Study on Utilization of Sugarcane Bagasse Residue in Concrete

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Abstract— Ordinary Portland cement is recognized as a major construction material through our the world. Many researchers all over the world are focusing on utilizing the industrial or agricultural waste material industrial waste such as blast furnace slag fly ash and silica fume are used as replacement of cement and RHA and baggage ash are agricultural waste replaced by cement when agricultural waste is buried under controlled condition that gives good properties like amorphous silica pozzolonic properties etc. Therefore, it is possible use sugar cane baggage ash as cement replacement to improve strength.

Keywords: Sugar Cane, Workability, Compressive Strength, Tensile Strength, Concrete

I. Introduction

Baggage ash is a by-product of sugarcane industry. Baggage is the fibrous matter that remains after extracted their juice form sugar cane. It can also be used to generate electricity. Dry baggage is burnt to produce steam. For every 10 tonnes of sugar cane. Sugar factory produce nearly 3 tonnes of wet baggage. The high moisture content of baggage is 40-50%. The burnt sugarcane baggage leaves the ash which is having properties similar. Cement thus it can be used as the replacement of cement material. It is known that the sugarcane production in world-wide is near about 1500 million tonnes andit produces 30% of baggage, by burning this baggage we get nearly 8% of baggage ash.

Fig. 1: Sugar Cane Bagasse

This huge amount of baggage ash disposal is a serious concern of environment. Thus, many researchers have tested the baggage ash for its use in many fields. From the testing we found that the baggage ash has Pozzolana property which can be an alternative option of cement. The higher content in baggage ash is silica which gives solid reason for using it in mortar and concrete the improve both compressive and tensile strength. The amount of silica presence is depending upon burning conditions and the soil on which the sugarcane was grown.

A. Objectives

1) The objective of using SCBA is to increase the strength of concrete by means ofcompressive strength and tensile strength replacing cement.
2) The use of SCBA will also reduce the cost of construction
3) The disposal problem of baggage is getting resolved.
4) By SCBA we can reduce the use of cement which is harmful due to hydrationproperty.
5) To improve the workability of concrete.

II. Literature Review

We have referred the literature work done by Indian as well as some foreign scholars in the field of using Recycled Aggregates obtained from the demolition of old structures and construction wastes along with Natural Aggregates in the concrete mixture.

A. R.Srinivasan and K.Sathiya:

The utilization of industrial and agricultural waste produced industrial are focusing in reducing the waste by treatment and reuse processes for economical, environmental, and technical reasons. Sugar-cane bagasse is a fibrous waste-product comes out from sugar refining industry with ethanol vapor. Sugar-cane Bagasse ash is causing serious environmental pollution which is difficult to handle. Bagasse ash has the presence of aluminum ion and silica. In this paper, Bagasse ash has been chemically and physically characterized, and partially replaced in the proportions of 0%, 5% and 10% by weight of cement in concrete. Fresh concrete is tested by compaction factor test and slump cone test. The hardened concrete are tests for compressive strength, split tensile strength, flexural strength and modulus of elasticity at the age of seven and 28 days was obtained. The result shows that the strength of concrete increases as percentage of bagasse ash replacement increased.

Apurva Kulkarni et.al 2013: The utilization of industrial and agricultural waste produced industrial are focusing in reducing the waste by treatment and reuse processes for economical, environmental, and technical reasons. Huge quantity of waste ash is available at very negligible cost. In this paper, Bagasse ash can be replaced by fly ash andlime in fly ash bricks. Trial bricks of size were tested with different proportions of 0%, 10%, 20%, 30%, 40%, 50% and 60% with replacement of fly ash and 0%, 5%, 10%, 15%and 20% with replacement of lime. These bricks were tested for Water absorption and Compression test as per Indian Standards. The aim of this research was to make economical bricks and to maintain balanced environment, and also to avoid problems of ash disposal.

Jayminkumar A. Patel and Dr. D. B. Raijiwala 2015: There are so many disadvantages of cement while using it. Cement industry produces CO2 during manufacturing of cement which causes environmental issues to the world. Today researchers are more focusing towards the environment issue globally. Sugar cane bagasse ash generated by sugar mill is creating environment issue because the wastages are dumped in land. In this work sugar cane bagasse ash is replaced by cement by 5%. The cubes were made and compared for M20 and M25 grade of concrete.

III. MATERIALS AND METHODOLOGY

In India, sugarcane is produced in both tropical and subtropical regions. There are three distinct geographical regions in which sugarcane is produced. These are: Satluj-Ganga plain from Punjab to Bihar containing 51% of the total area and 60% of the country's total production. The black soil belt from Maharashtra to Tamil Nadu along the eastern slopes of the Western Ghats. Coastal Andhra Pradesh and Krishna river valley. We note here that sugarcane gets more or less ideal condition for its growth in the tropical regions.The plant needs long hours of sunshine, cool nights with clear skies. Due to this productivity of sugarcane is higher in Maharashtra and Gujarat in comparison to other areas. Flat, plain and level plateau is an advantage for sugarcane cultivation because it facilitates irrigation and transportation of cane to the sugar mills.

A. Sugar Cane Ash

The utilization of industrial and agricultural waste produced by industrial processes has been the focus of waste reduction research for economical, environmental, and technical reasons. Sugar-cane baggage is a fibrous waste-product of the sugar refining industry, along with ethanol vapor. This waste product (Sugar-cane Baggage ash) is already causing serious environmental pollution, which calls for urgent ways of handling the waste. Baggage ash mainly contains aluminum ion and silica.

B. Chemical Composition of Sugarcane Ash

Now a days, it is commonplace to reutilize sugar cane baggage as a biomass fuel in boilers for vapor and power generation in sugar factories. Depending on the incinerating conditions, the resulting sugarcane baggage ash (SCBA) may contain high levels of SiO2and Al2O3, enabling its use as a supplementary cementious material (SCM) in blended cement systems. The chemical composition of sugarcane ash is given below:

COMPONENT	MASS%
SiO_2	78.34
Al_2	8.55
Fe_2O	3.61
CaO	2.15
Na_2O	0.12
K_2O	3.46
MnO	0.13
TiO_2	0.50
BaO	<0.16
P_2O_5	1.07
LOSS OF IGNITION	0.42

C. Cement

Cement is a binder, a substance that sets and hardens and can bind other materials together. The word "cement" traces to the Romans, who used the term opus caementicium to describe masonry resembling modern concrete that was made from crushed rock with burnt lime as binder. The volcanic ash and pulverized brick supplements that were added to the burnt lime, to obtain a hydraulic binder, were later referred to as cementum, cimentum, cement, and cement. The most important uses of cement are as a component in the production of mortar in masonry, and of concrete, a combination of cement and an aggregate to form a strong building material.

D. Portland cement

Portland cement is the most common type of cement in general use around the world, used as a basic ingredient of concrete, mortar, stucco, and most non-specialty grout. It developed from other types of hydraulic lime in England in the mid 19th century and usually originates from limestone. It is a fine powder produced by heating materials in a kiln to form what is called clinker, grinding the clinker, and adding small amounts of other-materials.

E. Aggregate

Construction aggregate, or simply "aggregate", is a broad category of coarse particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geo synthetic aggregates. The presence of aggregate greatly increases the durability of concrete above that of cement, which is a brittle material in its pure state. Thus concrete is a true composite material.

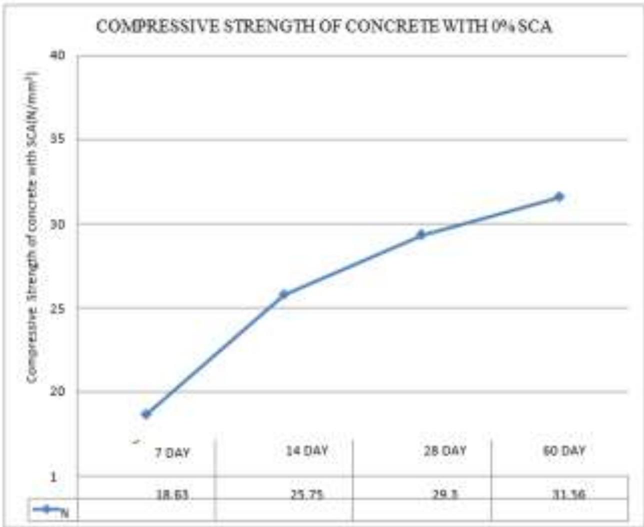
Sources for these basic materials can be grouped into three main areas: Mining of mineralaggregate deposits, including sand, gravel, and stone; use of waste slag from the manufacture of iron and steel; and recycling of concrete, which is itself chiefly manufactured from mineral aggregates.

IV. RESULT AND ANALYSIS

A. Compressive Strength Test:

1) Result Of 0% Replacement Of Cement By SCBA

Sugarcane baggage Ash replaced with 0% of cement increases compressive strength from 18.36 N/mm2 to 31.56 N/mm2 from 7th day to 60th day of curing. Compressive strength from 7th day to 14th day and 28th day increases by 7.12 N/mm2 and 10.67 N/mm2 respectively. And compressive strength increased by 2.26 N/mm2 from 28th to 60th day of curing. from this Graph 1 we get to know that replacing 0% of cement by SCBA gives compressive strength of 31.56 N/mm2 at 60th day of curing.

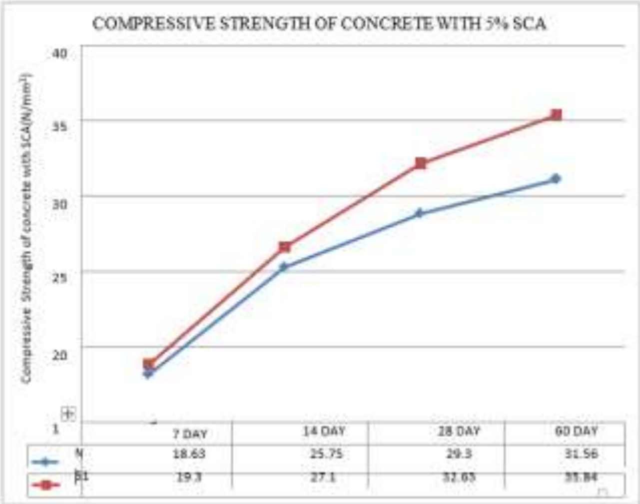


Graph 1: 0% Replacement Of Cement By SCBA

2) Result Of 5% Replacement of Cement By SCBA

Sugarcane baggage Ash replaced with 5% of cement increases compressive strength from 19.30 N/mm2 to 35.84 N/mm2 from 7th day to 60th day of curing. Compressive strength from 7th day to 14th day and 28th day increases by

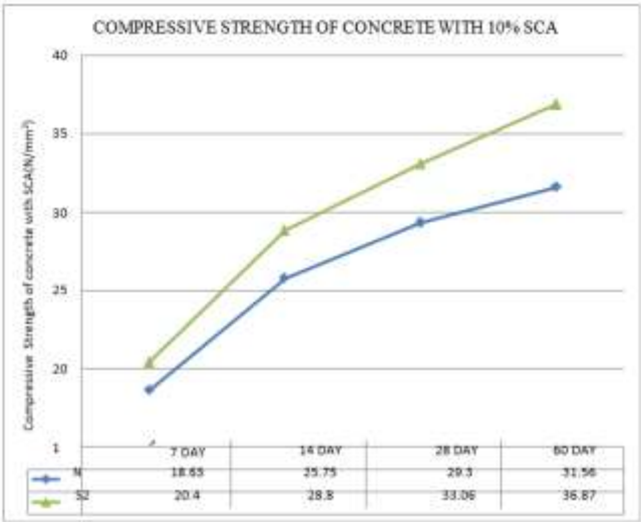
7.8N/mm2 and 13.33N/mm2 respectively. And compressive strength increased by 3.21N/mm2 from 28th to 60th day of curing. from this Graph 2 we get to know that replacing 5% of cement by SCBA gives compressive strength of 35.84N/mm2 at 60th day of curing.



Graph 2: Compressive Strength of Cement replaced by 5% of SCBA

3) Result Of 10% Replacement of Cement By SCBA

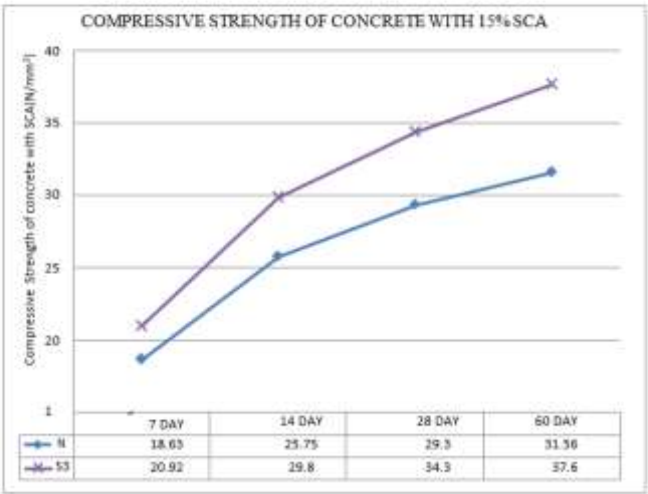
Sugarcane baggage Ash replaced with 10% of cement increases compressive strength from 19.30 N/mm2 to 35.84 N/mm2 from 7th day to 60th day of curing. Compressive strength from 7th day to 14th day and 28th day increases by 7.8N/mm2 and 13.33N/mm2 respectively. And compressive strength increased by 3.21N/mm2 from 28th to 60th day of curing. from this Graph 3 we get to know that replacing 10% of cement by SCBA gives compressive strength of 35.84N/mm2 at 60th day of curing



Graph 3: Compressive Strength of Cement replaced by 10% of SCBA

4) Result Of 15% Replacement Of Cement By SCBA

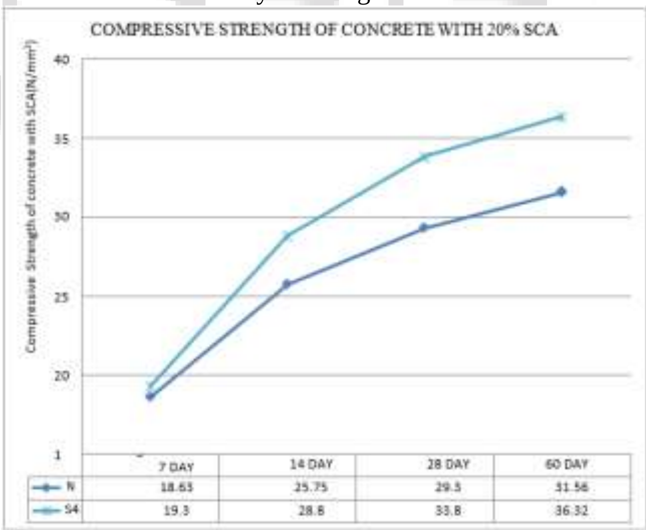
Sugarcane baggage Ash replaced with 15% of cement increases compressive strength from 20.92 N/mm2 to 37.60 N/mm2 from 7th day to 60th day of curing. Compressive strength from 7th day to 14th day and 28th day increases by 8.88N/mm2 and 13.37N/mm2 respectively. And compressive strength increased by 3.3N/mm2 from 28th to 60th day of curing. from this Graph 4, we get to know that replacing 15% of cement by SCBA gives compressive strength of 37.6N/mm2 at 60th day of curing.



Graph 4: Compressive Strength of Cement replaced by 15% of SCBA

5) Result Of 20% Replacement Of Cement By SCBA

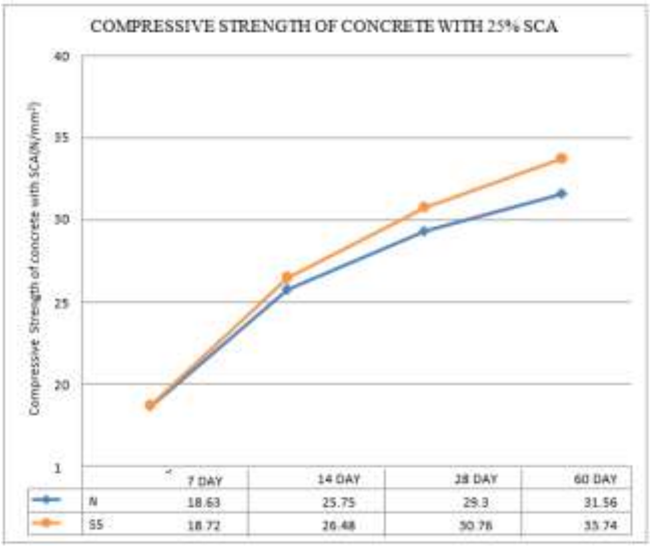
Sugarcane baggage Ash replaced with 20% of cement increases compressive strength from 19.30 N/mm2 to 36.32 N/mm2 from 7th day to 60th day of curing. Compressive strength from 7th day to 14th day and 28th day increases by 9.5N/mm2 and 14.50N/mm2 respectively. And compressive strength increased by 2.52N/mm2 from 28th to 60th day of curing. from this Graph 5, we get to know that replacing 20% of cement by SCBA gives compressive strength of 36.32N/mm2 at 60th day of curing.



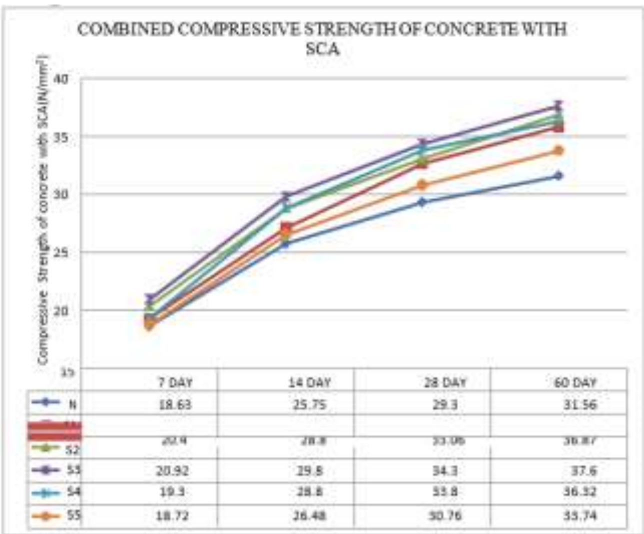
Graph 5: Compressive Strength of Cement replaced by 20% of SCBA

6) Result Of 25% Replacement Of Cement By SCBA

Sugarcane baggage Ash replaced with 25% of cement increases compressive strength from 18.72 N/mm2 to 33.74 N/mm2 from 7th day to 60th day of curing. Compressive strength from 7th day to 14th day and 28th day increases by 8.36N/mm2 and 12.64N/mm2 respectively. And compressive strength increased by 3.00N/mm2 from 28thto 60th day of curing. from this Graph 6, we get to know that replacing 20% of cement by SCBA gives compressive strength of 33.74N/mm2 at 60th day of curing.



Graph 6: Compressive Strength of Cement replaced by 25% of SCBA



Graph 7: Combined Compressive Strength of Cement replaced by SCBA

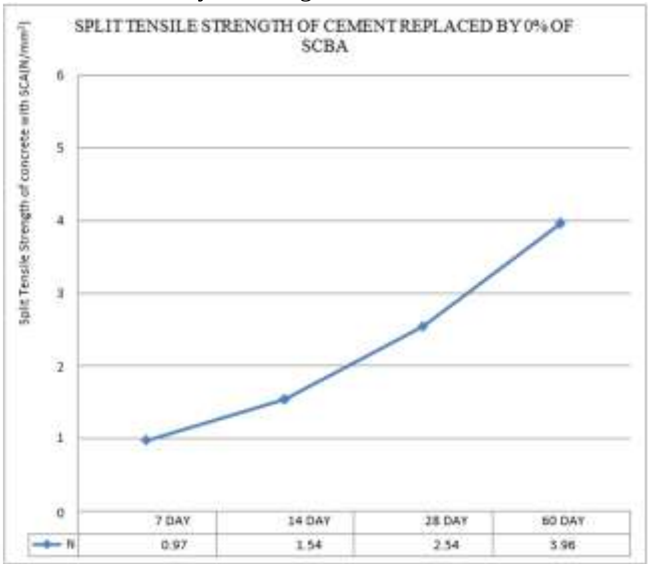
The combined Graph 7, compressive strength of various proportions by replacing cement with sugarcane baggage ash. The baggages are collected from near shops and burnt, the ash has been collected and sieved for using as a replacement of cement because it is having Pozzolana property. The proportions of SCBA replaced cement are taken as 0%, 5% 10%, 15%, 20% and 25%. and compressive test is 31.56 N/mm2, 35.84 N/mm2, 36.87 N/mm2, 37.60 N/mm2, 36.32 N/mm2 and 33.74 N/mm2 on 60th day respectively. The compressive strength of concrete using SCBA increases upto use of 15% replacement of cement and after 15% that is 20% and 25% strength of concrete deduces. The maximum result is by replacing 15% of cement by SCBA is20.92 N/mm2, 29.80 N/mm2, 34.30 N/mm2 and 37.60 N/mm2 on 7th, 14th, 28th and 60th day of curing.

B. Split Tensile Strength Test:

The results show that the Split Tensile strength at 60 days increased with the replacement of 15 percent cement with SCBA. This is due to the higher specific area of the SCBA which accelerated the pozzolanic reaction.

1) Split Tensile Strength of concrete with 0% of SCBA

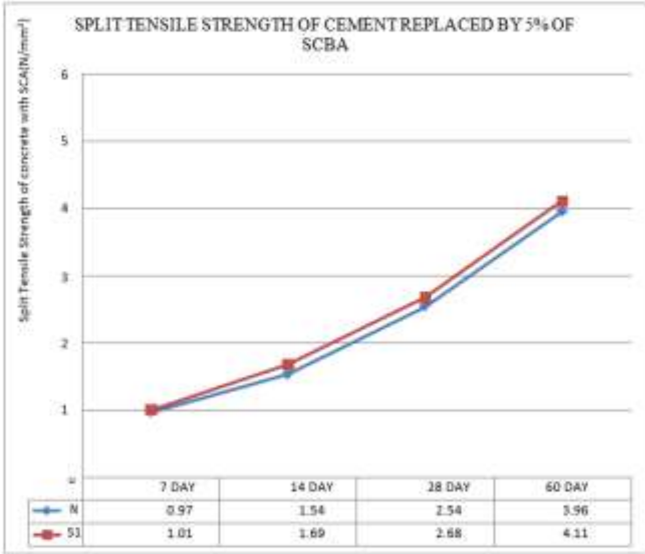
Sugarcane baggage Ash replaced with 0% of cement increases Split Tensile Strength from 0.97N/mm2 to 3.96 N/mm2 from 7th day to 60th day of curing. Split Tensile Strength from 7th day to 14th day and 28th day increases by 0.57 N/mm2 and 1.57 N/mm2 respectively. And tensile strength increased by 1.42N/mm2 from 28th to 60th dayof curing. from this Graph 8, we get to know that replacing 0% of cement by SCBA gives Split Tensile Strength of 3.96 N/mm2 at 60th day of curing.



Graph 8: Split Tensile Strength of concrete with 0% of SCBA

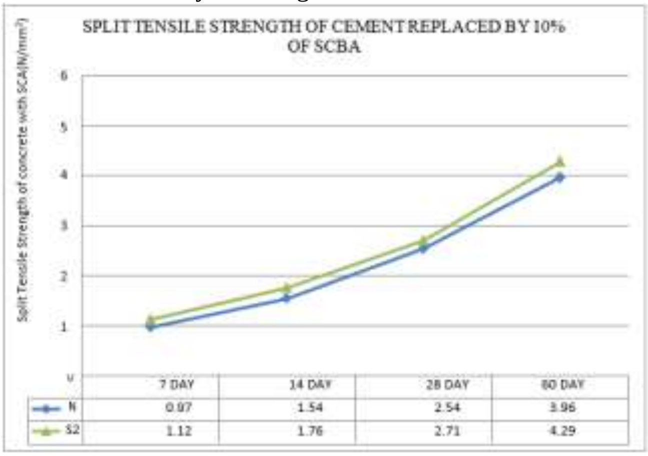
2) Split Tensile Strength of concrete with 5% of SCBA

Sugarcane baggage Ash replaced with 5% of cement increases Split Tensile Strength from 1.01N/mm2 to 4.11 N/mm2 from 7th day to 60th day of curing. Split Tensile Strength from 7th day to 14th day and 28th day increases by 0.66 N/mm2 and 1.67 N/mm2 respectively. And tensile strength increased by 1.43N/mm2 from 28th to 60th dayof curing. from this Graph 9, we get to know that replacing 5% of cement by SCBA gives Split Tensile Strength of 4.11N/mm2 at 60th day of curing.



Graph 9. Split Tensile Strength of Cement replaced by 5% of SCBA

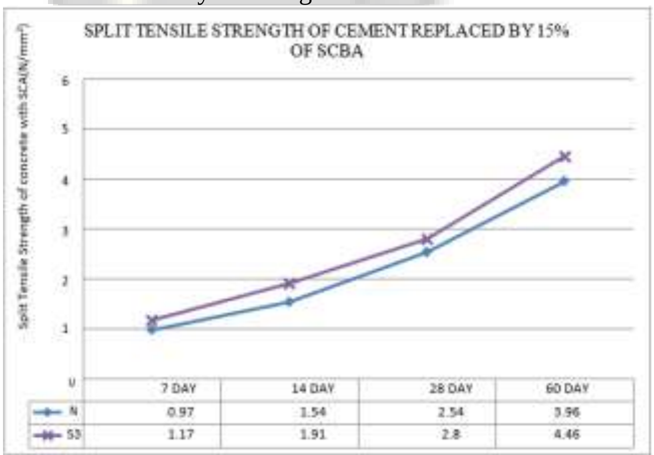
Sugarcane baggage Ash replaced with 10% of cement increases Split Tensile Strength from 1.12N/mm2 to 4.29 N/mm2 from 7th day to 60th day of curing. Split Tensile Strength from 7th day to 14th day and 28th day increases by 0.64 N/mm2 and 1.59 N/mm2 respectively. And tensile strength increased by 1.58N/mm2 from 28th to 60th dayof curing. from this Graph 10, we get to know that replacing 10% of cement by SCBA gives Split Tensile Strength of 4.29 N/mm2 at 60th day of curing.



Graph 10: Split Tensile Strength of Cement replaced by 10% of SCBA

3) Split Tensile Strength of concrete with 15% of SCBA

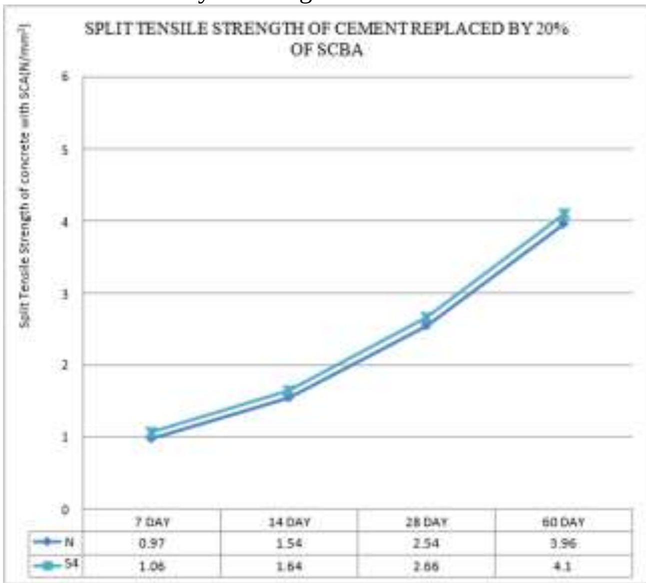
Sugarcane baggage Ash replaced with 15% of cement increases Split Tensile Strength from 1.17N/mm2 to 4.46 N/mm2 from 7th day to 60th day of curing. Split Tensile Strength from 7th day to 14th day and 28th day increases by 0.74 N/mm2 and 1.25 N/mm2 respectively. And tensile strength increased by 2.04N/mm2 from 28th to 60th dayof curing. from this Graph 11, we get to know that replacing 15% of cement by SCBA gives Split Tensile Strength of 4.46 N/mm2 at 60th day of curing.



Graph 11: Split Tensile Strength of Cement replaced by 15% of SCBA

4) Split Tensile Strength of concrete with 20% of SCBA

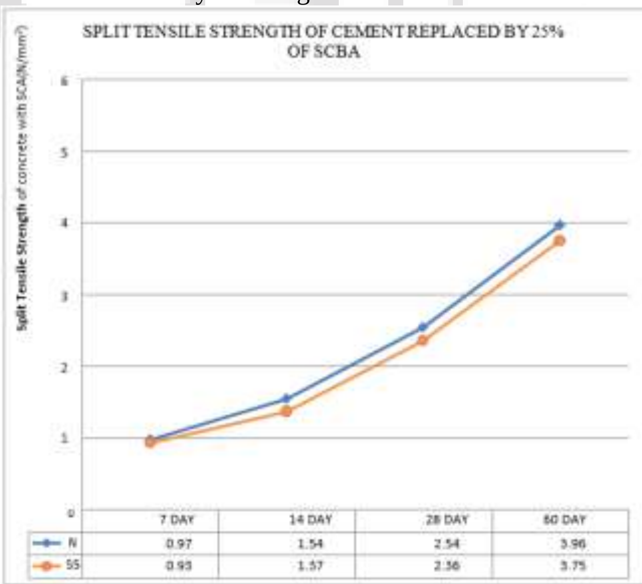
Sugarcane baggage Ash replaced with 20% of cement increases Split Tensile Strength from 1.06 N/mm2 to 4.10 N/mm2 from 7th day to 60th day of curing. Split Tensile Strength from 7th day to 14th day and 28th day increases by 0.35 N/mm2 and 0.73 N/mm2 respectively. And tensile strength increased by 2.31N/mm2 from 28th to 60th dayof curing. from this Graph 12, we get to know that replacing 20% of cement by SCBA gives Split Tensile Strength of 4.10 N/mm2 at 60th day of curing.



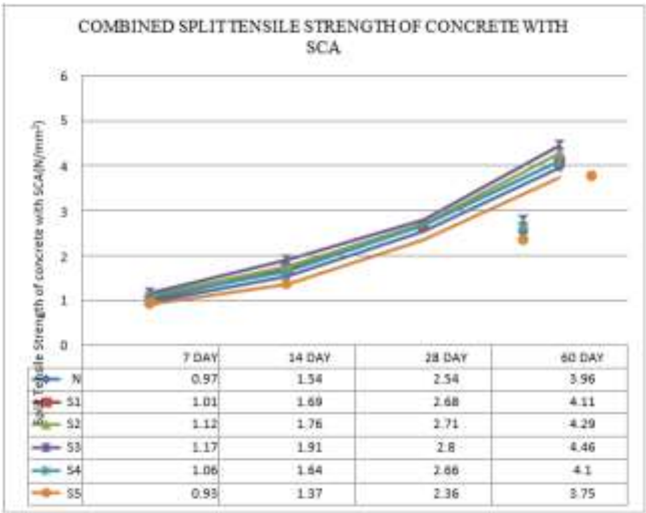
Graph 12: Split Tensile Strength of Cement replaced by 20% of SCBA

5) Split Tensile Strength of concrete with 25% of SCBA

Sugarcane baggage Ash replaced with 25% of cement increases Split Tensile Strength from 0.93 N/mm2 to 3.75 N/mm2 from 7th day to 60th day of curing. Split Tensile Strength from 7th day to 14th day and 28th day increases by 0.21 N/mm2 and 0.8 N/mm2 respectively. And tensile strength increased by 2.34N/mm2 from 28th to 60th day of curing. from this Graph 13, we get to know that replacing 25% of cement by SCBA givesSplit Tensile Strength of 3.75 N/mm2 at 60th day of curing.



Graph 13: Split Tensile Strength of Cement replaced by 25% of SCBA



Graph 14: Combined Split Tensile Strength of Cement replaced by SCBA

Graph 14 shows that the result of the Split Tensile strength of concrete cubes shows variation of Tensile strength of concrete with respect to SCBA replacement is 3.96 N/mm^2, $4.11N/mm^2$, $4.29N/mm^2$, 4.46N/mm2, $4.10N/mm^2$ and 3.75N/mm2 for 0%, 5%, 10%, 15%, 20% and 25% respectively on the age of 60th day. However, the Tensile strength increased as the no. of days of curing increased for each percentage S.C.A. replacement. The maximum tensile strength is in 15% replacement of cement by SCBA. The Split Tensile Strength of 15% replaced concrete with SCBA is 1.17 N/mm2, 1.91 N/mm2, 2.8 N/mm2 and 4.46 N/mm2 at 7th, 14th, 28th and 60th day of curing.

V. Conclusion

From the experimental results and discussion, the S.C.A. as a binding material in concrete. Also, use of these industrial wastes as cement in concrete can reduce the cost of material in construction, because of their low cost as due to abundant industrial from sugar cane industry waste. Use of S.C.A. can be utilized in rural areas and may also in the place where the conventional aggregates are costly and strength requirement is low.

S.C.A. concrete is also classifieds as structural lightweight concrete but it is less durable than normal concrete. Hence this type of light weight concrete is to be used where strength is not of much importance e.g. gardens, embankments, rural roads, etc.

A. Based On Experiments And Test Results On Fresh and Hardened Concrete The Following Conclusions Are Drawn:

1) Due to addition of S.C.B.A. it is observed that early strength gain is slightly increasing with addition of 05%, 10% and 15% S.C.B.A. when compared with normal concrete at 28thdays and 60th day.
2) As we take S.C.B.A. by varying percentage 0%, 5%, 10%, 15%, 20% and 25%, we find Compressive strength is 31.56N/mm2, 35.84N/mm2, 36.87N/mm2, 37.6N/mm2, 36.32N/mm2 and 33.74N/mm2 respectively on 60th day. It means that Compressive strengths of concrete increases up to 15% replacement of cement by S.C.A. Thereafter if replacement is more than 15% strength of concrete reduces.
3) As we take S.C.B.A. by varying percentage 0%, 5%, 10%, 15%, 20% and 25%, we find tensile strength is 3.96N/mm2, 4.11N/mm2, 4.29 N/mm2, 4.46 N/mm2, 4.1 N/mm2 and 3.75N/mm2 respectively on 60th day. It means that tensile strengths of concrete increases. Up to 15% replacement of cement by S.C.A. Thereafter if replacement is more than 15% strength of concrete reduces.
4) Thus S.C.B.A. are abundantly available in Utter Pradesh, there it can be considered as a low cost material.
5) Environmental problem of disposal is getting sorted out by reusing the wastage in a better way.

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