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An Experimental Study on Partialreplacement of Cement in Concrete with Sugarcane Bagasse Ash

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Abstract: *- The country is developing day by day and infrastructure play a very vital role in the development of country. As we know concrete is a main constituent of construction material and play major role in the safety of infrastructure.*
In the concrete Portland cement is used as a main ingredient. Therefore more use of Portland cement impact very badly on environment. So researcher focused on utilizing agriculture and industrial waste as a substituent of Portland cement. Many industrial wastes like blast furnace slag, fly ash and silica fume are used as a substituent cement material.
But nowadays agriculture waste is also a very big issue in our country so researcher looks into this matter and utilizing the sugar cane baggage ash as a cement material to reduce the load on cement and also minimize the pollution.
This paper contains preparation of sugarcane baggage ash as a replacement in cement with a percentage replacement of 5% 10% 20% 30% respectively.
Many industrial wastes like blast furnace slag, fly ash and silica fume are used as a substituent cement material. But nowadays agriculture waste is also a very big issue in our country so researcher looks into this matter and utilizing the sugar cane baggage ash as a cement material to reduce the load on cement and also minimize the pollution. The partial replacement of ordinary Portland cement however by agricultural waste or agro-waste has been seen as an alternative solution for decreasing CO2 emission due to less cement consumption for construction industry.
The residue after combustion presents a chemical composition dominates by silica. Sugarcane bagasse (SCB) is that the waste created after juice extraction from sugarcane. The Sugarcane bagasse ash (SCBA) is acquired through the control burning of sugarcane bagasse. The SCB creates the environmental nuisance thanks to direct disposal on the open lands and forms garbage heaps there in area. Besides SCBA, rice husk ash, palm kernel husk ash, fly ash, ground blast-furnace slag and silica fume have pozollonic properties that can be used in partial replacement of cement.
KEYWORDS: *- Portland cement, slag, fly, silica fume, pollution*
CO_2, SCBA, pozollonic

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I. INTRODUCTION

1. In a modern world every country deserves to have development and infrastructure that play vital role in the enhancement. The major used material in the infrastructure development is concrete. It is basically amalgam of aggregate, fine aggregate and ordinary Portland cement as the conventional binding material. In the production of cement affect environment very badly. The production of Ordinary Portland cement has been found to be responsible for about 6%–9% of global carbon (IV) oxide (CO2) emissions and cement industry has also been found to be the second largest CO2 emitting industry after the power generation.It was further found that each tone of cement production produces approximately one tone of CO2 emission. So researchers think about alternatives of cement and used industrial waste as the replacement of cement which

waste has adhesive property like cement. Many industrial wastes like blast furnace slag, fly ash and silica fume are used as a substituent cement material. But nowadays agriculture waste is also a very big issue in our country so researcher looks into this matter and utilizing the sugar cane baggage ash as a cement material to reduce the load on cement and also minimize the pollution.The partial replacement of ordinary

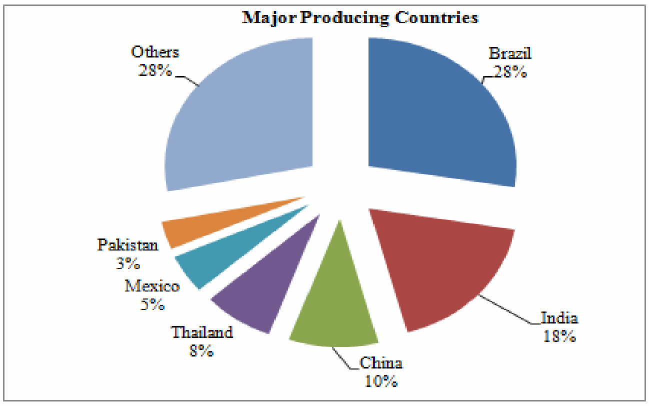
Portland cement however by agricultural waste or agro-waste has been seen as an alternative solution for decreasing CO2 emission due to less cement consumption for construction industry. Sugarcane is cultivated in India since ancient times. It is supposed to be originated from South and South-East Asia. India is that the second largest producer of cane sugar next to Brazil. Bagasse contain the fibrous non-biodegradable material that left over as juice is extracted from sugarcanes and sugar manufacturing industry eliminates out this residuein large quantity during sugar manufacturing process. Bagasse is often used as a fuel by the sugar industry and when leads to burned at high temperatures leads to the generation of sugarcane baggase ash. Many countries generate a big amount of sugarcane bagasse ash as a waste. Sugarcane is staple food crop cultivated in tropical and subtropical countries. It is the main resource for the sugar production. India acquires second rank in production of sugarcane in the world with 381,047,000 Metric Tons of production in a year. The processing of it in sugar-mill generates about 15 million tons of SCBA as a waste. One tone of sugarcane can generate approximate 24% of bagasse and 0.65% of residual ash. The residue after combustion presents a chemical composition dominates by silica. Sugarcane bagasse (SCB) is thatthe waste created after juice extraction from sugarcane. The Sugarcane bagasse ash (SCBA) is acquired through the control burning of sugarcane bagasse. The SCB creates the environmental nuisance thanks to direct disposal on the open lands and forms garbage heaps therein area. Besides SCBA, rice husk ash, palm kernel husk ash, fly ash, ground blastfurnace slag and silica fume have pozollonic properties that can be used in partial replacement of cement. It was investigated the effect of silica fume, fly ash and granulated blast fume on workability, compressive strength, elastic modulus and porosity of high strength concrete. Concrete produced from partial replacement of cement with SCBA has reaction formed by silicate, SiO_2 from SCBA and slaked lime, $Ca(OH)_2$ from cement to form calcium silicate hydrate which is responsible for the compressive strength. The quality of concrete produced from SCBA beyond an optimum quantity of SCBA will leaches out silicate which doesn't contribute to the strength of concrete sugarcane baggasse ash is a natural pozzolanic material rich in silica, alumina and iron oxide.

1.2 Sugarcane Production in India

Sugarcane production in India features a cycle of 2-3 years because the crop once planted usually stays for two years onthe field giving two harvests. The cane area and thereby production is primarily driven by the costs. Nevertheless, the assembly has witnessed a uniform upward movement and reached over 28 million tons in 2018-19 though moderated in the subsequent two
years. Production for the year 2020-21 is estimated at 25.5million tones.

1.3 State-wise production

State wise production indicates that more than 80% of sugar comes from only four states viz., Uttar Pradesh, Maharashtra, Karnataka and Tamil Nadu. Uttar Pradesh has traditionally been cultivating and contributing for 36-40% of total sugarcane produced in the country. Maharashtra has been the third largest producer but itsproduction was doubled since 20018-19 onwards and consequently its share has gone up to nearly 25% in therecent years. The steep jump in the overall sugarcane production in 2020-21 onwards could primarily beattributed to increase in production levels of Maharashtra.



Source: USDA

1.4 OBJECTIVE OF THE STUDY

1. To seek out the effect of partial replacement of sugarcane ash on the strength characteristics of concrete.
2. Four percentage levels of replacement i.e. 5, 10, 15 and 20 percent are considered for partially replacing cement with sugarcane ash. M35 concrete grade is initially designed without replacement and subsequently cement is partially replaced with sugarcane ash.
3. To study the cost benefit analysis.

1.5 SCOPE OF THE WORK

In this thesis present work is to carry out of detailed analysis of concrete using sugarcane baggage ash in following ways.

1. Design M35 grade of concrete mix.
2. Casting of concrete cubes of M35 grade of concrete with different percentages of Sugarcane Baggage Ash (0%, 5%, 10%, 15%, and 20%).
3. Curing of cubes in normal and HCL.

specimen of diameter 45mm and length 90mm were casted and cured for 28 days in water after they were immersed in 1% HCL and 1% H2so4 solutions by maintaining a ph of 5 regurarly. They concluded that self- compacting concrete was performing better than control concrete when exposed to 1% sulphuric acid and hydrochloric acid. They observed that the time taken for 10% mass loss for SCC was 18 weeks and for CC was 6 weeks.

II. LITERATURE REVIEW

1. M. VijayaSekhar Reddy, I.V Ramana Reddy,

Studied the behavior of High Performance Concrete (HPC) which is being the most used type of concrete in the construction industry. They replaced cement with supplementary cementing materials like fly ash, silica fume, and metakaolin. They concluded that there was a considerable increase in service life of the concrete structure and reduction in heat of hydration by using supplementary cementing materials in concrete. They observed the maximum and minimum percentage of reduction in strength of concrete when concrete was replaced with fly ash were 12.64% and 1.92%.

2. P. SrinivasRao .

Studied the durability characteristics of metakaolin blended concrete by adopting M20 Grade of concrete. An attempt was made with H2so4 and HCL. Steel fibres with 60 as aspect ratio at 0%,0.5%,1.0% and 1.5% of volume of concrete are used. They concluded that the percentage weight loss was reduced and compressive strength was increased in the case of fibre reinforced concrete and concrete containing 10% metakaolin replaced by weight of cement when compared to concrete and the percentage weight loss was less when immersed in HCL and H2so4.

3. P. Murthi and V.siva Kumar

Studied the resistance of acid attack of ternary blended concrete by immersing the cubes for 32 Weeks in sulphuric acid and hydrochloric acid solutions. Binary blended concrete was developed using 20% class F fly ash and ternary blended concrete was developed using 20% fly ash and 8% silica fume by weight of cement. They concluded that the ternary blended concrete was performing better that the ordinary plain concrete. They observed that the mass loss for 28 and 90 days of M20 PCC specimens were 19.6% and 16.1% respectively. They also observed that the time taken for reduction of 10% mass loss when immersed in 5% H2SO4 and 5% HCL solutions was 32 weeks.

4. A.K Al- Tamimi and M.sonebi

Studied the properties of self- compacting concrete when immersed in acidic solutions. Workability was obtained using slump cone test, L- box and orimet for SCC mix. Cylindrical

5. Madhusudhan Reddy

Studied the effect of HCL on blended cement and silica fume blended cement and their concretes. Concrete cubes were casted using deionised water with a series pf dosages implanted into water and using only deionized water for comparison. These cubes were tested for determining chloride ion permeability and compressive strength. They concluded that compressive strength reduction of sugarcane ash blended concrete and silica fume blended concrete was 2 to 19% at 28 days and 90 days.

6. UroojMasood

Studied the behavior of mixed fibre reinforced concrete exposed to acids. A mixture 75% glass and 25% steel fibres were used in mixed fibre reinforced concrete and cubes were casted and cured for 30, 60, 90, 120 and 180 days in acids and sodium sulphate. Test specimen were tested for weight loss and denseness of concrete of exposed and unexposed specimen at all the ages and compressive strength at 180 days. They concluded that resistance towards the sulphuric acid attack was maximum when 100% steel fibreswas used when compared to other fibres and without any fibres. Mixed fibre reinforced specimen and 100% steel fibre reinforced specimens exhibited more resistance towards the attack of sulphuric acid.

7. G. Siva Kumar

Studied on preparation of Bio-cement using sugarcane baggasse ash and its Hydration behavior.In this study they had used as partial replacement in ordinary Portland cement (OPC) by 10% weight. Compressive strength of the sample was carried out and reported that the cementious material in sugar cane bagasse ash is responsible for early hydration. The pozzolonic activity of bagasse ash results in formation of more amount of C-S-H gel which result in enhances the strength, and hence bagasse ash is a potential replacement material for cemen

III. MATERIALS USED

3.1GENERAL

The material selected for the analysis of partial replacement of cement with sugarcane bagasse ash includes cement, fine aggregate, coarse aggregate and sugarcane baggasse ash and water. In this chapter we look about the properties of following material.In this chapter discussed about the experimental studies and performed test on cubes on various ways. Also discussed the procedure of experiment done on the cubes for knowing the effect of SCBA on mixing of aggregate.

3.2CEMENT

Ordinary Portland cement of 53 grades from a single batch was used for the entire work and care has been taken that it has to been stored in airtight containers to stop it from being suffering from the atmospheric and monsoon moisture and humidity. The cement procured was tested for physical requirements in accordance with IS: 12269-1987 and for chemical requirements in accordance with IS: 4032-1977.

S.No	Characteristics	Values obtained experimentally	Values specified by IS
1	Specific gravity	3.15	
2	Standard consistency(%)	33	
3	Initial setting time	105(minutes)	30(minutes)
4	Final setting time	430(minutes)	600(minutes)
5	Compressive strength 3 days 7 days 28 days	 25.2 N/mm^2 37.9 N/mm^2 47.8 N/mm^2	 23 N/mm^2(minimum) 33 N/mm^2(minimum) 43 N/mm2(minimum)

3.3SUGARCANE BAGASSE ASH

Sugarcane bagasse consists of approximately 52% of cellulose, 26% of hemicelluloses of ligin. Each ton of sugarcane generates approximately 28% of bagasse (at a moisture content of 52%) and 0.64% 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. Inthis sugarcane bagasse ash was collected during the cleaning operation of a boiler in the sugar factory, located in the town of Meerut, Uttar Pradesh

3.4 Fine Aggregates

The materials smaller than 4.75 mm size is called fine aggregates. The code to be referred to understand the specification for fine aggregates is: IS 383:1970.

The criteria to classify fine aggregates are:

- If they are Natural/ Man-made.
- According to their size.
- According to the IS specification

Fine aggregate may be described more clearly according to their availability as:

• Natural Sand– it is the aggregate resulting from the natural disintegration of rock and which has been deposited by streams or glacial agencies

• Crushed Stone Sand– it is the fine aggregate produced by crushing hard stone. Crushed Gravel Sand– it is the fine aggregate produced by crushing natural gravel. According to size the fine aggregate may be described as coarse sand, medium sand and fine sand.IS specifications classify the fine aggregate into four types according to its grading as fine aggregate of grading Zone-1 to grading Zone-4. The four grading zones become progressively finer from grading Zone-1 to grading Zone-4. 90% to 100% of the fine aggregate passes 4.75 mm

IS sieve and 0 to 15% passes 150 micron IS sieve depending upon its grading zone. In this project Natural sand is used of following properties.

3.1.3 Coarse Aggregates:
Locally available well graded granite aggregates of normal size greater than 4.75 mm and less than 16mm. The code to be referred to understand the specification of the coarse aggregates from natural sources is: IS 383:1970. Coarse aggregate may be further classified as:
• Uncrushed Stone– it results from natural disintegration of rock.
• Crushed Stone– it results from crushing of gravel or hard stone.
• Partially Crushed Stone– it is a product of the blending of the above two aggregate. In this project Crushed stone used as coarse aggregate of following properties

3.1.4 Water
Potable water has been used for casting concrete specimens. The water is free from oils, acids, and alkalis and has a water-soluble Chloride content of 140 mg/lit. As per IS 456 – 2000, the permissible limit for chloride is 500 mg/lit for reinforced concrete; hence the amount of chloride present is very less than the permissible limit.Ph is an important criterion, if the pH value of water is lying between 6 to 8, then this water is free from organic matter. This water can be adopted for construction purposes.

EXPERIMENTAL INVESTIGATIONS
In the present experimental investigation sugar cane bagasse ash has been used as partial replacement of cement in concrete mixes. On replacing cement with different weight percentage
of SCBA the compressive strength is studied at different ages of concrete cured in different environments like normal water and HCL diluted solution. The details of experimental investigations are as follows
3.8 PREPARATION OF TESTING SPECIMEN
3.9 MIXING
Mixing of ingredients is done in pan mixer of capacity 40 liters. The cementations materials are thoroughly blended and then the aggregate is added and mixed followed by gradual addition of
water and mixing. Wet mixing is done until a mixture of uniform color and consistency are achieved which is then ready for casting. Before casting the specimens, workability of the mixes
was found by compaction factor test.
3.10 PREPARATION OF SPECIMENS
The cast iron moulds are cleaned of dust particles with mineral oil on allsides before concrete is poured in to the moulds. The moulds are and appliedplaced on a level platform. The well mixed concrete is filled in to the mouldsandkept on vibration table. Excess concrete was removed with trowel and top surfaces finished level and smooth as per IS 516-1969.
3.11 CURING OF THE SPECIMENS
The specimens are left in the moulds undisturbed at room temperature forabout 24 hours after casting. The specimens are then removed from the mouldsand immediately transferred to the different curing environment tubs i.e. cubes arecured in fresh water and 5% HCL diluted solution

4.1GENERAL
The result of experimental practices and analysis are presented in this chapter section 5.2 provides the result of compressive strength of M35 grade of concrete after partial replacement of cement with SCRB at various percentage and about effect of HCL on compressive strength.

4.2 Compressive strength Results-M35 grade at Normal water & HCL Solutions

Sample Designation	%Replacement of SCBA in Cement	Compressive strength at 7 days (σ_{cu})	Compressive strength at 28 days(σ_{cu})	Compressive strength at 60 days(σ_{cu})
C0	0	35	44	52.39
C1	5	38	47.6	48.6
C3	10	38.5	52.4	54.5
C4	15	36.5	47.6	51.65
C5	20	32.64	43.82	46.5
C6	25	33.85	44.65	41.3

Compressive Strength Results (M35 in normal water)

Sample Designation	%Replacement of SCBA in Cement	Compressive strength at 7 days(σ_{cu})	Compressive strength at 28 days(σ_{cu})	Compressive strength at 60 days(σ_{cu})
C0	0	33.5	41.5	46
C1	5	36.36	44.5	47.5
C3	10	37.5	51.73	48.76
C4	15	34.26	41.5	45
C5	20	31.34	41	44.5
C6	25	21.16	31.67	27

Compressive Strength Results (M35 in HCL)

3Results of Durability Studies

Sample Designation	%Replacement of SCBA in Cement	(σ_{cu})	($\sigma^1{}_{cu}$)	% decrease in strength
M0	0	35	33.5	4.2
M1	5	38	36.36	4.3
M2	10	38.5	37.5	2.59
M3	15	36.5	34.26	6.1
M4	20	32.64	31.34	3.8
M5	25	33.85	21.16	37.4

Reduction in Compressive strength under HCL attacking for 7 days

Sample Designation	%Replacement of SCBA in Cement	(σ_{cu})	($\sigma^1{}_{cu}$)	% decrease in strength
M0	0	44	41.5	5.56
M1	5	47.6	44.5	6.5
M2	10	52.4	51.73	1.27
M3	15	47.6	41.5	12.81
M4	20	43.82	41	6.43
M5	25	44.65	31.67	29.07

Reduction in Compressive strength under HCL attacking for 28 days

Sample Designation	%Replacement of SCBA in Cement	(σ_{cu})	($\sigma^1{}_{cu}$)	% decrease in strength
M0	0	52.39	46	12.19
M1	5	48.6	47.5	2.26
M2	10	54.5	48.76	10.53
M3	15	51.65	45	12.87
M4	20	46.5	44.5	4.3
M5	25	41.3	27	14.33

Reduction in Compressive strength under HCL attacking for 60 days

IV. CONCLUSION

General

The experimental study seen that the compressive strength of concrete increases with help of SCBA, if use in partially replacement of cement in concrete, after that the compressive strength gets decreases it's also seen that use of HCL for curing of cube in place of normal water is also helpful in the enhancement of compressive strength. Following conclusion is summarized as per experimental study.

1. By increasing the percentage of SCBA in mix design there is gradual decreases of compressive strength for 7 days.

2. After 14 days compressive strength of cube is increases for a certain percentage.
3. Maximum compressive get by the experiment is at 28 days after the replacement of 10% cement with SCBA.
4. Compressive strength is reduced very low acid attack after cured of 28 days. Scope for further work

To study the durability of concrete under various weathering conditions. To check the performance of bacillus subtilis by durability test. To verify the performance of bacillus subtilis with 1mm and 2mm crack width and 15mm, 20mm, 25mm, and 30mm crack depth.

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