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To Evaluate the Mechanical & Durability Properties of Nano Sugarcane Bagasse Ash in Cement Concrete

P. Mamatha*, Dr. SMV Narayana, T. Naresh Kumar*****

*M.Tech. PG Scholar, Annamacharya Institute of Technology & Sciences, Rajampet, Kadapa, Andhra Pradesh, India
**Professor, Dept of Civil, Annamacharya Institute of Technology & Sciences, Rajampet, Kadapa, Andhra Pradesh, India
***Professor, Dept of Civil, Annamacharya Institute of Technology & Sciences, Rajampet, Kadapa, Andhra Pradesh, India

ABSTRACT

The purpose of experimental study is to find the effect of Nano sugarcane bagasse ash on strength properties of concrete. A partial substitution of cement by an industrial by-products and bagasse ash are utilized as a replacement of cement. It is proposed to study the cement is partially replaced the material of 5 %, 10 %, 15 % and 20 % of Nano Sugarcane Bagasse ash. The impact shared utilization of Nano Sugarcane Bagasse ash on compressive strength, split tensile strength, Chloride Penetrability test& Water permeability test of M30 grade of concrete is studied. The investigated test after effect of concrete prepared utilization the different extents of Bagasse ash as compared there upon of controlled concrete. The different in different test results of Nano sugarcane bagasse ash (A1, A2, A3, A4 & A5) as compared to Micro sugarcane Bagasse ash (X1, X2, X3, X4 & X5) as shows the similar fashion. The XRD & SEM analysis is carried out to know the bond characteristics in the concrete specimens.

Keywords : OPC Cement, Nano Sugarcane Bagasse Ash, Coarse Aggregate, Fine Aggregate.

I. INTRODUCTION

Concrete is a most important materials among the building materials. Since the characteristics of concrete as a building material to develop the strength, Durability and economy have made it the world most widely used construction material. Production of one ton of cement produces approximately 7% of co_2 worldwide. The production of one ton of cement consumes about 1.5 tons of raw materials, 80 units of electric power apart from one ton of co_2 releases into air. Out of the total co_2 emission worldwide, cement industry comes about 7 % of co_2 emission. Annual cement manufacture rate of the world is grown up very more year by year. The production can be reduced demand is increased. Demand can be reduced by using supplementary cementing materials and other materials which decrease Portland cement content of concrete. The proportions of concrete can also be increased by using by-products & natural waste and industrial by-products as partial replacement to OPC. Sugarcane is major crop grown in over 110 countries and it produced is over 1500 million tons [5]. Sugarcane produced in India is over 300 million tons per year. After the removal of all economical sugar from sugarcane about 40-45 % fibrous waste is obtained. One ton of sugarcane can produce nearly 26% of bagasse and 0.62% of residual ash [3-4]. The fibrous waste is reused in the industry as fuel boilers for generation of heat leaving 8-10% ash. The Nano sugarcane Bagasse ash is high volume of un-burnt matter, silicon, aluminum and calcium oxides. The use of Nano sugarcane Bagasse ash as cement replacement material to improves quality and decrease the cost of construction material such as mortar and concrete. There are more innovative advantages and social uses in using of Nano sugarcane bagasse ash in concrete. Because of sugarcane bagasse ash contains more amount of silica. Which is involved into the structure by absorption from the soil during the growth of plant and is a pozzolanic material which behaves like cement included of lime and water. In order to make the concrete more eco-friendly and greener there is need to use Nano SCBA in concrete. The present study is carried out on M_{30} grade of concrete with Nano sugarcane bagasse ash. The other materials such as collected, aggregates were collected from nearby quarries, 53 grade OPC cement was used in all mixtures. The Mechanical & Durability properties of the concrete were examined by the replacement of OPC with Nano sugarcane Bagasse ash.

II. MATERIALS AND METHODS

In present investigation the collected materials are 53 grade OPC cement, Nano SCBA, Natural sand, crushed granite aggregate were used in concrete.

Cement:

Ordinary Portland cement of 53 grade manufactured by Zuari Cement Company confirming to IS 12269-1987 is used. Natural sand confirming to zone II, with specific gravity of 2.65, fineness modulus 2.88 and 20mm crushed granite aggregate with specific gravity of 2.7 were used.

Nano Sugarcane Bagasse Ash:

Nano sugarcane bagasse ash was obtained from KBD Sugars & Distilleries Pvt Ltd, Mudipapanapalli (V), Sugalimitta (P), Punganuru (M). The specific gravity of Nano sugarcane bagasse ash is 1.8 and the surface area is 901.77 m^2/kg .the sugarcane bagasse ash particle size is calculated by using XRD test analysis for the samples. From the analysis Nano sugarcane Bagasse ash size is Nanometers. XRD of sugarcane bagasse ash is shown in fig.1

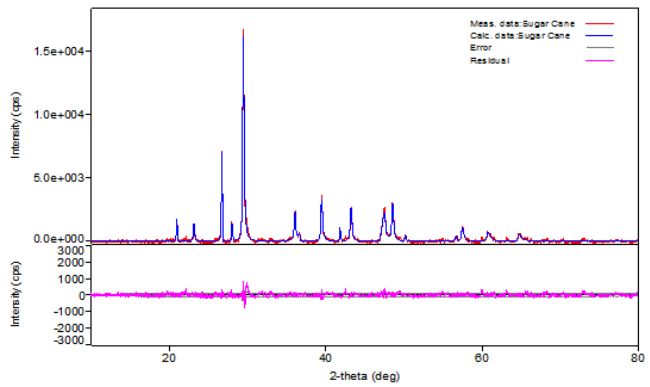

Figure 1. XRD analysis for Nano sugarcane bagasse ash

Table: 1 Chemical properties of Nano sugarcane bagasse ash in chemical composition results in XRD test

Material	Results in %
SiO_2	87.50
Al_2O_3	3.8
Fe_2O_3	4.9
CaO	2.56
MgO	0.68
Na_2O	0.16
K_2O	0.47
S_2O	0.15
LOI	8.27

III. MIX PROPORTIONING

In present investigationM_{30} grade of concrete is used with a water-cement ratio of 0.45. The M_{30} grade of concrete mix design is done as per IS 10262:2009 with mix proportions 1:2.95:1.72.concrete mixtures were prepared by varying percentage of replacement with Nano SCBA by 5%, 10%, 15% and 20%.

IV. EXPERIMENTAL INVESTIGATION

Compressive Strength Test:

The compressive strength of concrete (150 mm × 150 mm × 150 mm) are tested by means of compressive testing machine according to ASTM C39. All proportions were tested after 7 days, 14 days and 28 days curing period at standard 20 ± 2°C.

Split Tensile Strength Test:

Split tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. Spilt tensile strength of concrete is as prescribed by IS 5816 - 1999 is conducted. Specimens of 150mm diameter × 300mm height were used for this test. The specimens were tested for 7, 14, 28 and 60days.

Rapid Chloride ion penetration test:

According to ASTM C1202 test, a water-saturated, 50 mm thick, 100 mm diameter concrete specimen is subjected to a 60v applied DC voltage for 6 hours using the RCPT apparatus. In one reservoir is a 3.0% NaCl solution and in the other reservoir is a 0.3 M NaOH solution. The total charge passed is determined and this is used to rate the concrete according to the criteria included.

Water permeability test:

The determination of water penetration depth is specified by BS EN- 12390-8:2000. In this test, water

was applied on the face of the 150mm concrete specimen under a pressure of 5 to 10 kg/cm^2. The constant pressure maintained for a period of 72h. After the period, the specimen were taken out and split into halves. The water penetration contour in the concrete surface was marked and then maximum depth of penetration value has to be recorded as water penetration. This test will be conducted after 60 days water curing of concrete cubes.

V. EXPERIMENTAL RESULTS AND DISCUSSIONS

The M_{30} grade of OPC Concrete results with various proportions of Nano sugarcane Bagasse ash was tested for compressive strength and split tensile strength, Chloride Penetrability test and Water permeability test.

LEGEND:

Table 2. shows the percentages of Nano SCBA used for M_{30} grade concrete

Mix Designation	Binding materials
A1	100 % Cement
A2	5 % Nano SCBA+ 95% Cement
A3	10 % Nano SCBA+ 90 %Cement
A4	15 % Nano SCBA+ 85 % Cement
A5	20 % Nano SCBA + 80% Cement

Table -2 Mix proportions

Effect of Nano SCBA on Strength of Concrete:

The concrete specimens with partial replacement of cement by Nano SCB were tested by using the CTM and the test results are shown in table no: 3, fig-2 gives the graph shown in compressive strength of different concrete mixtures at 7, 14, 28 and 60 days.

Table 3 Compressive test results for Nano Sugarcane Bagasse ash

Mix Designations	Compressive Strength (N/mm^2)			
	7-Days	14-Days	28-Days	60-Days
A1	21.78	27.78	32.67	35.60
A2	24.32	32.59	38.23	40.86
A3	30.17	35.23	40.10	41.80
A4	33.21	37.34	42.06	42.15
A5	34.25	38.64	43.24	44.84

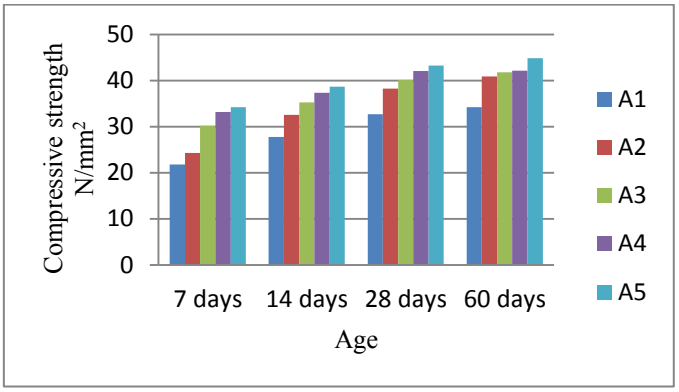

Figure 3. Effect of Nano SCBA on concrete

At 7 days curing age, it was observed that the compressive strength showed an increase as the Nano Sugarcane bagasse ash content increased up to 20%.

Table: 4 Split Tensile strength results for Nano SCBA

Mix Designations	Tensile Strength(N/mm^2)			
	7-days	14-days	28-days	60-days
A1	2.99	3.09	3.18	3.80
A2	3.08	3.60	3.71	4.02
A3	3.14	3.69	3.83	4.24
A4	3.35	3.86	3.98	4.46
A5	2.84	2.82	3.81	4.12

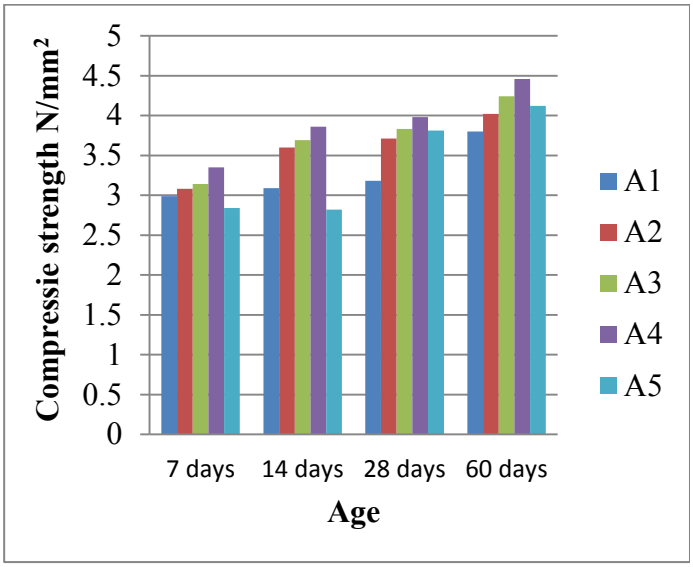

Figure 4. Effect of Nano SCBA on concrete

At 7 days curing age, it was observed that the split tensile strength showed an increase as the Nano Sugarcane bagasse ash content increased up to 15%.

5.4.1 Effect of Nano Sugarcane Bagasse ash on RCPT of Concrete:

The RCPT of M30grade concrete mixes replacing OPC by Nano SCBA at 5%, 10%, 15% and 20% is investigated. The results of RCPT of A1, A2, A3, A4and A5 concrete mixtures tested at 60 days are represented in table-15. A graphical representation age versus RCPT is represented in table 12.

Table 5: Chloride ion permeability rating

Mix no.	Proportion of Binding Materials	Rapid chloride permeability test, mAh
		60 days
A1	Conventional mix	332.1 (very low)
A2	95% Cement+5% Nano SCBA	1390.05(Low)
A3	90 % Cement+10 % Nano SCBA	1906.4 (Low)
A4	85% Cement+15% Nano SCBA	1581.3 (Low)
A5	80 % Cement+20% Nano SCBA	993.6(Very low)

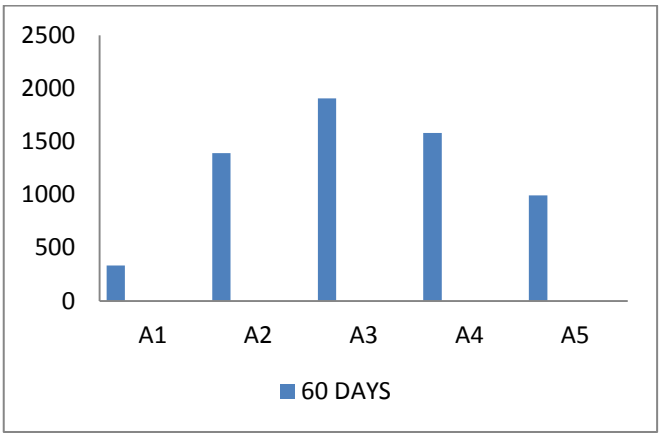

Figure 5: chloride penetration Vs percentage of Nano Sugarcane bagasse ash

5.5 Water Permeability Test:

5.5.1 Effect of Nano SCBA on Water permeability test of Concrete:

The Water penetration test M30grade concrete mixes replacing OPC by Nano SCBA at 5%, 10%, 15% & 20% were investigated. The results of Water penetration of A1, A2, A3, A4and A5 concrete mixtures tested at 60 days are represented.

Table 6. shows Depth of penetration in mm

S.NO	MIX NOTATIONS	DEPTH OF PENETRATION IN m/sec
1	Conventional Concrete	6.591×10^{-13}
2	5% Nano SCBA + 95% Cement	7.24×10^{-12}
3	10% Nano SCBA + 90 % Cement	9.84×10^{-11}
4	15 % Nano SCBA + 85 % Cement	8.79×10^{-13}
5	20 % Nano SCBA + 80 % Cement	9.906×10^{-13}

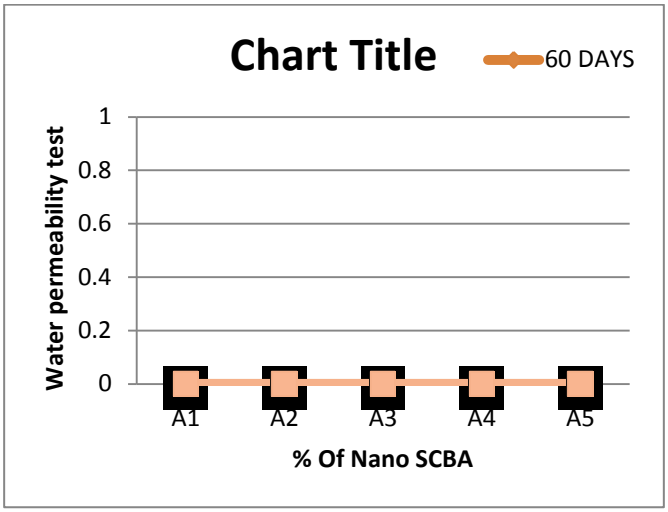

Figure 6: water penetration Vs percentage of Nano SCBA

Many researchers have observed that there was increase in Compressive Strength and Tensile strength of concrete on using Nano Sugarcane Bagasse ash.

Prasanth O. Modani [1] investigated to study the compressive strength of concrete by using of 10 % of SCBA gives the maximum compressive and tensile strength as compared to Conventional concrete. Hariharan et al [2] investigated the compressive strength of concrete up to 20% of SCBA resulted lower porosity, water absorption & high dielectric strength compared to standard porcelain insulator. Megat et al [7] investigated to compressive strength of concrete as a pozzolanic material and partial replacement in cement concrete production at a percentage up to 20%. Nwofar et al [5] the results concluded that the 80.55% of SCBA give the better compressive strength compared to conventional concrete. Sreenivasan et al [3] results shows that the cement could advantageous replaced with SCBA up to maximum limit 10%. It is possible to use SCBA as cement replacement material to improve quality and reduce the cost of construction materials such as concrete. D. Whiting [20] the results concluded that the 10 % of SCBA gives the maximum limit of RCPT for sugarcane bagasse ash.

VI. CONCLUSION

The results of the present investigation show that Nano sugarcane bagasse ash can be used as a pozzolanic material in concrete.

1. The compressive strength of concrete of Nano sugarcane bagasse ash concrete (A1, A2, A3, A4 & A5) increases with increase in bagasse ash at by age.
2. As for refereed many research journals the M_{30} grade concrete(X1, X2, X3, X4 & X5) with 10% of bagasse ash has gives maximum strength at 60 days which 16.35% more than conventional concrete.
3. For tensile strength of Nano sugarcane bagasse ash (A1, A2, A3, A4 & A5) with 15 % increases with increases in bagasse ash at by age.
4. For M_{30} grade of concrete with 10% of bagasse ash (X1, X2, X3, X4 & X5) shows that the tensile strength at 7 days, 14 days, 28 days and 60 days.
5. So, Utilization of SCBA is a pozzolanic material that the potential to be used as partial replacement material and can help to the environmental sustainability.
6. Many researches had the results at the age on the compressive strength of concrete. In SCBA (X1, X2, X3, X4 & X5) of M_{30} grade of concrete shows maximum compressive strength gives up to 15% replacement level of SCBA. The value of Compressive strength was 24.7 N/mm^2, 22.12 N/mm^2 & 24 N/mm^2 at 15% of SCBA at the age of 28 days.
7. In Nano sugarcane bagasse ash (A1, A2, A3, A4 & A5) gives up to the values of 34.25 N/mm^2, 38.64 N/mm^2, 43.42 N/mm^2 & 44.84 N/mm^2 are the 20% of optimum results compared to conventional concrete at the age of 60 days. So, those Nano materials will give great strength as compared to the normal materials. In this study Nano bagasse ash was used in cement concrete it gives better results in sugarcane bagasse ash.

The results shows that the SCBA concrete had significantly higher compressive strength compare to that of the Conventional concrete. It is found that the cement could be advantageously replaced with SCBA up to maximum limit of 15%. Although, the Partial replacement of cement by SCBA increases workability of fresh concrete.

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