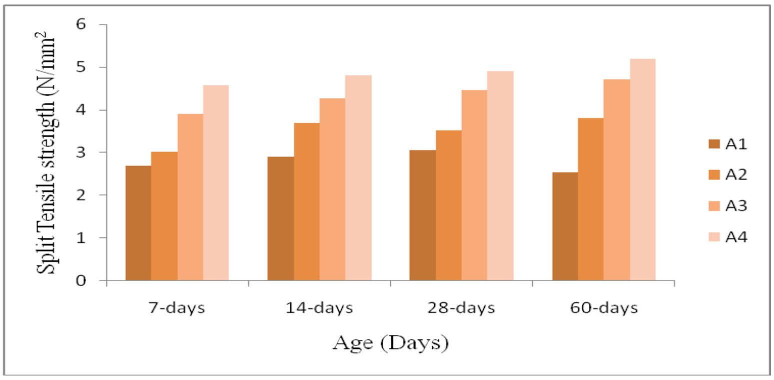
2. Split Tensile Strength

a) Effect of Nano RHA on Split Tensile Strength of Concrete

Table 9: Split tensile strength test results for using Nano RHA

Mix Designation	Proportions of Binding Materials	split tensile strength N/mm²			
		7Days	14Days	28 Days	60 Days
A1	100% cement	2.7	3.02	3.9	4.57
A2	95% cement + 5% Nano RHA	2.9	3.7	4.26	4.8
A3	90% cement + 10% Nano RHA	3.06	3.51	4.47	4.9
A4	85% cement + 15% Nano RHA	2.54	3.81	4.72	5.2

Fig 6: Effect of Nano RHA on concrete

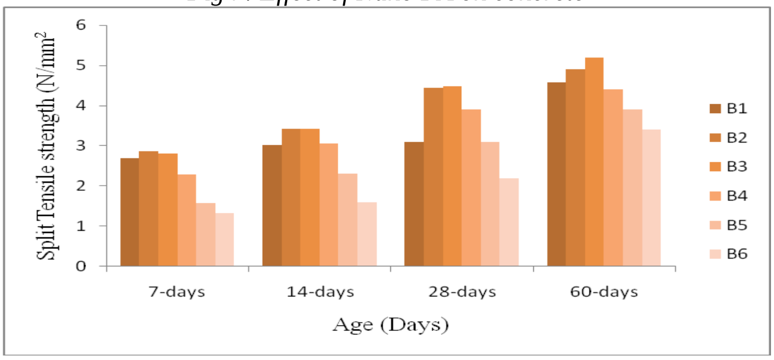


b) *Effect of 20% to 60% of Nano FA on Split Tensile Strength of Concrete*

Table 10: Split tensile strength test results for Nano FA

Mix Designation	Proportion of binding material	Split tensile strength N/mm^2			
		7 Days	14Days	28Days	60Days
B1	100% Cement	2.7	3.02	3.09	4.57
B2	80% Cement+20% Nano FA	2.86	3.43	4.45	4.9
B3	70% Cement+30% Nano FA	2.8	3.53	4.49	5.2
B4	60% Cement+40% Nano FA	2.29	3.05	3.9	4.4
B5	50% Cement+50% Nano FA	1.57	2.3	3.1	3.9
B6	35% Cement+60% Nano FA	1.33	1.6	2.2	3.4

Fig 7: Effect of Nano FA on concrete

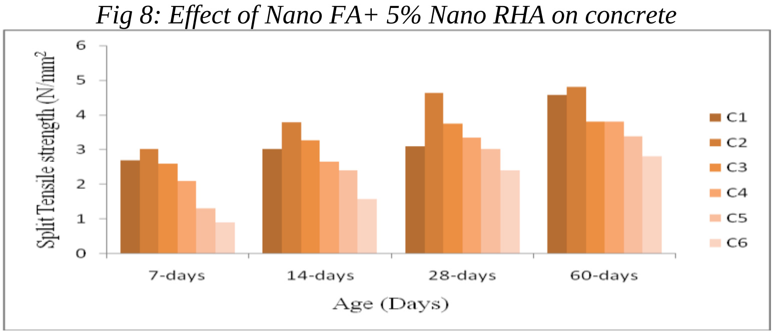


✓ *Effect of 20% to 60% of Nano FA + 5% of Nano RHA on Strength of Concrete*

Table 11: Split tensile strength results for 20% to 60% Nano FA+ 5% Nano RHA

Mix Designation	Proportions of binding materials	Split tensile strength N/mm^2			
		7Days	14Days	28Days	60Days
C1	100% cement	2.7	3.02	3.09	4.57
C2	20% Nano FA+ 5% Nano RHA+75% cement	3.02	3.78	4.63	4.8
C3	30% Nano FA+ 5% Nano RHA+60% cement	2.6	3.26	3.75	3.8
C4	40% Nano FA+ 5% Nano RHA+55% cement	2.1	2.65	3.35	3.8
C5	50% Nano FA+ 5% Nano RHA+45% cement	1.3	2.4	3.02	3.38
C6	60% Nano FA+ 5% Nano RHA+30% cement	0.9	1.57	2.4	2.8

Fig 8: Effect of Nano FA+ 5% Nano RHA on concrete

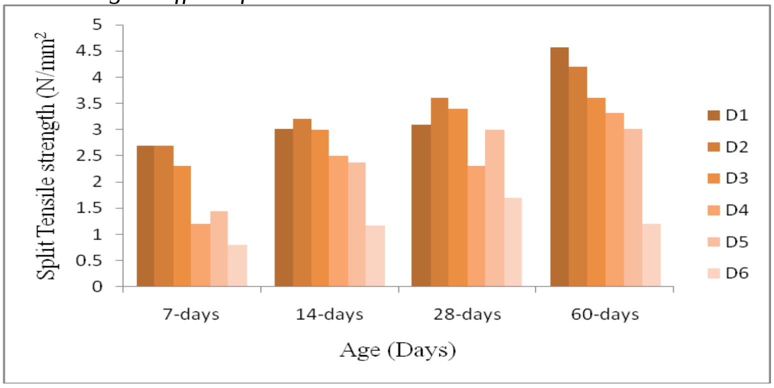


✓ *Effect of 20% To 60% of Nano FA+ 10% of Nano RHA on Strength of Concrete*

Table12: Split tensile strength results for 20% to 60% Nano FA+ 10% Nano RHA

Mix Designation	Proportions of binding materials	Split tensile strength N/mm^2			
		7Days	14Days	28Days	60Days
D1	100% cement	2.7	3.02	3.09	4.57
D2	20% Nano FA+10%Nano RHA + 70% cement	2.7	3.2	3.6	4.2
D3	30% Nano FA+10% Nano RHA + 60% cement	2.3	3.0	3.4	3.6
D4	40% Nano FA+10%Nano RHA + 50% cement	1.2	2.5	2.3	3.32
D5	50% Nano FA+10% Nano 0.9RHA + 40% cement	1.45	2.37	3.0	3.02
D6	60% Nano FA+10%Nano RHA + 25% cement	0.8	1.17	1.7	1.2

Fig 9: Effect of Nano FA + 10% Nano RHA on concrete

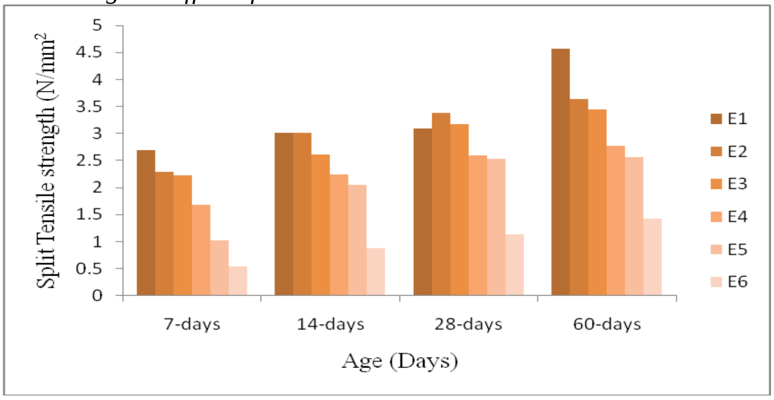


✓ *Effect of 20% to 60% of Nano FA + 15% of Nano RHA on Strength of Concrete*

Table 13: Split tensile strength results for 20% to 60% Nano FA+ 15% Nano RHA.

Mix designation	Proportions of binding materials	Split tensile strength(N/mm^2)			
		7 days	14 days	28 days	60 days
E1	100% cement	2.7	3.02	3.09	4.57
E2	20% Nano FA+15% Nano RHA+ 60% cement	2.29	3.02	3.38	3.63
E3	30% Nano FA+ 15% Nano RHA+55%cement	2.23	2.61	3.18	3.44
E4	40% Nano FA+15% NanoRHA+45%cement	1.69	2.25	2.60	2.78
E5	50% Nano FA+15% Nano RHA+35%cement	1.02	2.05	2.54	2.57
E6	60% Nano FA+ 15% Nano RHA+20%cement	0.54	0.88	1.14	1.42

Fig 10: Effect of Nano FA+1 5% Nano RHA on concrete



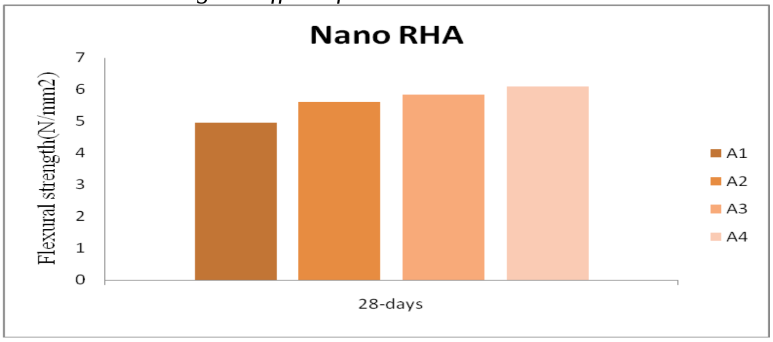
3. Flexural Strength Test

a) Effect of Nano RHA on Flexural Strength of Concrete

Table14: Flexural strength at 28 days for using Nano RHA

Mix designation	Proportions of Binding Materials	Flexural strength at 28 days (MPa)
A1	100% cement	4.96
A2	95% cement + 5% Nano RHA	5.61
A3	90% cement + 10% Nano RHA	5.83
A4	85% cement + 15% Nano RHA	6.1

Fig 11: effect of Nano RHA on concrete

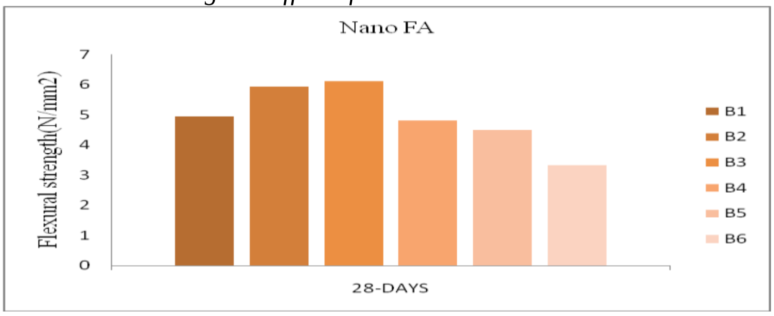


b) *Effect of 20% to 60% of Nano FA on Flexural Strength of Concrete*

Table15: Flexural strength at 28 days for using Nano FA

Mix designation	Proportion of binding material	Flexural strength at 28 days (MPa)
B1	100% Cement	4.96
B2	80% Cement+20% Nano FA	5.95
B3	70% Cement+30% Nano FA	6.12
B4	60% Cement+40% Nano FA	4.82
B5	50% Cement+50% Nano FA	4.50
B6	35% Cement+60% Nano FA	3.33

Fig 12: Effect of Nano FA on concrete

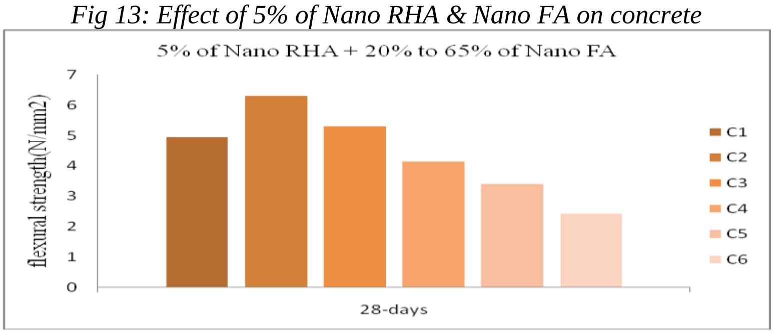


✓ *Effect of 20% to 60% of Nano FA + 5% of Nano RHA on Flexural Strength of Concrete*

Table 16: Flexural strength by using 20% to 60% Nano FA + 5% Nano RHA

Mix designation	Proportions of binding materials	Flexural strength at 28 days(MPa)
C1	100% cement	4.96
C2	20% Nano FA+ 5% Nano RHA+75%cement	6.30
C3	30% Nano FA+ 5% Nano RHA+60% cement	5.3
C4	40% Nano FA+ 5% Nano RHA +55% cement	4.14
C5	50% Nano FA+ 5% Nano RHA+45% cement	3.40
C6	60% Nano FA+ 5% Nano RHA+30% cement	2.43

Fig 13: Effect of 5% of Nano RHA & Nano FA on concrete

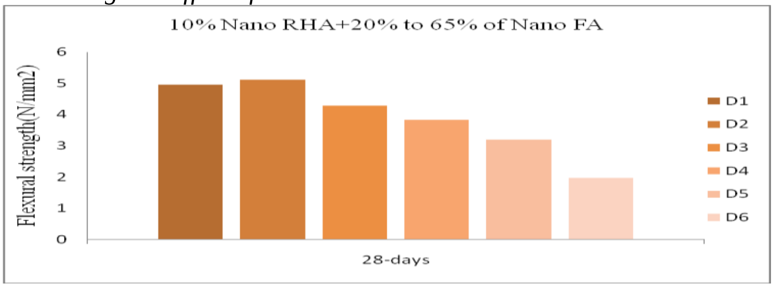


✓ *Effect of 20% to 60% of Nano FA + 10% of Nano RHA on Flexural Strength of Concrete*

Table 17: Flexural strength by using 20% to 60%Nano FA + 10% of Nano RHA

Mix designation	Proportions of binding materials	Flexural strength at 28 days (MPa)
D1	100% cement	4.96
D2	20% Nano FA+10%Nano RHA + 70% cement	5.11
D3	30% Nano FA+10%Nano RHA + 60% cement	4.28
D4	40% Nano FA+10%Nano RHA + 50% cement	3.83
D5	50% Nano FA+10%Nano RHA+ 40% cement	3.2
D6	60% Nano FA+10%Nano RHA + 25% cement	1.98

Fig 14: Effect of 10% Nano RHA &Nano FA on concrete

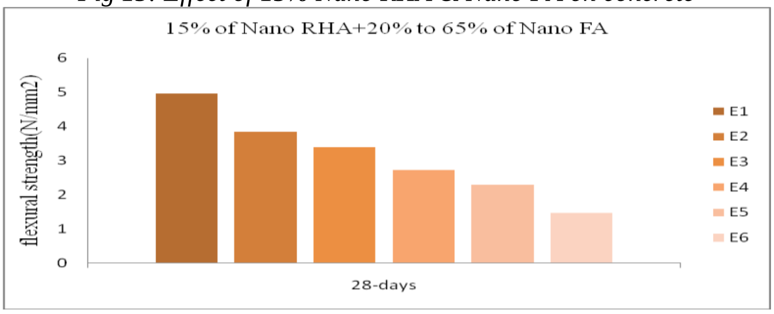


✓ *Effect of 20% to 60% of Nano FA + 15% Nano RHA on Flexural Strength of Concrete*

Table 18: Flexural strength by using 20% to 60% Nano FA + 15% of Nano RHA

Mix designation	Proportions of binding materials	Flexural strength at 28 days(MPa)
E1	100% cement	4.96
E2	20% Nano FA+15% Nano RHA+ 60% cement	3.85
E3	30% Nano FA+ 15% Nano RHA+55%cement	3.40
E4	40% Nano FA+15% Nano RHA+45%cement	2.73
E5	50% Nano FA+15% NanoRHA+35%cement	2.30
E6	60% Nano FA+ 15%NanoRHA+20%cement	1.47

Fig 15: Effect of 15% Nano RHA & Nano FA on concrete



VI. CONCLUSION

The compressive strength, tensile strength and flexural strength of concrete increases at all ages with increase in Nano Rice Husk Ash replacement with OPC up to 15%

a) The increase in compressive strength of concrete with 15% Nano Rice Husk Ash replacement is 15% and 23.3% more than the control concrete at 28 days and 60 days respectively.
b) The increase in tensile strength of M_{30} concrete with 15% Nano Rice Husk Ash replacement is 18.18% and 13.15% more than the control concrete at 28 days and 60 days respectively.
c) The increase in flexural strength of M_{30} concrete with 15% Nano Rice Husk Ash replacement is 22.98% more than the

control concrete at 28 days.

The compressive strength, tensile strength and flexural strength M_{30} concrete with Nano fly ash replacement up to 30% increases at all ages compared to conventional concrete. Then with further increase in Nano fly ash the strength decreases.

a) Highest compressive strength of concrete with 30% Nano fly ash replacement is 13.54% and 16.66% more than the control concrete at 28 days and 60 days. Respectively.
b) Maximum tensile strength of concrete with 30% Nano fly ash replacement is 12.42% and 13.15% more than the conventional concrete at 28 days and 60 days respectively.
c) Highest flexural strength of concrete with 30% Nano fly ash replacement is 23.3% more than control concrete at 28 days.

The highest compressive strength, tensile and flexural of M_{30} concrete with replacement of cement by combination of Nano fly ash and Nano Rice Husk Ash is obtained for concrete with 20% Nano fly ash and 5%Nano Rice Husk Ash combination.

a) The highest compressive strength is 13.9% and 12.1% more than control concrete at 28 days and 60 days respectively.
b) The highest tensile strength is 16% and 7.9% higher than control concrete at 28 days and 60 days respectively.
c) The highest flexural strength is 27% more than the control concrete at 28 days.

Suggestions for Future Study

a) The mechanical properties of concretes with the Nano fly ash, Nano rice husk ash and the combinations as replacements for cement in concrete can be studied by using superplasticizers.
b) The suitability of these concretes for RCC can be studied.
c) Durability studies can be carried on these concretes.
d) The workability properties of these concretes can be studied and self-compaction concretes with the combinations of Nano rice husk ash and Nano fly ash can be studied.
e) High strength, high performance concretes with the above combination can be tried.

REFERENCES

*[1] **K. Ganesan et al (2008)** "Rice Husk Ash Blended Cement: Assessment of Optimal Level of Replacement for Strength and Permeability Properties of Concrete" Elsevier journal of Construction and Building Materials 2008, Vol.22 (8):1675-1683.*

*[2] **P. Chindaprasirt et al (2008)** "Resistance to chloride penetration of blended Portland cement mortar containing palm oil fuel ash, rice husk ash and fly ash" Elsevier journal of Construction and Building Materials 2008, Vol.22 (5):932-938.*

*[3] **M. Rozainee et al (2008)** "Effect of fluidising velocity on the combustion of rice husk in a bench-scale fluidised bed combustor for the production of amorphous rice husk ash" Elsevier Bio-resource Technology 99 (2008) 703–713.*

*[4] **Gemma Rodriguez de Sensale (2010)** "Effect of rice husk ash on durability of cementitious materials" Elsevier journal of Cement and Concrete Composites Volume 32, issue 718-725.*

*[5] **Mustafa A.M et al (2011)** "The processing, Characterization and Properties of Fly ash Based Geopolymer Concrete". Advanced Study Centre Co. Ltd, Rev. Adv. Mater. Sci. vol. 30, pp 90-97, 2012.*

*[6] **Rawaid Khanet et al (2011)** "Reduction in environmental problems using rice-husk ash in concrete" published in Elsevier journal of construction and building materials 30 (2012) 360-360.*

*[7] **Konstantin Kovler et al (2011)** "Properties of fresh and hardened concrete" Elsevier journal of cement and concrete research 41(2011) 775-792.*

*[8] **Ravande Kishore et al (2011)** "Study on Strength Characteristics of High Strength Rice Husk Ash Concrete" Elsevier journal of Procedia Engineering 14 (2011) 2666–2672.*

*[9] **Amir Juma et al (2012)** "A Review on Experimental Behavior of Self Compaction Concrete Incorporated with Rice Husk Ash" International Journal of Science and Advanced Technology (ISSN 2221-8386) Volume 2 No 3 March 2012.*

*[10] **Suman et al, (2012)** "Fly Ash Concrete: A Technical Analysis for Compressive Strength" published in International Journal of Advanced Engineering Research and Studies E-I SSN2249–8974.*

*[11] **Andri Kusbiantoro et al. (2012)** "The effect of microwave incinerated rice husk ash on the compressive and bond strength of fly ash based geo-polymer concrete" Elsevier journal of Construction and Building Materials 36 (2012) 695-703.*

*[12] **Denni Asra Awizar et al. (2013)** "Nano silicate Extraction from Rice Husk Ash as Green Corrosion Inhibitor" published by International journal of Electrochemical Science 8 (2013) 1759 – 1769.*

*[13] **Rahmat Madandoust et al (2013)** "Mechanical properties of concrete containing waste glass powder and rice husk ash" Elsevier journal of Bio systems engineering 116 (2013) 113-119.*

*[14] **Satish H (2013)** "Combine Effect of Rice Husk Ash and Fly Ash on Concrete by 30% Cement Replacement" is published by Elsevier in Procedia Engineering 51 (2013) 35 – 44.*

*[15] **C.H. Huang et al. (2013)** "Mix proportions and mechanical properties of concrete containing very high-volume of Class F fly ash" Elsevier journal of construction and building materials 46 (2013) 71–78.*

[16] **R. P. Chauhan et al (2013)** *"Radon Resistant Potential of Concrete Manufactured Using Ordinary Portland Cement Blended with Rice Husk Ash" Elsevier journal of Atmospheric Environment 2013 Volume.81:413-420.*
[17] **Thirumalai Raja Krishnasamy et al. (2014)** *"Bagasse ash and rice husk ash as cement replacement in self-compacting concrete" Gradevinar67 (2015) 1, 23-30.*
[18] **Kurapati Srinivas (2014)** *"Nanomaterials for Concrete Technology" International Journal of Civil, Structural, and Environmental and Infrastructure Engineering Research and Development Vol. 4, Issue 3.*
[19] **B.H.V. Pai1 et al (2014)** *"Comparative study of Self Compacting Concrete mixes containing Fly Ash and Rice Husk Ash" American journal of Engineering research (AJER) Volume-3.*
[20] **K.V.Priya et al. (2014)** *"Effect of Nano-Silica in Rice Husk Ash Concrete" IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 39-43.*
[21] **Mini Soman et al. (2014)** *"The Strength and Behaviour of High Volume Fly Ash Concrete". International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 3, Issue 5, May 2014.*
[22] **Mangesh B et al (2014)** *"Studies on Utilization of Fly Ash and Rice Husk Ash in Concrete" International Journal of Engineering and Technical Research (IJETR) ISSN: 2321-0869, Volume-2, Issue-11, November 2014.*
[23] **Prinya chindaprasirt et al. (2014)** *"Strength and Chloride Resistance of the Blended Portland Cement Mortar Containing Rice Husk Ash and Ground River Sand" Materials and Structures 2015 Volume 48 Issue 11 pp 3771-3777.*
[24] **Obilade, I.O. (2014)** *"Use of rice husk ash as partial replacement for cement in concrete" International Journal of Engineering and Applied Sciences 2014. Volume- 5. No 4.*
[25] **Divya Chopra et al (2015)** *"Strength, permeability and microstructure of self-compacting concrete containing rice husk ash" Bio Systems Engineering 130 (2015) 72-80.*
[26] **PriyankJilowa et al. (2015) "***An Experimental Study on Strength of Concrete by Partial Replacement of Cement with Fly-Ash and Rice Husk Ash with addition of Steel Fibres" International Journal on Emerging Technologies* **6** *(2): 131-138(2015).*
[27] **Ali Behnoodet al. (2015) "***Effects of copper slag and recycled concrete aggregate on the properties of CIR mixes with bitumen emulsion, rice husk ash, Portland cement and fly ash" Elsevier journal of Construction and Building Materials 96 (2015) 172-180.*
[28] **Socrates Ioannou et al. (2015)** *"Performance characteristics of concrete based on ternary calcium sulfo aluminate–anhydrite–fly ash cement" published in Elsevier journal of Cement and Concrete Composites 55 (2015)196-204.*
[29] **Irshad Ali (2015) "***Behavior of Concrete by using Waste Glass Powder and Fly Ash as a Partial Replacement of Cement" International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 Vol. 4 Issue 05, May-2015.*
[30] **Jitender Kumar et al (2015)** *"A Study on the Effect of Fly Ash and Rice Husk Ash on Strength Parameters of Pavement Quality Control" International journal on emerging technologies 6(2):28-34(2015).*