Experimental Study on Concrete with Sugarcane Bagasse Ash as a Partial Replacement of Cement with Sodium Chloride

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Abstract— Concrete is widely used for construction most of the buildings and bridges in India can be called as back-bone to the infrastructural development of the nation built. But due to increase in cost of the cement not only increases the budget of a Construction but also it is serious threat to the country's developments. It is also identified that some of industrial waste products like Bagasse Ash are having some cementitious and siliceous properties. The use of the agricultural and industrial wastages can use to replacement of cement in concrete partly. So, it can be to reduce the cost of making concrete and also its improvement in the properties of concrete and reduce environmental pollution impacts. In this study, Sugarcane Bagasse ash has been chemically and physically characterized, and replaced partially in the ratio of 5%, 10%, 15%, 20% and 25% by weight of cement in concrete. Concrete like to test by slump cone test and compaction factor test were undertaken to known the hardened concrete test compressive strength at the age of 7 days, 14 days and 28 days. The result shows that the increase strength of concrete. In this present study Sugarcane Bagasse Ash (SCBA) has been replaced partially in the ratio of 5%, 10%, 15%, 20% and 25% by weight of cement in concrete. Concrete specimens were cured in normal water and 5% NACL solution comparison is made with compressive strength of concrete.

Keywords: Sugarcane Bagasse Ash, Concrete, Compressive Strength

I. INTRODUCTION

Cement, both in mortar and concrete is the most important element of the infrastructure and can be a durable construction material. Cement industry is the second largest Co2 emitting industry behind the power generation. Which is one of the important green house gas as the global warming. Utilization of agricultural, agro-industrial and industrials by-products in Cement concrete production has become a more to the researchers over the world. Such wastes as cement replacement materials can reduce the cost of concrete for constructions and also minimize the environmental effects with the disposal of these wastes. Currently, many countries are using pozzolanic materials in concrete structures for improving to get more compressive strength and reducing the cost of concrete in construction. Approximately 2150 million tons of sugarcane is annually produced over all the world which it is about 42-45% bagasse after juice crushing for sugar industry giving an average annual production of 840 million tons of bagasse as a waste material from sugar industry.The natural pozzolans and industrial by-products are there generally available at substantially lower costs than Portland cement. They are more finer than cement and possess pozzolanic and sometimes cementitious properties. Thus, their use as partial replacement for cement can lead to considerable.

II. LITERATURE REVIEW

1) G. Sireesha et al., (2013) investigated on "An experimental study on strength properties of concrete when cement partially replaced with sugar cane bagasse" has been made to used sugarcane bagasse ash SCBA a residue from sugar industry as a supplementary cement replacement material. In this present study investigates with the strength and durability properties of the concrete when the cement is replaced with SCBA in different proportions stage. In the first stage the S.C.B.A is partially replaced in the percentages of 0 to 30% in increasing steps of 5%. Further in the second stage the SCBA is heated up to 8500c for about 10 hours in a muffle furnace and is replaced in the percentages of 0 to 40% in increasing steps of 5%. Cubes, Cylinders and Beams are casted and tests are conducted and compressive strength, split tensile strength and flexural strength obtained for both the conditions. The maximum compressive, split tensile, flexural strengths are obtained at 5% when the cement is replaced with the maximum compressive strength is obtained at 15%, tensile strength is obtained at 20% and flexural strength is obtained at 30% when the cement is replaced and comparing the results of the two trails, the results obtained by replacing cement are better.
2) Mr. Lavanya M.R et al. had studied on "An Experimental Study on the Compressive Strength of Concrete by Partial replacement of Cement with Sugar cane bagasse ash". by using the sugar cane bagasse ash , a finely grounded waste product from the sugarcane industry, as replacement in partially for cement in conventional concrete. The test was conducted as per Bureau of Indian Standard (BIS) codes to evaluate the stability of SCBA for partial replacement up to 30% of cement with varying water cement (w/c) ratio. So Addition of SCBA results in improvement of strength in all cases and according to the obtained good results, it can be concluded that Bagasse ash can increase the overall strength of concrete when used up to a 15% cement replacement level with w/c ratio of 0.35, bagasse ash is a valuable pozzolanic material and it can potentially be used as a partial replacement for cement where it improve the strength of concrete.
3) T.Shafana, R.Venkatasubramani, conducted a research on possibility of using sugarcane bagasse ash as replacement of fine aggregate in concrete. They partially replaced 10%, 15%, 20%, 25% and 30% of natural sand with SCBA. They compared compressive strength,

tensile strength and flexural strength with those of concrete made with natural fine aggregate. The test results indicate that it is possible to manufacture concrete containing sugarcane bagasse ash with characteristics similar to those of natural river sand aggregate concrete, provided that the percentage of sugarcane bagasse ash as fine aggregate is limited to 10 percent.

4) P. Krishnam Raju, V. Ravindra et al., had aimed to adopt marine water both for mixing and curing of concrete in the construction industry as the potable water is a scarce commodity on the planet Earth. Two concrete mixes viz, M20 and M25 using ordinary Portland cement (OPC) of 53 Grade as per the Guide lines of concrete mix proportioning (revised) with a slump of 100 to 150mm were considered. The mixes were prepared with "Potable water mixing and Sea water curing" & "Sea water mixing and Sea water curing". A total specimen of 54 cubes, 54 cylinders and 54 beams including specimens for reference concrete were cast for both the mixes and exposed to 7days, 28days and 90days period of curing in order to investigate the compressive strength behaviour, modulus of rupture and flexural strength. The reference concrete is prepared with OPC using potable water mixing and cured with the same water. The study reveals that there is no reduction in compressive strength due to mixing of sea water and also due to mixing and curing with sea water compared to its target strength.

III. Experimental Investigations

A. *Sugarcane Bagasse Ash*

Sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicelluloses of ligin. Each ton of sugarcane generates approximately 26% of bagasse (at a moisture content of 50%) and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide (sio2). In spite of being a material of hard degradation and that presents few nutrients, the ash is used on the farms as a fertilizer in the sugarcane harvests. In this sugarcane bagasse ash was collected during the cleaning operation of a boiler in the sugar factory, located in the town of Chodavaram, Andhra Pradesh.

Bagasse is burned as fuel in the sugarcane mill or used as a source of cellulose for manufacturing animal feeds. Paper is produced from bagasse in several Latin American countries, in the Middle East, and in sugar-producing countries that are deficient in forest resources

B. *Effect of Nacl on Concrete*

Although concrete sidewalks and driveways look very solid, concrete is actually a porous material that can and does absorb water. In cold weather the snow or ice is a solid and does not penetrate into concrete. But, when ice melters are applied to snow or ice, the melting ice/snow is turned into a salt/water mix and is absorbed by concrete. Additionally, rock salt is hydroscopic, which means that rock salt actually attracts more water to it. So when ice is melted by rock salt and changes into a salt/water mix, it enters the concrete with approximately 10% more water than would normally enter concrete. When temperatures fall below 25 degrees, having this extra water in concrete causes a large problem. In these colder temperatures, the extra water in the salt/water mix starts to re-freeze and expand, but the additional water adds additional ice in the concrete, which in turn adds additional hydraulic pressure on the concrete. When the hydraulic pressures of the re-freezing water exceeds the compression strength of the concrete, damage can occur. Additionally, the more often the freeze/thaw cycle happens, the more likely the damage is to occur. This being said, a one-time use of rock salt is unlikely to cause damage.

IV. Methodology

In this experimental work conducted tests on cement with (OPC 53 grade), fine aggregate, coarse aggregate.

Tests on cement:

1) Standard consistency test
2) Initial setting time
3) Final setting time
4) Specific gravity of cement

Tests on fine aggregate and coarse aggregate:

1) Fineness modulus of fine aggregate and coarse aggregate.
2) Specific gravity of fine aggregate and coarse aggregate

Tests on workability:

1) Slump cone test.
2) Compaction factor test.

In this experimental work, a total of 118 numbers of concrete specimens were casted for testing. The standard size of cube 100mm×100mm×100mm is used for casting. The mix design of concrete was done according to IS 10262:2009 for M35grade of concrete.

Based upon the quantities of ingredient of the mixes, the quantities of SCBA for 5%, 10%, 15%, 20% and 25% replacement by weight of cement were estimated and cubes were casted.

The specimens were cured in normal water and 5% NaCl foe age of 7 days, 14 days and 28 days, the specimens were tested.

The specimens were taken out from the curing tank just prior to the test. The compressive strength of concrete test was conducted using a compression testing machine.

V. Results

A. *Sugarcane Bagasse Ash*

Sugarcane Bagasse Ash (SCBA) has a Physical Properties and Chemical Properties the value as given in below table.

Physical Properties of SCBA:

S. No.	Property	Value
1	Density	575Kg/m^3
2	Specific Gravity	2.2
3	Mean particle size	0.1-0.2 µm
4	Min specific surface area	2500m^2/ kg
5	Particle shape	Spherical

Chemical Properties of SCBA:

S No	Component	Symbol	Percentage
1	Silica	S_iO_2	63
2	Alumina	Al_2O_3	31.5
3	Ferric Oxide	Fe_2O_3	1.79

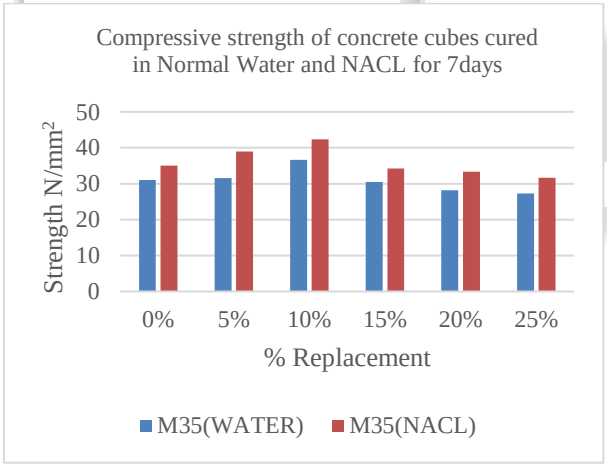
4	Manganese Oxide	M_nO	0.004
5	Calcium Oxide	C_aO	0.48
6	Magnesium Oxide	M_gO	0.39
7	Loss on Ignition	LOI	0.71

Compressive Strength of Concrete in Normal Water (M35)

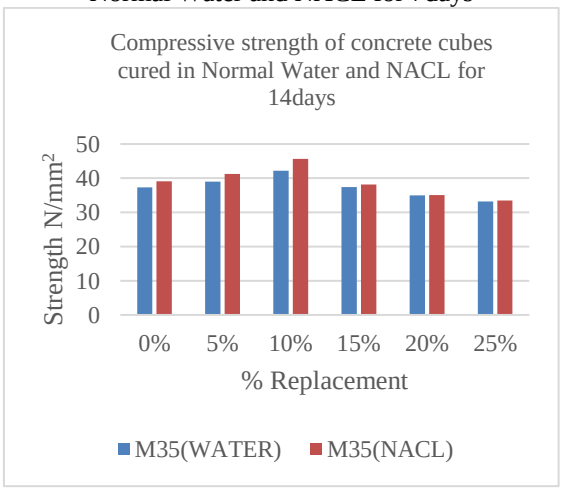
% Replacement of SCBA	Compressive strength of concrete at 7 days Curing	Compressive strength of concrete at 14 days Curing	Compressive strength of concrete at 28 days Curing
0	31	37.3	43
5	31.6	39	45.8
10	36.6	42.2	47.5
15	30.5	37.4	39.5
20	28.16	35	37.66
25	27.3	33.2	35

Compressive Strength of Concrete (M35 in 5% NaCl)

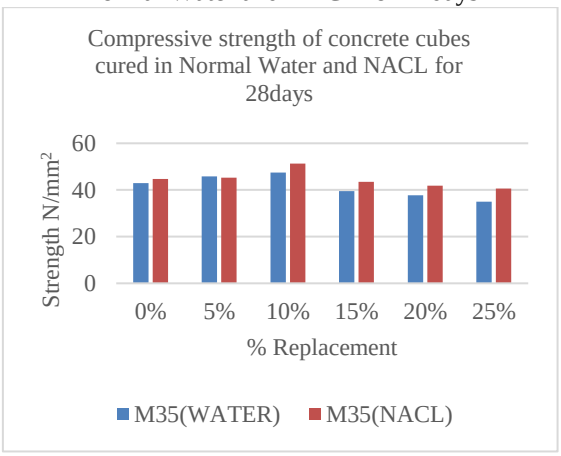
% Replacement of SCBA	Compressive strength of concrete at 7 days Curing	Compressive strength of concrete at 14 days Curing	Compressive strength of concrete at 28 days Curing
0	35	39.1	44.66
5	39	41.2	45.33
10	42.33	45.6	51.3
15	34.25	38.2	43.5
20	33.33	35.1	41.83
25	31.66	33.5	40.66



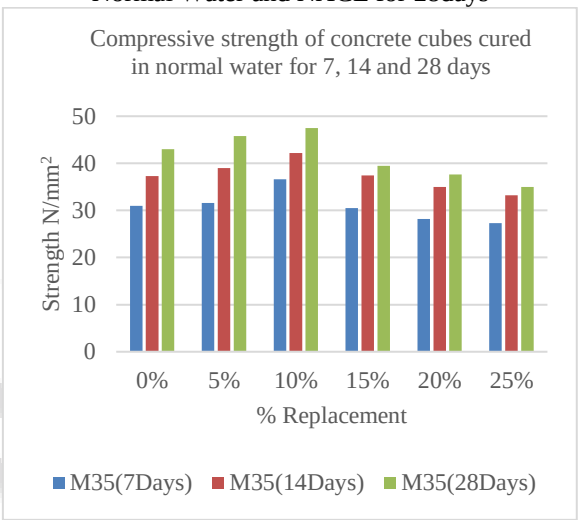
Graph I: Compressive strength of concrete cubes cured in Normal Water and NACL for 7days



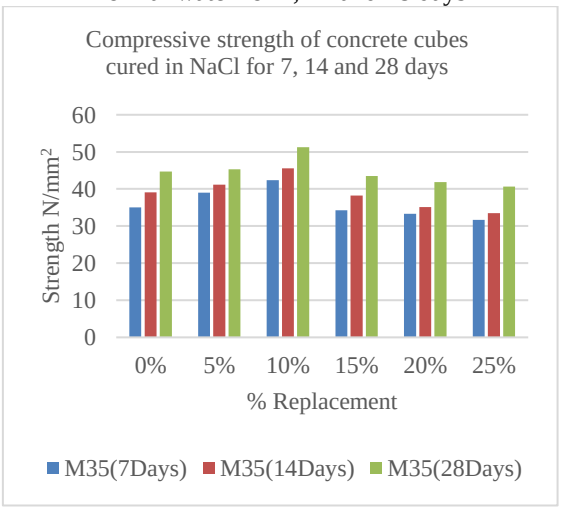
Graph II: Compressive strength of concrete cubes cured in Normal Water and NACL for 14days



Graph III: Compressive strength of concrete cubes cured in Normal Water and NACL for 28days



Graph IV: Compressive strength of concrete cubes cured in normal water for 7, 14 and 28 days



Graph V: Compressive strength of concrete cubes cured in NaCl for 7, 14 and 28 days

The compressive strength of concrete at 7, 14 and 28 days with 5%, 10%, 15%, 20% and 25% SCBA replacement and without SCBA replacement in concrete has been represented in Graph 1,2,3,4 & 5.The SCBA were increased the compressive strength of concrete at the different ages of

7,14 and 28 days for curing with normal water were compressive strength of concrete increased at the age of 7 days, 14days were observed and at the age of 28 days compressive strength of concrete decreased when cured in NACL solution. When concrete is cured in NACL solution has better results in compressive strength for 7 days and 14 days than concrete cured in normal water but decreased for 28 days when concrete cured in NACL than concrete cured in normal water. Graph 1 to 5 representation values. The improvement of compressive strength is mostly due to the micro filling ability and pozzolanic activity of SCBA. Smaller particle size of SCBA will fill the micro-voids within the cement. The SCBA due to its pozzolonic activity it is readily reacts with normal water and calcium hydroxide, its a by-product of cement hydration and produces additional calcium silicate hydrate. The additional calcium silicate hydrate increases the compressive strength of concrete because it is a major strength-contributing compound. Also, the additional calcium silicate hydrate reduces the porosity of concrete by filling the capillary pores, and thus improves the microstructure of concrete leading to increased compressive strength.

VI. CONCLUSION

1) Sugar Cane Bagasse Ash (SCBA) Concrete its better in increased in Compressive Strength of Concrete when compared to ordinary concrete when replacement upto 10% of sugar cane bagasse ash with cement weight when cured in normal water.
2) The compressive strength of concrete is studied when replacement of cement with SCBA as 5%, 10%, 15%, 20% and 25% with weight replacement of cement is cured in normal water for 7 days, 14 days and 28 days has shown in graph its increase in strength.
3) The compressive strength of concrete with 5%, 10%, 15%, 20% and 25% with weight replacement of cement with SCBA cured in NaCl solution has shown in graph its increase in strength for 7 days and 14 days and observed decrease at an age of 28 days.
4) Increase of Compressive strength is mainly to presence of high amount of Silica in Sugarcane Bagasse Ash.
5) The Results show in graph that Sugar Cane Bagasse Ash concrete affected more when exposed to chloride attack.
6) Utilization of the waste material from Sugarcane Industry Sugar Cane Bagasse ash can be advantageously useful to replacement of cement in the preparation of concrete even when it is exposed to chloride attack.

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