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Experimental Investigation On Partial Replacement Of Cement With Sugarcane Bagasse And Corn Cob Ash

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ABSTRACT

With cement as its main component, concrete is the material most frequently used in building. Due to the continuous emission of Carbon di-oxide in cement production pollutes the environment greatly. Supplementary cementitious materials are solid materials that have been finely ground and are used to substitute some of the cement in a concrete mix. Examples of these materials are sawdust ash, rice grain ash, egg shell powder, sugarcane bagasse ash and corncob ash. In addition to keeping these by-products out of the land fill and away from pollution, employing them in concrete building improves the qualities of the material both while it's new and after it has hardened. In order to produce an eco-friendly brick with the right structural qualities, several studies have looked into the possibility of using organic waste products in the building sector. These waste items include sugarcane bagasse, which may be used to partially replace cement. Various treatment procedures were employed in earlier studies to treat organic waste and get it ready for usage in the building sector.

KeyWords: Cement, Sugarcane Bagasses(SBA), CorncobAsh (CCA),Compressive Strength, Flexural Strength, Split Tensile Strength.

I. INTRODUCTION

Availability and price of concrete's component parts, such as cement and aggregates, determine how much it will cost to produce concrete altogether. After water, cement is the most consumed commodity worldwide and the most widely used building material. Since cement is costly component in concrete, even a little decrease in its price perunit will have a significant influence on entire cost of construction. Cement output is growing annually, and the cement sector is responsible for a sufficient part of global carbon dioxide emissions. Cement use needs to be reduced since we cannot continue to produce it at an increasing rate due to its substantial participation to environmental pollution, the high price of OPC, and its excessive use of natural resources like limestone, among other things. When industrial and agricultural by-products are utilised in part instead of the energy-intensive OPC, sufficient energy and cost affordable can be realised. It is also known that the workability and durability of concrete may be not ably improved by the use of mineral admixtures made from agricultural waste. Utilising agricultural and industrial waste products to make cement is a sustainable method of getting rid of a lot of stuff that would otherwise harm the air, water, and land.

Utilising industrial byproducts and agricultural wastes as supplemental cementitious materials in place of cement is one workable way to reduce the amount of cement used. Fly ash, silica fume, volcanic ash, rice husk ash, sugarcane bagasses (SBA), maize cob ash (CCA), and other waste items with pozzolanic qualities have all been tested for use in blended cements. Numerous by products from industries, such as fly ash, silica fume, and blast furnace slag, are substituted for cement in various ways. However, agricultural waste is becoming a major problem in our nation, therefore researchers are looking at this and using sugarcane baggage ash as a cement ingredient to lessen pollution and the amount of cement needed. However, one potential substitute for regular Portland cement is to partially replace it with agricultural waste, or agro-waste. The agricultural waste product known as maize cob is derived from corn, the most significant grain crop in sub-Saharan Africa. With 40 percentage of the global crop 377.5

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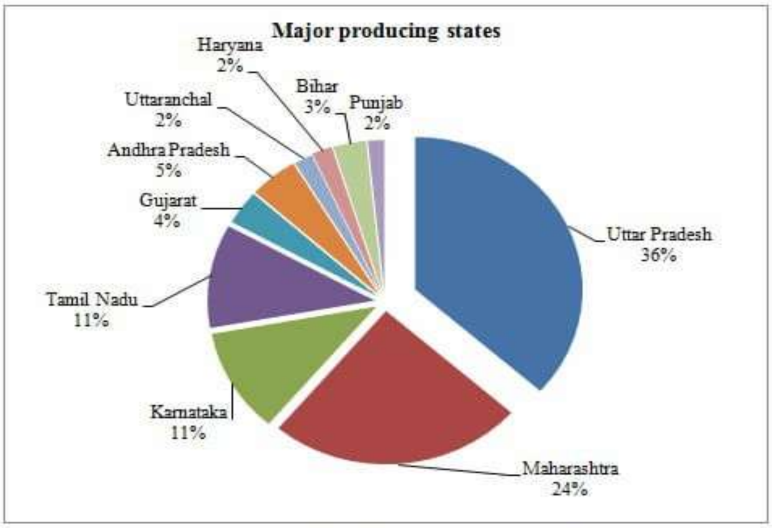
million metric tonnes, of which 20 percentage is exported, the United States leads the world in maize production (world atlas, 2017).In 2017, Nigeria produced 10.5 million metric tonnes of maize, ranking second in Africa and thirteenth globally. South Africa, on the other hand, produced the most, producing 12.5 million metric tonnes. CCA and sugarcane bagasse ash are used to partially substitute regular Portland cement, making up to 5percentage, 10percentage and 15percentage of the cement. For seven, fourteen, and twenty-eight days, concrete cubes, cylinders, and prisms were cast, cured, and their mechanical qualities evaluated.



Source: Ministry of Agriculture, GoI

Fig.1.Sugarcane Production in India

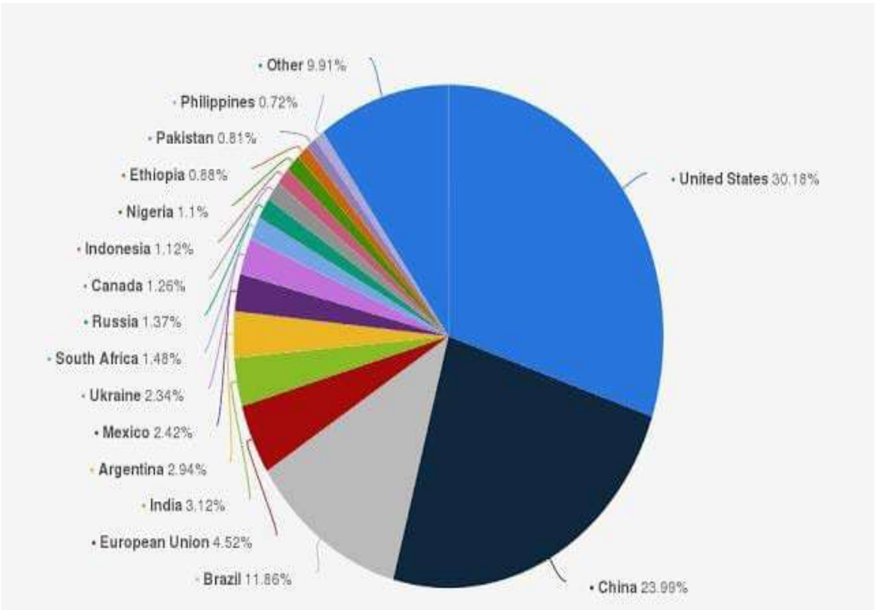


Fig.2.Corn Cob Production in India

Scopes and Objectives of the Work

The current study for this thesis uses sugar cane baggage ash to conduct a thorough investigation of concrete in the following ways.

- Concrete mix design gradeM30.
- The casting of M30 grade concrete cubes with varying amounts of SBA such as zero percentage, 5 percentage, 10 percentage, 15 percentage, and 20 percentage.
- Curing cubes in HCL and normal conditions.

- In this study, maize cob ash (CCA) is the waste that is of concern. Employ maize cob ash (CCA) as a pozzolan a without taking into account the chemical's suitability for such a purpose. Utilise a nearby black smith furnace to burn ground coke outdoors while utilising charcoal as fuel.

II. LITERATUREREVIEW

Kamau and Ahmed (2020): A study tested the use of CCA as a partial cement substitution in concrete mixtures, with highest compressive strength at 7.5percentage substitution. Higher substitution levels showed remarkable strength suitable for structural construction. CCA's potential as a powerful pozzolan was demonstrated. **Anjaneyulu (2019**) also tested the use of waste materials in concrete, producing concrete cubes with varying proportions of CCA and SDH. Maximum compressive strength was recorded at fifty-six days for 10percentage CCA and 24.9 N/mm^2.

Priya et al (2018): Compared the strength of concrete by replacing coarse aggregate with steel slag and cement with CCA. The study found that concrete gains its maximum strength at five percentage cement substitution with CCA and Forty percentage coarse aggregate subsstitution with steel slag, based on compressive, split tensile, and flexural strength tests.

Okwadha(2017) A study investigated the use of plant solid waste ash (SDH), carbonated calcium sulphate (CCA), and sugarcane bagasse ash (SCBA)as partial substitutions forcement in concrete production. Chemical analysis revealed pozzolanic activity in SDA, MCA, and SCBA. Workability increased with cement substitution, but declined for SCBA. The optimal compressive strength increased with increased cement substitution, but decreased due to reduced cementitious matrix production. The study concluded that blended concrete can reduce environmental deterioration caused by waste mining, disposal, cement production, and raw material extraction.

Dauda (2016) a study examined the behavior of pozzolan a cement components made from substitute materials for affordable housing. The researchers used a mix ratio of 1:8 solid sandcrete blocks and varied the CCA content every five percent. The highest compressive strength was measured at 30percentage substitution, reaching 2.10N/mm^2. After a year of exposure to the northern savannah climate, the strength remained constant. Highest value of 2.1N/mm^2 was achieve dat 30 percentage substitution. The researchers suggested replacing 0-40percentage of cement with CCA and allowing the substance to cure for 90 days.

Toryila (2016) a study on concrete substituted with CCA found that increasing the substitution with CCA decreased the concrete strength. Flexural strength decreased with 5 percentage substitution, and the compressive strength increased with 10 percentage substitution. The initial setting time for OPC-CCA decreased with CCA substitution. The study suggests CCA can be used in concrete production, building units, and light construction projects, but not exceeding 10percentage.

III. MATERIALS AND METHODS

Cement

Throughout the whole project, OPC in 53 grades from a one batch was used, and great care was taken to ensure that it was maintained in airtight containers to prevent it from being harmed by ambient. The purchased cement underwent testing to meet IS: 12269-1987 physical standards and IS: 4032-1977 chemical requirements.

Table.1 Characteristics of Cement

S.No	Characteristics	Value
1	consistency	34mm
2	Fineness	8percentage
3	Setting time	
	Initial	88minutes
	Final	245minutes
4	Compressive strength	
	Three days	28.78MPA
	Seven days	40.54Mpa
	Twenty-Eight days	54.72Mpa

Fine Aggregate

The fine aggregate, adhering to IS383-1970's Zone II and IS: 2386-1963,without biological contaminants, silt, or clay. Physical characteristics of fine aggregate were evaluated.

Table.2 Characteristics of Fine Aggregate

S.No	Characteristics	Value
1	Sp.gravity	2.60
2	Density(Bulk)	1.54gm/cc
3	Fineness	2.74
4	zone	II

Coarse Aggregate

The research utilized crushed coarse aggregates (20mm) from nearby crusher facilities, evaluating their physical characteristics.

Table.3 Characteristics of Coarse Aggregate

S.No	Property	Value
1	Bulking density	1.61gm/cc
2	Sp.gravity	2.74
3	Fineness	7.17
4	Impact Strength	25.21percentage
5	Crushing Strength	25.22percentage

Water

Concrete is mixed using fresh, portable water that is devoid of oil and organic debris. A graduated jar was used to measure the necessary amount of water, which was then added to the concrete. Weigh batching was used to get the remaining materials for the manufacture of the concrete mix. There shouldn't be any pH values below 7.

Sugarcane Bagasse Ash

About 52percentage of sugarcane bagasse is made up of cellulose, while 26percentage is made up of hemicelluloses and lignin. About 28percentage of bagasse (with a moisture level of 52percentage) and 0.64percentage of residual ash are produced per tonne of sugarcane. After burning, silicon dioxide (siO_2) predominates in the residue's chemical makeup. Ash is utilised as a fertiliser in sugarcane harvests on farms despite being a substance that degrades quickly and offers little nutrients. This sugarcane bagasse ash was gathered when a boiler at the sugar mill, which is situated in the Tamil Nadu town of Ayyampalayam, Dindigul district, was being cleaned.

Table.4 Physical characteristics of SCBA

S.No	Properties	Value
1	Density	578kg/m^2
2	Sp.gravity	2.2
3	particlesize	0.1-0.2
4	Surfacearea (Minimum)	2500m$^{2/}$kg
5	Shape	spherical

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Corn Cob Ash:

Burning corncob trash yields corncob ash, which has asp. gravity of 2.55.About 70 percentage of the total SiO2 and Cao content is represented by CCA.

Physical and Chemical Analysis of CCA

It was discovered that CCA had a lower Sp. gravity and mean size than cement. Accordingly, 62.30percentage of the silica in this specific CCA specimen is linked. When iron oxide, silicon oxide, and aluminium oxide were combined, the overall percentage exceeded the at least 70percentage required for pozzolanas (ASTM 618, 2005). In the long run, the pozzolanic reaction benefits from the high proportion of silicon oxide.

Table.5 Physical Characteristicss of CornCob Ash

Tests		Corn CobAsh
Moisture content		0.25percentage
Sp.gravity		2.18
Density	(Dry)	2180kg/mm^3
	(Bulk)	923kg/mm^3

IV. RESULT AND DISCUSSION

Compressive Strength Test

The study tested the concrete compressive behaviour of grade M30 (1:1:2) using sugar can ebagasse ash instead of cement. Results showed that concrete becomes stronger with age, with early age strength being lesser than later age strength, as observed in laboratory observations.

Table.7 Compressive behaviour of M30 grade concrete

Ordinary Portland Cement substitution with SCBA (percentage)	Compressive Strength (N/mm^2)					
	Seven days	Fourteen days	Twenty-Eig ht days	Seven days	Fourteen days	Twenty Eightdays
0	7.1	13.3	28	7.8	14.5	28.1
	8	15.5	28.8			
	8.4	14.6	27.5			
5	8.8	16.4	28.4	9.7	16.1	29.1
	9.7	14.6	28.8			
	10.2	17.3	29.7			
10	9.7	15.5	30.2	10.8	17.03	31.4
	11.1	16.8	31.5			
	11.5	16	32.4			
15	7.5	13.3	28	8.4	15.2	28.2
	9.3	15.5	29.3			
	8.4	16.8	27.5			

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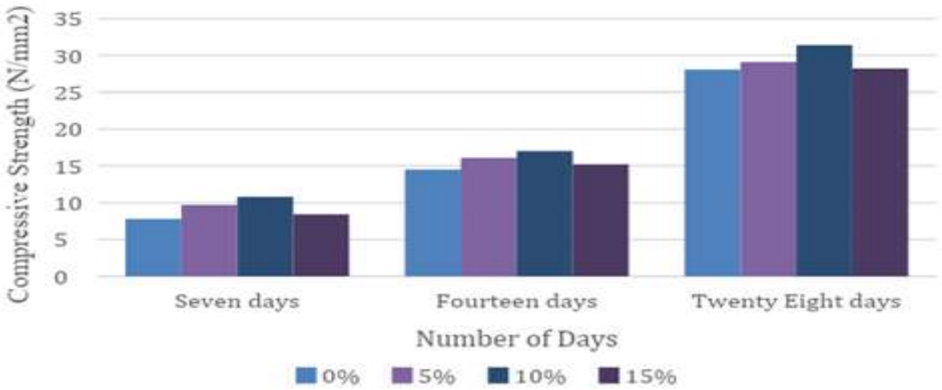

Fig.3.Compressive strength of concrete

Split Tensile Strength

Emphasise Cylinder specimens of 300 mm X 150 mm in size were manufactured for the investigation of tensile strength. Tensile strength is ascertained by casting a cylinder. We tested the cylinders by positioning them consistently. When the specimens' surface water level dropped, they were collected for testing beyond twenty-eight days of wet curing. The Universal Testing Machine was used to conduct this test (UTM). The following formula provides the amount of tensile stress (T) operating evenly to the line of action of applied loading:

Tsp=$2P/\pi dl$

Table.8 Split tensile strength of M30 grade concrete

S.No	**Percentage of Substitution of SCBA**	**Seven Days**	**Fourteen Days**	**Twenty-Eight Days**
		(N/mm^2)		
1	0	1.52	2.33	2.9
2	5	1.34	2.50	2.96
3	10	1.94	2.98	3.40
4	15	1.23	2.36	2.78

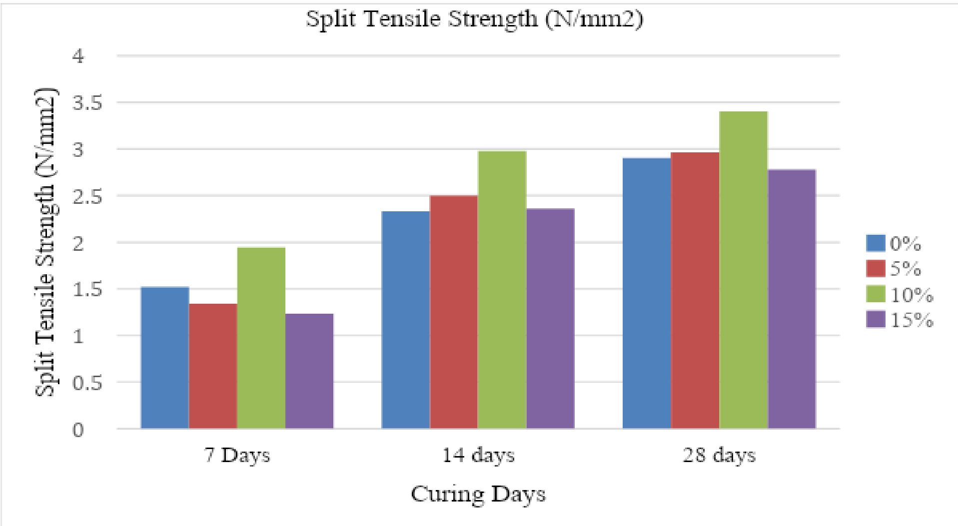

Fig.4. Split tensile strength of concrete

V. CONCLUSION

The study identified SCBA as a suitable substitute for cement in concrete, with the best results achieved when 10 percentage of cement was replaced, enhancing compressive strength. In addition to decreasing waste, using SCBA in concrete also reduces the quantity of cement needed. It is advised that more study be done to evaluate the usage of SCBA in concrete for a number of concrete parameters, including split tensile, compressive strength, and slump cone tests. The results of the experimental study show that adding SCBA to concrete increases its compressive strength; however, if concrete is used in place of some cement, the compressive strength of the mixture decreases. It also shows that using HCL instead of regular water to cure cubes improves the concrete's compressive strength. In this work, we examine the partial substitution ofwaste materials for cement in order to lower cement output. The ash from sugar canebagasse and maize cobs are the materials used in partial substitution. Agricultural waste products include maize cob and sugarcane bagasse. Concrete with corncob improves workability and is resistant to chemical degradation. When 15 percentage of the substitution materials are replaced, the compressive strength value falls and stays strong. When compared to before substitution, split tensile strength also keeps strength constant with partial substitution. Concrete's flexural strength progressively rises throughout the course of curing. The addition of sugarcane bagasse improves the new concrete's resistance to segregation, while corn cob ash makes the concrete more workable. This indicates a rise in the mechanical qualities of concrete. When waste resources like corn cob ash and sugarcane bagasse are used to partially substitute the cement.

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