Research the fresh and hardened characteristics of self-curing cement mortar that incorporating Agro- industrial waste

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***Abstract*—The study focuses on the benefits and applications of self -curing mortar. Cement mortar produced using mineral admixtures are of denser nature and the curing of such mortar by using conventional methods is found ineffective. Hence the self- curing concept came forward in which water is supplied internally due to which better hydration of product takes place. Self -curing mortar is the concrete that can retain the water content for the enhancement of strength. In this research admixture Polyethylene glycol was used and its effect was examined on the performance of SBA base cement mortar. In the present work, SBA is used as partial replacement for cement mortar. Ordinary Portland cement, SBA and fine aggregates was tested to examine physical properties in accordance with BIS specifications. In this study, an attempt has been made to investigate the fresh and harden properties of cement is replaced by 10,15,20 and 25 % of self-curing cement mortar with a constant W/c of 0.5 of self-curing cement are also examined for 0,0.5 and 1 % of self-curing agent The study was aimed to evaluate fresh property like flow mortar test and mechanical properties by compressive strength. The fresh and hardened properties of concrete were studied to check its performance in various curing condition. After 7and 28days with different percentages of sugarcane bagasse ash and polyethylene glycol 400, the average compressive strength is determined. The traditional self-curing mortar cube and the compressive strength are contrasted. According to the research, concrete mixes with up to 1% of polyethylene glycol 400 and 20% sugarcane bagasse ash added to the cement exhibit superior compressive strengths than other mixes.**

Keywords— PEG, SBA, SCM.

I. INTRODUCTION

For concrete constructions to achieve performance and durability criteria, proper curing is essential. This is accomplished in traditional curing by applying external curing following mixing, putting, and finishing. A method for adding extra moisture to concrete for improved cement hydration and decreased self-desiccation is called self-curing or internal curing. There are currently two main approaches for curing concrete internally. The first technique replaces the water lost to chemical shrinkage during cement hydration by providing an internal water supply through saturated porous lightweight aggregate (LWA). In the second method, poly-ethylene glycol (PEG) is used to assist retain water on the concrete surface by reducing water evaporation.

A. Self-curing concrete.

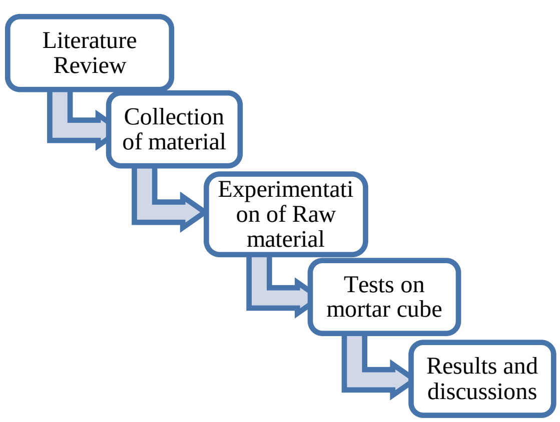
Concrete's exterior surface continuously loses moisture due to the difference in chemical potential between the liquid and vapor phases. The addition of polymers to the concrete mix primarily reduces the chemical potential of the water molecules by forming hydrogen bonds with them. This lowers the vapor pressure, which in turn slows down the pace at which water evaporates off the surface.

B.Sugar cane bagasse ash.

India's sugar sector is regarded as the country's and the farmers' main economic pillar. More than 500 sugarcane factories are operating across the nation, according to data from the Indian Sugar Mill Association. Indian sugar factories have recently begun producing electricity and selling the extra to the government via the electrical grid. In the nation, sugarcane is grown on a vast scale, and India has overtaken other countries in terms of production. In 2016, India produced 35.5 crore metric tons of sugarcane on average (NITI Aayog, 2020). Bagasse finds the most use in the production of electricity because it has a very high gross calorific value of 2250 kcal/kg when it is wet. Boilers that use bagasse as fuel and operate between 400° and 600°C are used to create the steam needed for this purpose. However, it resulted in the bagasse's partial combustion and produced a low fuel value. As a result, cogeneration plants in the sugar industry were established in the 1980s to meet India's energy needs. Due to the increased use of fossil fuels, this cogeneration plant is currently a promising choice for the production of electricity.

As a result, cogeneration units for producing power from bagasse have been erected in practically all significant sugar factories. Because the cogeneration unit was operating at a relatively high temperature and pressure, bagasse ash was expelled as a residue. For every tonne of sugarcane used in the manufacturing of sugar, 26% bagasse and 0.62% ash are created. The result is that approximately 10 million metric tons of SBA are wasted each year. For increased crop output, bagasse ash is advised for use as a fertilizer. In essence, farmers are reluctant to apply bagasse ash as fertilizer to their fields. Furthermore, the cogeneration unit did not create the activated sugarcane bagasse ash needed to make cement. Bagasse ash is thus exposed and dumped. As a result, only a very limited amount of bagasse ash was used. Additionally, there are numerous environmental disposal issues with cogeneration units. The raw material's source, chemical composition, calcining conditions, and other elements all have an impact on the characteristics of sugar 6 cane bagasse ash (SBA). In this experiment, an effort has been made to substitute some of the cement with sugarcane bagasse ash.

II. METHODOLOGY



I. MATERIALS

A. cement

The Indian Standards IS 4031-1988 [8] were followed in the use and testing of Portland pozzolana cement (PPC) that complied with IS 1489-part 1 [7]. Table 1 lists the characteristics of the cement that was used.

B. Sugar cane bagasse ash.

In the cogeneration boilers of sugar factories, bagasse from sugarcane is utilized as fuel. The leftover ash from burning the bagasse is collected as a byproduct using a bag-house filter, and it is then dumped on the closest piece of land. The present investigation involved the collection of bagasse ash from a sugar mill located in Harur, Dharmapuri, Tamil Nadu, India. The raw bagasse ash was dried at a temperature of 105–110ºC for a duration of 24 hours in order to eliminate any evaporable water content. In order to achieve improved reactive materials and remove significant unburnt fibrous fractions, the dried bagasse ash was further sieved using a 300 µm sieve (Bahurudeen et al. 2015; Deepika et al. 2017).

The sieved SBA was adopted in the manufacture of blended concrete process of sugarcane bagasse ash production is shown in the Figure 3.2. The specific gravity of Sugarcane Bagasse is found to be 1.95, tested as per IS 1727- 2004. The oxide composition of the sugarcane bagasse is found by X-ray Sugarcane Bagasse Ash Sugarcane (Raw material) Bagasse waste Cogeneration boiler Raw Bagasse Ash 15 Fluorescence analysis and the results are shown in table 3.2. The results shows that the Sugarcane Bagasse ash contains 74.783% of silicon, so it is a confirmed as pozzolanic material ash contains 74.783% of silicon, so it is a confirmed as pozzolanic material.

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C.Fine aggregate

Fine aggregate was therefore obtained in accordance with IS 383-1970 [9] Specifications, conforming to the grading curve zone II with specific gravity 2.65 and fineness modulus 2.11.

D.PEG

Low molecular weight PEG is known as PEG-400. It is a thick, colorless, and transparent liquid. PEG 400 is frequently utilized in many different medicinal formulations, partly because of its low toxicity. In water, acetone, benzene, glycerin, glycols, and aromatic hydrocarbons, it is soluble; in aliphatic hydrocarbons, it is only marginally soluble. The chemical formula for PEG-400 is 2nH4n+2On+1. Its density is 128 g/cm3, and its melting point is between 4 and 8ºC (39 and 46ºF; 277 and 281K).

II. PREPARATION OF SPECIMENS

In a 1:3 ratio, fifteen mortar cube mixes were created using binary and control cementitious systems. These mixes included different amounts of sugarcane bagasse ash and polyethylene glycol 400 to partially replace the weight of OPC. Bagasse ash is substituted for cement in self-curing cement mortar at percentages of 0, 10, 15, 20, and 25%. Additionally, 0.5 and 1% of polyethylene glycol 400 are added for every percentage of bagasse ash.

III. EXPERIMENTAL RESULTS AND DISCUSSION

A.Flow table test

The consistency of the mortar mix is ascertained using the cement mortar flow table test. The Indian Standard (IS) code IS: 4031 (Part 5) - "Methods of Physical Tests for Hydraulic Cement" - describes the process. A general description of the process is provided below: consists of a steel table that is round and has a raised lip all the way around, measuring roughly 70.6 cm in diameter. a cylindrical mold with dimensions of 10 cm in diameter and 15 cm in height. for combining and packing the mortar into the mold.a balance that can detect even one gram. To quantify the volume of water

Fig.1.Flow table

TABLE I. FLOW TABLE TEST ON MORTAR

Replacement of OPC by SBA (%)	Flow (%)
0%	110
10%	108
15%	107
20%	109
25%	108

A.compressive test of mortar cube.

Compressive strength of the mortar cubes measured in N/mm2; computed from the section mean dimensions by dividing the greatest force applied to the cubes during the test by the cross-sectional area.

Fig2.Compressive strength of motar cube

TABLE I. COMPRESSIVE STRENGTH OF THE CEMENT MORTAR FOR 7 AND 28TH DAYS

Cement ID	Compressive strength (N/mm^2)			
	7^{th} day	Remarks	28^{th} day	Remarks
OPC100	38		54	
SBA10	39		56	
SBA15	41	As per IS 269:2015 should be greater than 37 N/mm^2	60	As per IS 269:2015 should be greater than 53 N/mm^2
SBA20	38		55	
SBA25	36		52	

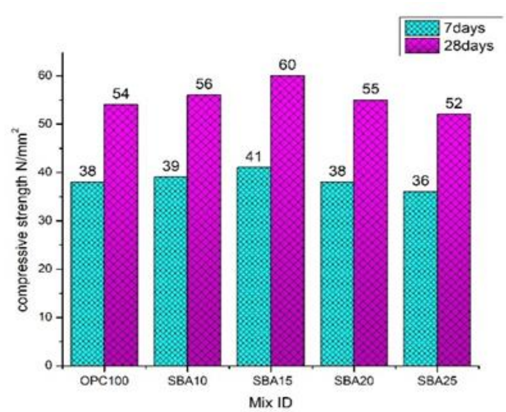

Fig .3.Graph for Compressive strength of the cement mortar for 7 thand 28th day

TABLE II. COMPRESSIVE STRENGTH OF THE CEMENT MORTAR WITH PEG400 0.5% IN FOR 7 AND 28TH DAYS

Cement ID	Compressive strength (N/mm²)			
	7th day	Remarks	28th day	Remarks
OPC100	39	As per IS 269:2015 should be greater than 37 N/mm^2	55	As per IS 269:2015 should be greater than 53 N/mm^2
SBA10	41		57	
SBA15	43		60	
SBA20	40		58	
SBA25	38		54	

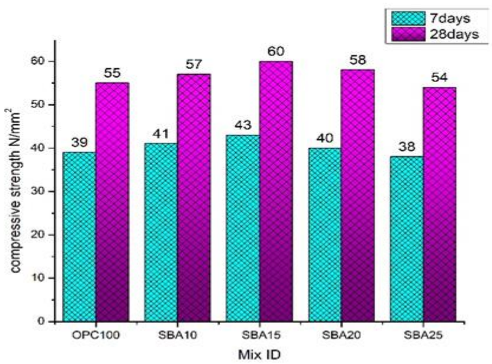

Fig.4.Graph for Compressive strength of the cement mortar for 7th and 28th day

TABLE III. COMPRESSIVE STRENGTH OF THE CEMENT MORTAR WITH PEG400 0.5% IN FOR 7 AND 28TH DAYS

Cement ID	Compressive strength (N/mm²)			
	7th day	Remarks	28th day	Remarks
OPC100	39	As per IS 269:2015 should be greater than 37 N/mm^2	55	As per IS 269:2015 should be greater than 53 N/mm^2
SBA10	41		57	
SBA15	43		60	
SBA20	40		58	
SBA25	38		54	

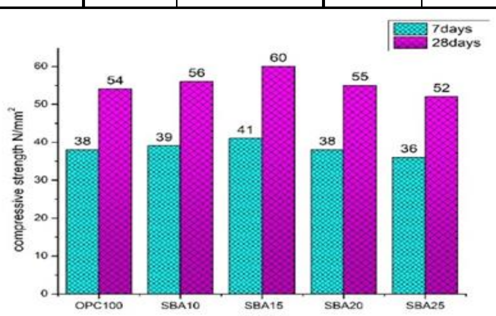

Fig.5.Graph for Compressive strength of the cement mortar with PEG0.5% for 7 and 28th days

C.Results and discussion

The study of the impact of adding various amounts of polyethylene glycol and sugarcane bagasse ash to self-curing mortar cubes.

1. Workability Assessment:

The cement mortar's workability was assessed using the flow table test. The test's findings showed that as the amount of SBA in the mixture grew, the flow % decreased. Workability is a critical component of construction, and this observation raises the possibility that mortar placement and handling may be adversely affected by greater SBA levels.

2. Compressive Strength Tests:

Tests of compressive strength were conducted seven and twenty-eight days following the self-curing mortar cubes' manufacture. The addition of SBA and PEG improved the mortar cubes' compressive strength, according to the data. The highest levels of compressive strength were attained at 15% replacement for SBA and 0.5% replacement for PEG, suggesting that these particular ratios were most successful in fortifying the mortar. 15% replacement for SBA and 0.5% replacement for PEG, suggesting that these particular ratios were most successful in fortifying the mortar.

IV. CONCLUSION

- The primary aim of this study focused on the mechanical implications of self-curing mortar composed of Sugarcane Bagasse Ash (SBA) and Ordinary Portland Cement (OPC). While the conclusions of this research were presented at the end of each chapter, the key findings of this investigation, as a comprehensive overview, are outlined below.
- As the proportion of Ordinary Portland Cement replaced with Sugarcane Bagasse Ash increased, the workability of the mixture decreased. This phenomenon is linked to the pozzolanic properties of SBA. The study suggests that a 25% replacement rate is optimal for achieving the desired workability characteristics.
- The compressive strength of the 10% SBA replacement was found to be lower than that of the OPC (Control mix) at the 7th day. This indicates that the cement may not fully hydrate

when SBA is used as a partial replacement. However, it's noted that the compressive strengths of the binary self-curing mortar cubes are higher compared to conventional self-curing mortar cubes.

- The study suggests that the incorporation of Sugarcane Bagasse Ash enhances both the hydration reaction and pozzolanic activity in the cement mixture.
- The optimal replacement level for Sugarcane Bagasse Ash in cement is determined to be up to 15%, and the addition of 0.5% polyethylene glycol 400 is also mentioned. Beyond this threshold, adding more SBA leads to a reduction in the compressive strength of the mortar.

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