Durability studies on concrete with sugarcane bagasse ash as a partial replacement of cement in sodium sulphate solution

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***Abstract*— The influence of sodium sulphate concentration on the sulphate resistance of plain and mixed cements was studied for the current thesis. Specimens were cast in both conventional concrete and concrete with varied percentages of sugarcane bagasse ash replacing some of the cement. The concrete mix design for M35 is used as regular concrete. Normal concrete substitutes 5%, 10%, 15%, and 20% of sugarcane bagasse ash for cement. 180 days were devoted to conducting this investigation. Two different types of specimens—those made of conventional concrete and those made by partially substituting sugarcane bagasse ash for cement—were subjected to five different concentrations of sodium sulphate solutions. concentrations of 5% sulphate. These values are typical of the levels of sulphate found in extremely salty soils. By doing an experimental analysis and assessing the compression strength loss, the sulphate resistance was assessed. The cement substituted with 20% SCBA of specimens that were cured in 5% Sodium Sulphate concentrations showed the greatest damage as a result of Sulphate attack. The increased Sulphate resistance seen in cement that had 10% SCBA in place of the original cement is evidence of the use of these cements in sulphate environments.**

***Index Terms*— Influence, Sodium Sulphate, Attack, Specimens, Resistance**

I. INTRODUCTION

The most crucial component of the infrastructure is cement, which is also used in mortar and concrete and is a strong building material. Scientists and researchers worldwide are constantly looking for ways to develop alternative binders like mineral additives that are found in nature in various forms like blast furnace slag, fly ash, and silica fume. This is due to the rising demand for and use of cement as well as the backdrop of waste management. The use of these components in the manufacturing of concrete has a favourable impact on the environment while decreasing disposal issues. The waste product of the sugar industry is sugarcane bagasse (SCB). 40% of the water in fresh bagasse makes it a popular fuel source for sugar refineries. Because sugarcane fibre is a valuable raw resource for paper, fake wood, and other products as well as a flammable material for the sugar industry, it has special significance. Amorphous silica, which possesses pozzolanic qualities, is present in the resulting ash when this waste is burnt under regulated circumstances. This investigation's main goals are to assess bagasse ash as an additional cementitious material in relation to the mechanical properties of concrete and to determine the ideal level of replacement in concrete formation in order to reduce the environmental issues related to cement production and ash production. One of the major waste products produced worldwide is ash from sugarcane bagasse, which may be utilized as a mineral supplement due to its high silica concentration (SiO2). Because of sulphate assault, reinforced concrete buildings deteriorate when sulphate ions are present in soil, ground water, or sea water. Concrete penetration is greatly influenced by the quality of the water. The IS: 456(2000) regulation specifies the water quality requirements for concrete mixing and curing. Chlorides and sulphates are present in brackish water. When chloride or sulphates are under 500 ppm or 1000 ppm, respectively, the water is safe to drink, while water with much greater salt concentrations has been successfully utilised. The method of sulphate assault on concrete is intricate. The invention of Sulphate Resisting Type Cement was the outcome of research into the degradation of concrete caused by Sulphate assault.

II. LITERATURE SURVEY

Chatveer and Lertwattanaruk[2008][1]: In this study, agro-waste from a power plant that produces energy was processed and utilised in place of some of the cement. The resilience of mortars against sulphate assault, including expansion and loss of compressive strength, was studied. SCBA was employed as a substitute for Portland cement in the parametric investigation at values of 0%, 10%, 30%, and 50% by weight of binder. The ratios of water to binder were 0.55 and 0.65. The durability of mortar subjected to sulphate assault was tested using 5% solutions of sodium (Na2SO4) and magnesium (MgSO4) sulphates.

Corral-Higuera at al [2011][2]: Reinforced concrete was created utilising recycled concrete coarse aggregate and Portland cement was partially replaced with supplemental cementing ingredients such fly ash and silica fume as a means of promoting the sustainability of the concrete industry. The effectiveness of the recycled and extra materials against Sulphate attack and reinforcement corrosion was assessed on test specimens that were partially submerged in 3.5% Na2SO4aqueous solution. Electrochemical methods such as open circuit potential and linear polarisation resistance were used to measure weight loss of concrete, corrosion potentials, and corrosion current density of reinforcement for this purpose.

Maldonado-Bandala at al [2011][3]: One of the most important factors that shorten the useful life of reinforced concrete structures is corrosion (RCS). Because of this, it's important to develop concrete compositions that increase steel durability while minimising environmental effect. To slow down the rate of corrosion brought on by chloride ions and sulphate, binary concretes were created and their effectiveness as a partial replacement for Portland cement was assessed. Using the electrochemical methods of corrosion potential (Ecorr) and linear polarisation resistance, the behaviour of corrosion was observed over a period of 14 months in two aqueous solutions of NaCl and Na2SO4 that were both 3.5%. (Rp). The binary combination that demonstrated the best corrosion prevention under the study's circumstances comprised 80% sugar cane bagasse ash and 20% Portland cement.

Noor-ul Amen [2010][4]: In order to address environmental issues related to waste management, this study reports on the recycling of bagasse ash, a waste product of the sugar industry, as a cement substitute in concrete. On the physical and mechanical characteristics of hardened concrete, such as compressive strength, splitting tensile strength, chloride diffusion, and resistance to chloride ion penetration, bagasse ash content as a partial replacement of cement has been studied. According to the findings, bagasse ash is a useful mineral additive and pozzolan when used in the recommended replacement ratio of 20% cement, which reduced chloride diffusion by more than 50% without having any negative impacts on the cured concrete's other qualities.

Chuslip and Kiattikomol [2009][5]: The loss on ignition (LOI) of raw bagasse ash gathered from the Thai sugar industry is significant at 20%. The LOI was lowered to 5% after 45 minutes of grounding and ignition at 550oC. With LOIs of 10% and 15%, these high and to give ground bagasse ashes. These ground bagasse ashes were substituted for Portland cement type I in mortar at weight ratios of 10%, 20%, 30%, and 40%, respectively. The findings demonstrated that mortars containing ground bagasse ash with high LOI developed compressive strengths more slowly than mortars containing ground bagasse ash with low LOI.

R.Srinivasanan and K.Sathiya [2010][6]: In this study, bagasse ash that has undergone chemical and physical characterization as well as partial replacement of 0%, 5%, 10%, 15%, 20%, and 25% by weight of cement in concrete is used. The durability of bagasse concrete for marine, sulphates, and chlorides attack was tested, as well as fresh concrete tests like the compaction factor test and slump cone test. Hardened concrete tests like compressive strength, split tensile strength, and modulus of elasticity at the ages of 7 and 28 days were also conducted.

S. Aigbodion, Hassan and Nyior [1993][7]: To assess the likelihood of their usage in the industry, bagasse ash has been chemically and physically described in this article. SEM/EDAX analysis of particle shape, X-ray diffractometry analysis of composition and crystalline material presence, physical characteristics and refractoriness of bagasse ash have all been investigated.

III. METHODOLOGY FOR EXPERIMENTS

In the current experimental inquiry, sugar cane bagasse ash has been used to concrete mixtures in lieu of cement to replace some of the cement. Researchers looked at how adding various amounts of sugar cane bagasse ash as an extra ingredient affected the compressive strength and sulphate resistance of concrete mixtures. These are the specifics of the experimental studies. The compression testing apparatus (based on a microprocessor) used to test the cube specimens is of a common brand. The testing device has a 2000-ton capacity. With the help of a control valve, the machine has the ability to regulate the pace of loading. The plates are kept in perfect testing condition by regularly cleaning them and checking the oil level. The cube specimens are taken out of the curing tank after the requisite amount of time has passed and cleaned to eliminate any surface water. It is mounted to the apparatus so that the load is distributed evenly. The specimen's flat surfaces are set on the bearing surfaces. Rotating the handle brings the top plate into contact with the specimen. Closed is the oil pressure valve and the machine is switched on.

4.1 WORKABILITY

The workability of sugarcane bagasse ash concrete in various percentage ratios was evaluated using the compaction factor equipment in accordance with IS 1197. Fig. 1 shows workability apparatus.

Fig.1 Workability Appratus

4.2 COMPRESSIVE STRENGTH OF CONCRETE SPECIMENS

According to IS 516-1959, concrete specimen cubes ere used to measure the compressive strength of sugarcane bagasse ash concrete. Fig.2 shows Compression Testing Machine

Fig. 2: Compression Testing Machine

4.3 SULPHATE ATTACK

According to the second equation provided, the by-product CaSO4 engages in a reaction with cement components once again to produce tobermorite and sulphuric acid (H2SO4). These two by-products significantly reduce the concrete's strength.

IV. RESULTS AND DISCUSSIONS

Physical and chemical analysis of cement and SCBA: Ordinary Portland cement employed in the current experiments conforms to the IS requirements in terms of its physical qualities (Table 4.1). Cement has a 53 MPa 28-day cube compressive strength.In the current study, SCBA from the agricultural industry was utilized

WORKABILITY:- When compared to regular concrete, SCBA concretes are less workable . It is implied that the SCBA's huge surface area is what causes the decline in workability.

Compressive Strength of Concrete: The goal mean strength was attained by the compressive strengths of bagasse ash-blend concrete specimens that had been cured in normal water for 28 days with weight replacements of cement of 0%, 5%, 10%, 15%, and 20%. The values are shown in Table 1.

Table 1: Compressive strength

Sample Desig.	% of SCBA	Compress. strength at 7 days f_{cu}(MPa)	Compress. strength at 28 days f_{cu} (MPa)	Compress. strength at 60days f_{cu} (MPa)	Compress. strength at 90days f_{cu} (MPa)	Compress. strength at 180days f_{cu} (MPa)
W_1	0	38.24	46.19	56.82	59.99	60.33
W_2	5	39.25	47.08	57.54	60.18	61.80
W_3	10	39.69	48.145	57.86	61.16	62.78
W_4	15	37.45	45.61	55.28	58.12	59.84
W_5	20	36.82	44.14	54.01	57.81	57.80

Sulphate attack: Significant sulphate attack is seen in concentrated solutions of 5% sodium sulphate, with cubes of 20% replacement being cured in 5% solution for 180 days exhibiting the greatest decrease in compressive strength. The Fig. 3 shows the strength for the samples after attack upto 180 days.

Table 2: Strength after sulphate attack on the samples

Sample Designation	% of SCBA	f_{cu} (MPa)	f_{cu} (MPa)	% reduction
N_{11}	0	60.33	55.90	7.32
N_{21}	5	61.80	57.38	7.15
N_{31}	10	62.78	58.36	7.04
N_{41}	15	59.84	54.94	8.19
N_{51}	20	57.87	52.48	9.30

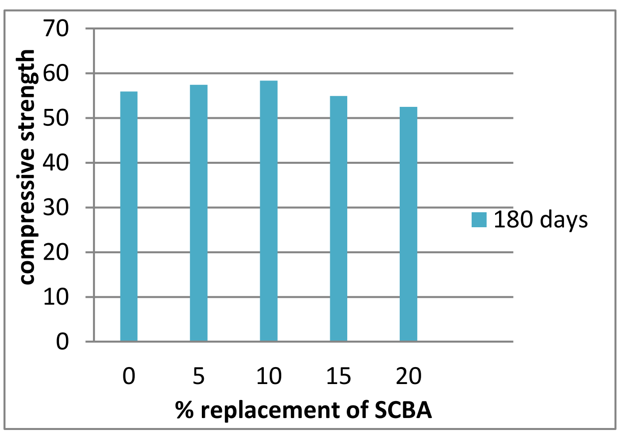

Fig. 3: Compressive strength after 180 days attack

V. CONCLUSIONS

1. SCBA has 420 m2/kg more specific surface area than cement, which is 320 m2/kg. When compared to regular concrete, SCBA concretes are less workable. It is implied that the SCBA's huge surface area is what causes the decline in workability.
2. After curing in normal water for 28 days, concrete's compressive strengths (with weight replacements of cement of 0%, 5%, 10%, 15%, and 20%) have attained the desired mean strength.
3. The compressive strengths of concrete (with 0%, 5%, 10%, 15%, and 20% weight replacement of cement with SCBA) cured in different concentrations i.e.,1%, 2%, 3%, 4%, and 5% of Sodium Sulphate solution for 7, 28, 60, 90, and 180 days show that at 5% replacement there is an increase in strength, and at 10% replacement there is an increase in strength, and at 15% replacement and 20% replacement strength is reduced compared to 5% .

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