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STRENGTH AND DURABILITY PROPERTIES OF CONCRETE USING BAGASSE ASH AND FIBRE

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Abstract: We are aware that manufacturing of cement causes lots of damagesto our environment. It emits carbon compounds and other chemicals. The researches have shown that one ton of cement manufacture releases half ton of carbon dioxide, so there is a need to control the usage of cement. On the hand material wastes such as Sugarcane Bagasse Ash and fibre is difficult to dispose which is hazardours to environment. The Bagasse ash and fibre imparts high early strength to concrete and also reduce the permeability of concrete.The Silica present in the Bagasse ash reacts with components of cement during hydration and imparts additional properties such as chloride resistance, corrosion resistance etc. Therefore, the use enhances the properties ofconcrete and also reduces the cost and makes the concrete more durable.This paper mainly deals with the replacement of cement with Bagasse ash and fibre in fixed proportions and analyzing the effect of HCI on SCBA blended concrete. The concrete mix designed by varying the proportions of Bagasse ash for (5%, 10% and 15%) and Bagasse fibre for (0.5% and 1.0%) the cubes are been casted and cured in normal water and 5% HCL solution for ages of 7, 14 and 28 days. The test result indicates that the strength of concrete increases upto 10% Sugar cane bagasse ash and 1.0% Sugar cane ash replacementwith cement.The natural, bio-degradable features and chemical constituents of the sugarcane bagasse (SCB) have been attracting attention as a highly potential and versatile ingredient in composite materials. Various components of SCB is shown to possess the ability of being applied as raw material for manufacturing of composite materials at multiple levels of properties and performances.

Index Terms -Sugar Cane Bagasse (SCB), Fine Aggregate (FA), Coarse Aggregate (CA), Compressive Strength, Split Tensile Strength, Flexural Strength, Durability.

I. INTRODUCTION

As apart of the cement replaced with pozzolan materials like bagasse ash,bagasse fibre, fly ash, rice husk ash, geopolymer concrete, rice straw debris etc., were used to reduce the environmental impact of CO_2 emission.In the past few years, many research and modifications has been done to produce concrete which has the desired characteristics. There is always a search for concrete with higher strength and durability. Particularly mineral admixtures are indispensable in production of high strength concrete for practical application. The useof mineral admixtures as a pozzolana has increased worldwide attention over the recent years because when properly used it as certain percent, it can enhance various properties of concrete both in the fresh as well as in hardened states like cohesiveness, strength, permeability and durability. The best mineral admixtures in optimumproportions mixed with OPC improves qualities of concrete such as lowers the heat of hydration, increases the water tightness, reduces alkali-aggregate reaction, improves workability and resistance to attack by sulphate soils, sea water. Sugarcane bagasse ash and fibre contains the properties of high silica, alumina, iron and alkalis and it also provides good results on concrete as a cement replacement.

The majority of the components in raw bagasse debris are SiO_2(60– 75%), CaO, K_2O, and other minor oxides like Al_2O_3, Fe_2O_3, andSO_3. The measure of silica present in the lingering remains is straightforwardly identified with the consuming temperature of bagasse in the kettle. Because of the presence of unburned particles, the misfortune on the start of crude bagasse is accounted for to be higher than as far as possible in the norm for use as pozzolanic material. Numerous wayswere proposed to expand the consistency of the business to the interestof reasonable turn of events. Expanded utilization of advantageous cementitious materials, expanded dependence on reused materials, and improved mechanical properties.

The water consistency and setting time of the mixed concretes expanded with the expansion of sugarcane bagasse ash in light of weakening impact. Water prerequisite of the bagasse debris mixed blend was more than the control blend because of the presenceof huge stringy particles. Compressive strength, water assimilation, and chloride dissemination in cement were examined. Tests with sugarcane bagasse ash had better execution contrasted with control examples. The greater part of the past exploration concentrates straight forwardly handled bagasse debris to solidify fineness and utilized as mineral admixture in cement.

Due to their renewability, high strength and stiffness, as wellas environmental friendliness. Advancements in industrial biotechnology provide ample opportunities for economic utilization of cellulosic agro-residues such as sugarcane bagasse. Sugarcane bagasse (SCB) is an abundant fibrous waste of the sugarcane industry and it is normally used for animal feed, enzymes, paper and biofuel conversion application. Due to its high cellulose content (40–50%), SCB is a good source of cellulose fibre for the synthesis of cellulose nanocrystals.

The use of bagasse debris in concrete successfully serves to ration the regular assets and brings down concrete utilization. Increased waste utilisation through the use of sugarcane bagasse trashis required to lessen the rising cost of materials, notably concrete, forthe building of concrete and empty considerable squares. Thus the replacement of waste or remains in concrete for the substitution of concrete or total would prompt expansion in carbon credits.

II. OBJECTIVE

1.The current study's goal is to mix-design M30 grade of concrete and identifies its necessary components.

2.To investigate the behaviour of concrete with bagasse ashand fibre.

3.To examine the mechanical and durability properties of theConcrete with and without bagasse ash and bagasse fibre.

III. MATERIAL PROPERTIES

3.1 Cement

The cement utilised in this study was Ordinary Portland Cement (OPC) 53 grade, which complies with IS 12269-2013. Specific gravity, setting time, fineness, compressive strength, loss onfire, and insoluble residue tests were performed. The results are tabulated in table 1 as per confirming to Indian Standards (IS12269- 2013).

Table -1: Physical properties of cement

SNo	Tests	Values obtained
1	Specific gravity	3.15
2	Normal Consistency	34.0%
3	Initial Setting Time	65mins
4	Final Setting Time	475mins
5	Fineness	270 $m^{2/}$/kg

3.2 Coarse Aggregate

Locally-purchased fine aggregate that complied with Indian Standard Specifications IS: 383-2016 to Zone II was employed in the experimental programme. Zone II is where the fine aggregate is located. The specific gravity of fine aggregate was found to be 2.6.

3.3 Fine Aggregate

The stones were crushed to produce coarse aggregate, whichwas then passed through a 20 mm screen to meet IS 383 -2016. An experiment carried out in accordance with IS 2386 (Part III) determined the specific gravity to be 2.7. According to IS 2386 (Part IV), the crushing value, impact value, and abrasion of coarse aggregate were evaluated. The test results showed that the aggregate was of extremely high quality, and the same was used for research. The test findings for crushing value were 27, impact value was 22, and Los Angeles abrasion value was 28.

3.4 Water

Water is essentially the required constituent material of concrete for the purpose of chemical reaction with cement and also togive required workability for the fresh concrete. Water available locally is drinking water and conforms to IS 456-2000. This water wasused to produce concrete and for the curing of concrete specimens.

3.5 Sugarcane Bagasse Ash and Fibre

Bagasse Ash's characteristics are displayed in Table 2 and 3. In this investigation, bagasse fibre with aspect ratios of 50 and 75 was employed.

Table - 2: Physical properties of Sugarcane bagasse ash

SNo	Tests	Mass %
1	Density(g/cm^3)	2.52
2	Surface area(cm^2/gm)	5140
3	Particle size (µm)	28.9
4	Colour	Grey

Table - 3: Chemical properties of Sugarcane bagasse ash

SNo	Tests	Mass %
1	Alumina (Al_2O_3)	29.18
2	Ferric oxide ($Fe_2 O_3$)	29.16
3	Calcium oxide (CaO)	1.91
4	Magnesium oxide (MgO)	0.82
5	Sulphur tri oxide (SO_3)	0.55
6	Loss of Ignition	0.71
7	Chloride	-

3.6 Hydrochloric Acid

Table 4: Physical properties of Hydrochloric acid

Molecular formula	HCl in water(H2O)
Molar mass	35.47 g/mol
Appearance	Clear colourless to light yellow liquid
Density	1.8g/cm^3
Melting point	27.32^{0}c
Boiling point	110^{0}c
Solubility in water	Miscible
Acidity	(pka)-8.1
Viscosity	1.9mpa at 25^{0}c

3.7 Sodium Sulphate

Table 5: Physical properties of Sodium Sulphate

Molecular formula	Na2SO4 in water(H2O)
Molar mass	142.04g/mol (anhydrous)
Appearance	White Crystalline Solid
Density	2.66g/cm^3
Melting point	884^{0}c(anhydrous)
Boiling point	1429^{0}c(anhydrous)
Solubility in water	Soluble in water , glycerol
Refractive index	1.468(anhydrous)

IV. Preparation of Mix

Mix design was made to produce M30 concrete. Fine aggregate, coarse aggregate and water were same to produce control concrete and bagasse ash concrete containing bagasse fibre.. The mix design proportion for M30 grade of concrete in Table 6.

Table 6: Proportion for M30 grade concrete

	Cement	w/c ratio	FA	CA
Ratio	1	0.40	1.44	2.55
Ingredients of concrete (kg/m³)	450	180	648	1148

V. Results and Discussions

Sixty three cubes of size and Twenty one cylinders and flexural beams of size served as the control specimens for the mechanical and durability characteristics of concrete. Out of seventeen batch specimen, one batch specimen was considered as a control concrete, three set of three batch specimens with bagasse ash(5, 10, and 15%) addition to bagasse fibre (0.5 and 1%).

5.1 Tests on Hardened Concrete

5.1.1 Compressive Strength

The test findings for control concrete and bagasse ash concretecontaining bagasse fibre are displayed in Table 7.

Table 7: Compressive strength at Different Ages

S.No	Specimen Designation	Compressive Strength (N/mm^2)		
		7 days	14 days	28 days
1	CB	23.94	30.52	35.04
2	B10F1.0	29.15	37.48	43.64

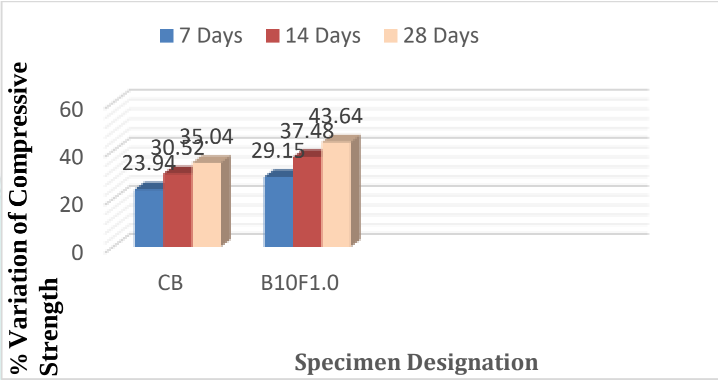

Fig 1: Percentage variation of Compressive Strength at Different ages of Curing

The strength of concrete made with 10% bagasse ash and 1%volume fraction bagasse fibre is increased by 24.54% compared to control concrete.

5.1.2 Split Tensile Strength

The test findings for control concrete and bagasse ash concrete containing bagasse fibre are displayed in Table 8. Figure 2 displays the percentage variance in split tensile strength at 28 Days.

Table 8: Split Tensile strength at 28 Days

S.No	Specimen Designation	Split Tensile Strength (N/mm^2)
1	CB	3.36
2	B10F1.0	4.46

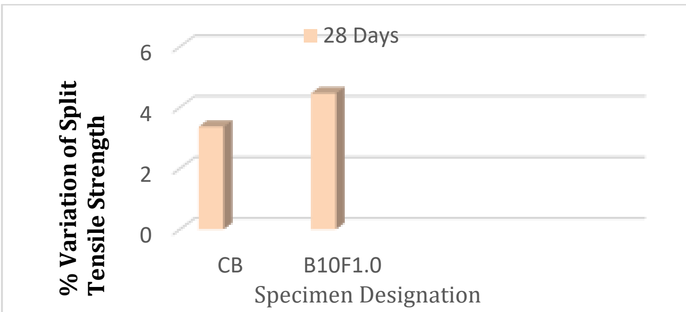

Fig 2: Percentage variation of Split Tensile Strength at 28 Days

According to the results, the split tensile strength of bagasse ash concrete with bagasse fibre, the strength concrete made with 10% of bagasse ash concrete with 1.0% of volume fraction bagasse fibre gives 32.73% increases the strength from the control concrete.

5.1.3 Flexural Strength

The test findings for control concrete and bagasse ash concrete containing bagasse fibre are displayed in Table 9. Figure 3 displays the percentage variance in flexural strength at 28 Days.

Table 9**:** Flexural strength at 28 Days

S.No	**Specimen Designation**	**Split Tensile Strength (N/mm^2)**
1	CB	13.85
2	B10F1.0	17.70

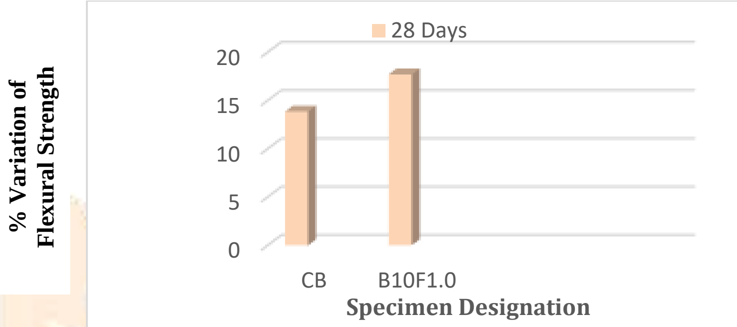

Fig 3: Percentage variation of Flexural Strength at 28 Days

According to the results, the Flexural strength of bagasse ashconcrete with bagasse fibre, the strength concrete made with 10% of bagasse ash concrete with 1.0% of volume fraction bagasse fibre gives 27.79% increases the flexural strength from the control concrete.

5.2 Durable Properties

5.2.1 Acid Test

The test findings for control concrete and bagasse ash concrete containing bagasse fibre are displayed in Table 10.

Table 10: Acid Test Results on Specimens

S.No	**Specimen Designation**	**Initial Cube Weight, kg**	**Cube weight at 90 days, kg**	**% Weight loss**	**Residual Compressive Strength, N/mm^2**
1	CB	8.41	8.30	1.28	28.70
2	B10F1.0	8.22	8.13	1.12	36.62

From the test results, the control specimen weight loss of 1.28% of the specimen. The 5% ratio of bagasse ash with different volume fraction (0.5 and 1%) weight loss in the range of 1.00 to 1.06% of the specimen. The 10% ratio of bagasse ash with different volume fraction (0.5 and 1%) weight loss in the range of 1.09 to 1.12% of the specimen. The 15% ratio of bagasse ash with different volume fraction (0.5 and 1%) weight loss in the range of 1.10 to 1.12% of the specimen.

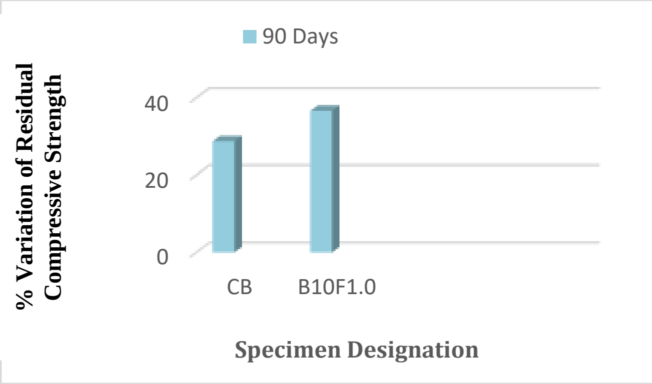

Fig 4: Percentage Variation of Residual Compressive Strength

In comparison to control concrete, 10% ratio of bagasse ash with various volume fraction (0.5 and 1%) ratio in the range of 22.96 to 27.59 %.

5.2.2 Sulphate Attack Test

The test results on sulphate attack on specimens are displayed in table 11

Table 11: Sulphate Attack Test Results on Specimens

S.No	Specimen Designation	Initial Cube Weight, kg	Cube weight at 90 days, kg	% Weight loss	Residual Compressive Strength, N/mm^2
1	CB	8.40	8.35	0.60	32.50
2	B10F1.0	8.24	8.19	0.60	40.84

From the test results, the control specimen weight loss of 0.62% of the specimen. The 5, 10 and 15% ratio of bagasse ash with different volume fraction (0.5 & 1%) weight loss in the range of 0.85 to 0.48, 0.36 to 0.60 and 0.25 to 0.62%of the specimen respectively compared with the control concrete.

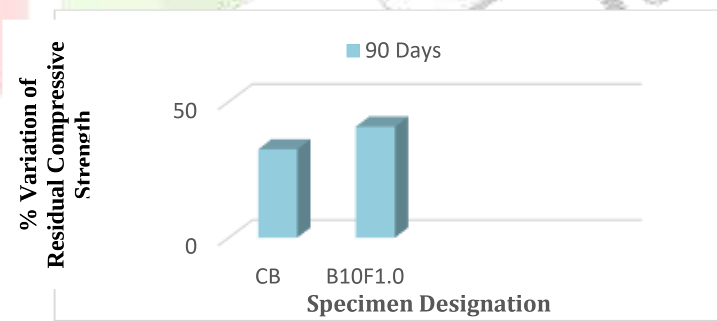

Fig 5: Percentage Variation of Residual Compressive Strength

According to the test results,a 5, 10 and 15% ratio of bagasse ash with varied volume fractions (0.5 and 1%) increased residual compressive strength in the range of 18.03 to 18.98, 19.78 to 25.66 and 15.41 to 21.84% respectively compared with the control concrete.

5.2.3 Fire Resistance Test

The test results on sulphate attack on specimens are displayed in table 12

Table 12: Fire Resistance Test Results on Specimens

S.No	Specimen	Initial	28days Cube Weight, kg	Residu

	Designation	Cube Weight, kg	1hr fire	2hr fire	3hr fire	al Compressive Strength, N/mm²
1	CB	2.55	2.52	2.49	2.44	33.45
2	B10F1.0	2.44	2.40	2.38	2.34	39.60

After the test results, the control specimen weight loss of 1.06 to 4.08% of the specimen. The 5, 10 and 15% ratios of bagasse ash with different volume fractions (0.5 and 1%) weight loss in the range of 3.23 to 3.27, 3.71 to 4.09 and 5.02 to 5.04% respectively.

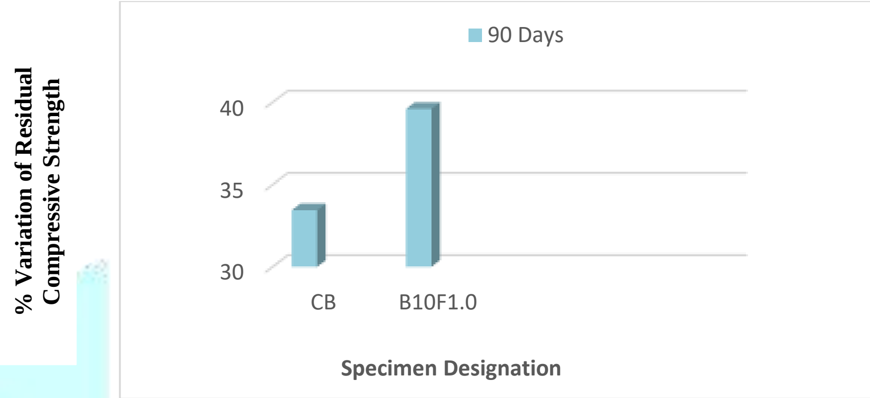

Fig 6:Percentage Variation of Residual CompressiveStrength

The residual compressive strength percentage change during thefire resistance test is shown in Figure 6. The 5, 10 and 15% ratio of bagasse ash with varied volume fractions (0.5 and 1%) increased in the range of 11.80 to 13.60, 12.70 to 18.38 and 8.22 to 13.30% respectively.

VI. Conclusion

1. Sugarcane bagasse ash and fibre concrete performed better when compared to ordinary concrete up to 10% replacement of bagasse ash concrete with 1.0% of volume fraction bagasse fibre.
2. Increase of strength is mainly to presence of high amount of silica in sugarcane bagasse ash. It also enhances the properties.
3. It makes the concrete more durable. Sugarcane bagasse ash and fibre added to the mixes rate in cement reduced. Bagasse ash and fibre in concrete reduces the environmental pollution.
4. The compressive strength increases gradually from 40.33 N/mm^2 to 43.64 N/mm^2 for the cement replacement of 10% of bagasse ash concrete with 1.0% of volume fraction bagasse fibre at the age of 28 days.
5. The Split tensile strength increases gradually from 3.98 N/mm^2 to 4.46 N/mm^2 for the cement replacement of 10% of bagasse ash concrete with 1.0% of volume fraction bagasse fibre at the age of 28 days.
6. The Flexural strength increases gradually from 14.44 N/mm^2 to17.70 N/mm^2 for the cement replacement of 10% of bagasse ash concrete with 1.0% of volume fraction bagasse fibre at the age of 28 days.
7. An evaluation of the durability properties of bagasse ashconcrete with bagasse fibre shows immense response on acid test, sulphate attack test and fire resistance test. From these results, the 10% of bagasse ash with 1% of bagasse fibre concrete on residual compressivestrength increases 27.59% on acid attack test, 25.66% on sulphate attacktest, 18.38% on fire resistance test when compared with the control concrete.

REFERENCES

[1] Amin MN, Ashraf M, Kumar R, Khan K, Saqib D, Ali SS and Khan S, 2020, Role of Sugarcane Bagasse Ash in Developing Sustainable Engineered Cementitious Composites. Front. Mater. 7:65.doi:10.3389/fmats.2020.00065.

[2] Berenguer, R. N. Lima, A. C. Valdes, M. H. F. Medeiros, N. B. D.Lima, J. M. P. Q. Delgado, F. A. N. Silva, A. C. Azevedo, A. S.Guimaraes, B. Rangel, 2020, Durability of Concrete Structures with Sugar Cane Bagasse Ash, Advances in Materials Science and Engineering, Article ID 6907834, 16 pages, 2020.

[3] Chylinski, F.; Michalik, A.; Kozicki, M., 2022, Effectiveness of Curing Compounds for Concrete, Materials, 15, 2699. https://doi.org/10.3390/ma15072699.

[4] Jagadesh, P., Ramachandramurthy, A. & Murugesan, R, 2018, Overview on Properties of sugarcane bagasse ash as Pozzolan, Indian Journal of Geo Marine Science, 47(10), pp. 1934-1945.

[5] Khaliq,W and Ehsan, M.B, 2016, Crack healing in concrete using various bio influenced self-healing techniques, vol. 102, pp. 349–357,2016.

[6] Sajjad Ali Mangi, N Jamaluddin, M H Wan Ibrahim, Abd Halid Abdullah, A S M Abdul Awal, Samiullah Sohu and Nizakat Ali, 2017, Utilization of sugarcane bagasse ash in concrete as partial replacement of cement, IOP Conf. Ser.: Mater. Sci. Eng. 271 012001

[7] Seyed Alireza Zareei, Farshad Ameri & Nasrollah Bahrami, 2018,Microstructure, Strength and durability of eco-friendly concretes containing sugarcane BA, Construction and Building Materials, vol. 184, pp. 258-268.

[8] Wang, J, Ersan, Y. C, Boon, N and De Belie, N, 2016, Application of microorganisms in concrete : a promising sustainable strategy to improve concrete durability, pp. 2993–3007, 2016.

[9] IS 456 (2000) Code of Practice for Plain and Reinforced Concrete, (4 th revision), *Bureau of Indian Standards*, New Delhi.

[10] IS 383 (1987) Specification for Coarse and Fine Aggregate from Natural sources for concrete, (8th Reprint October 1991), *Bureau of Indian Standards*, New Delhi.

[11] IS 516 (1975). Methods of Tests for Strength of Concrete, *Bureau of Indian Standards*, New Delhi. IS 2386 (Part 3) (1963). Methods of testing for Aggregates for concrete, Specific Gravity, Density, Absorption, and Organic Impurities, *Bureau of Indian Standards*, New Delhi.

[12] IS 2386 (Part 3) (1963). Methods of testing for Aggregates for concrete, Specific Gravity, Density, Absorption, and Organic Impurities, *Bureau of Indian Standards*, New Delhi.