EXPERIMENTAL INVESTIGATION OF CONCRETE USING SUGARCANE BAGGASE ASH AS A PARTIAL REPLACEMENT FOR CEMENT

Submitted By

N.YOGESHWARAN (17CER212)

C.SNEKALAXMI (17CER173)

M.RAM NITHIN (17CET244)

in partial fulfilment of the requirements

for the award of the degree

of

BACHELOR OF ENGINEERING IN

CIVIL ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

KONGU ENGINEERING COLLEGE

(Autonomous)

PERUNDURAI, ERODE – 638 060

APRIL-2021

DEPARTMENT OF CIVIL ENGINEERING

KONGU ENGINEERING COLLEGE

(Autonomous)

PERUNDURAI, ERODE – 638 060

APRIL-2021

BONAFIDE CERTIFICATE

This is to certify that the project report entitled **EXPERIMENTAL INVESTIGATION OF CONCRETE USING SUGARCANE BAGASSE ASH AS A PARTIAL REPLACEMENT FOR CEMENT** is the bonafide record of project work done by **YOGESHWARAN N (17CER212), SNEKALAXMI C (17CER173), RAM NITHIN M (17CET244)** in partial fulfillment of the requirements for the award of the Degree of Bachelor of Engineering in Kongu Engineering College of Anna University, Chennai during the academic year 2020 - 2021.

SUPERVISOR HEAD OF THE DEPARTMENT

Date:

Submitted for the end semester viva voice examination held on _______

EXAMINER I **EXAMINAR II**

DEPARTMENT OF CIVIL ENGINEERING

KONGU ENGINEERING COLLEGE

(Autonomous)

Perundurai, ERODE – 638 060

APRIL– 2021

We affirm the project titled **EXPERIMENTAL INVESTIGATION OF CONCRETE USING SUGARCANE BAGASSE ASH AS A PARTIAL REPLACEMENT FOR CEMENT** being submitted in partial fulfillment of the requirements of the award of Bachelor of Engineering in the original report carrying out by us. It has not formed part of any other project report or dissertation on the basis of which the degree or award was conferred on an earlier occasion on this or any other candidate.

DATE: **Signature of the Candidates**

YOGESHWARAN N (17CER212)

SNEKALAXMI C (17CER173)

RAM NITHIN M (17CET244)

I certify that the declaration made by the above candidates is true to the best of my knowledge.

Date: **Name and Signature of the Supervisor with seal**

ABSTRACT

Cement being of the major contributors to Carbon emission needs a revolution in its production or modification to the existing cement. One such way to reduce cement usage is to replace the cementitious compound with a suitable material that does not alter the original purpose of cement in concrete. One of such fibrous waste product from the sugarcane refining industry is sugarcane bagasse ash. .When compared to other types of agro wastes it serves as a best cementitious additive material The Sugarcane bagasse ashes (SCBA), which are ashes from biomass burning are found to act as supplementary cementitious material. Moreover, studies were conducted to relate the strength and durability of concrete by the percentage of replacement of sugarcane bagasse ash to cement. The studies revealed that the SCBA imparts more strength to cement at 10% replacement when compared to 20% replacement. However, this study is intended to use 20% of SCBA replacement in cement by adding silica fume. Concrete being mainly reinforced with steel has the problem of corrosion. To overcome the problem of corrosion as well as to reduce the use of cement and to attain the compressive strength of 10% replacement of SCBA, this experiment is intended to analyze the behavior of concrete with 20% replacement of SCBA with silica fume at different concentrations such as 0%,5%,10%,15%. Silica fume a by-product of smelting process in the silicon and ferrosilicon industry. To support high strength of concrete silica fume was added different proportions.

ACKNOWLEDGEMENT

First and foremost our thanks are to the Almighty, the great Architect of universe, who has blessed us successfully to accomplish this project.

It is an immense pleasure to place on the record our deep sense of gratitude and regards to the correspondent **Thiru. P.SACHITHANANDAN** and the management for permitting us to do this project.

We express our heartfelt gratitude to our Principal **Prof. V. BALUSAMY B.E (Hons)., M. Tech(Metallurgy)., Ph.D.,** for allowing us to use all the facilities that are available in the college to complete our project.

We take immense pleasure to express our heartfelt thanks to our beloved Head of the Department **Dr. P.S.KOTHAI M.E., Ph.D.,** for her encouragement and kind support.

We greatly acknowledge the whole hearted cooperation rendered by our guide **Mr. P.DINESH KUMAR M.E.,** for her encouragement to us for the successful completion of this project.

We thank our project co-ordinators **Mrs .R.K.SANGEETHA M.E.,** for their valuable guidance.

We thank teaching staff members and non-teaching staff members of Civil Engineering Department who stood with us to complete our project successfully.

Last but not the least, we extend the thanks to our **PARENTS** and **FRIENDS** for their moral support

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 GENERAL:

Utilization of industrial and agricultural waste as source of raw material for the construction of not only encourages sustainable and pollution free environment but also provides the economic situation. One of such fibrous waste product from the sugarcane refining industry is sugarcane bagasse ash. When compared to other types of agro wastes it serves as a best cementitious additive material. The usage of 15 % of SCBA for replacement of cement does not affect the compressive & tensile strength of concrete. Result is such that by replacing 15 % of bagasse ash, high strength concrete can be produced. Silica fume a by-product of smelting process in the silicon and ferrosilicon industry helps in improving the strength and performance of concrete. It also helps in preventing the reinforcement Steel from corrosion. 15% addition of silica fume increases compressive strengthh & split tensile strength .Addition of silica fume in 10% to 20% of Portland cement increases ITZ (interfacial transition zone) around aggregate. In this paper we are going to use bagasse ash as a replacement of cement with 20% by altering the amount of silica fume such as 0%, 5%, 10% and 15%. This study is carried out with a partial replacement of cement by sugarcane bagasse ash which is an agricultural waste. To obtain the strength of concrete some mechanical tests are carried out such as compressive, flexural, splitting tensile.

1.2 CEMENT

Ordinary Portland Cement (OPC) is one of the most popular building materials used all across the globe. 53 Grade OPC provides high strength and durability to structures because of its optimum particle size distribution and superior crystallized structure. Being a high strength cement, it provides numerous advantages wherever concrete for special high strength application is required, such as in the construction of skyscrapers, bridges, flyovers, chimneys, runways, concrete roads and other heavy load bearing structures.

Table No. 1.1Chemical Composition of Cement

Chemical Composition	Percentage
SiO_2	20.44
Al_2O_3	2.84
CaO	67.73
MgO	1.43
Na_2O	0.02
K_2O	0.26
MnO	0.16

1.3 FINE AGGREGATE

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. Due to scarcity of river sand M Sand is used. Manufactured sand is a term used for aggregate materials less than 4.75mm and which are processed from crushed rock or gravel. Due to booming of construction activities in our country, natural sand resources are increasingly depleted and its cost is becoming increasingly high.

For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent. River sand was used in preparing the concrete as it was locally available in sand quarry.

1.4 COARSE AGGREGATE

Coarse aggregates are an integral part of many construction applications, sometimes used on their own, such as a granular base placed under a slab or pavement, or as a component in a mixture, such as asphalt or concrete mixtures. It is the aggregate most of which is retained on 4.75mm IS sieve and contains only so much finer material as is permitted by specification. According to size coarse aggregate is described as graded aggregate of its nominal size i.e., 40mm, 20mm, 16mm and 12.5mm etc. for example a graded aggregate of nominal size 20mm means an aggregate most of which passes 20mm IS sieve. A coarse aggregate which has the sizes of particles mainly belonging to a single sieve size is known as single size aggregate. For example 20mm single size aggregate mean an aggregate most of which passes 20mm IS sieve and its major portion is retained on 10mm IS sieve.

1.5 WATER

Water is a transparent, tasteless, odorless, and nearly colorless chemical substance, which is the main constituent of Earth's streams. It is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quality and quality of water are required to be looked into very carefully.

1.6 SUGARCANE BAGASSE ASH (SCBA):

Sugarcane (*Saccharin officinarum*) is the largest crop by production quantity in the world. A large amount of wet bagasse is yielded and the management of this residue is of great importance from an environmental point of view. The combustion of this bagasse is one of the most common practices, resulting in the production of an additional residue, the sugarcane bagasse ash (SCBA). Chemical and mineralogical composition of SCBA makes it a potential supplementary material in portland cement blends and also in geopolymeric binders. Fineness, crystallinity, and the presence of unburned particles are crucial for the development of pozzolanic reactivity and for having good mechanical performance. Durability of SCBA-based mortar and concrete is appropriate, and in many cases 20% replacement of cement can be carried out without significant performance loss. Also, SCBA and sugarcane straw ash are good candidates for preparing geopolymeric binary systems. A reduction of CO_2 emissions has been proposed with the use of these residues.

In the process of making sugar, sugarcane is crushed to extract the juice. The fibrous residue is called bagasse and is used as a fuel source for feeding a boiler. Sugarcane bagasse ash (SCBA) is thus a residue obtained from the burning of bagasse in the sugar industry. In general, the ash with high silica content contains a high portion of quartz (Faria, Gurgel, & Holanda, 2010). It is characterized as a solid waste and is usually disposed of as landfill. The SCBA contains a large amount of silica (62%) and some Al_2O_3, CaO, Fe_2O_3, and potassium oxide (K_2O). LOI of about 10% implies the high content of unburnt organic matter. The major crystalline phases found in sugarcane bagasse ash are quartz (SiO_2) and cristobalite (SiO_2).

1.7 SILICA FUME:

Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolan. Concrete containing silica fume can have very high strength and can be very durable. Silica fume is available from suppliers of concrete admixtures and, when specified, is simply added during concrete production. Placing, finishing, and curing silica-fume concrete require special attention on the part of the concrete contractor. Silicon metal and alloys are produced in electric furnaces as shown in this photo. The raw materials are quartz, coal, and woodchips. The smoke that results from furnace operation is collected and sold as silica fume, rather than being landfilled. Perhaps the most important use of this material is as a mineral admixture in concrete.

Silica fume consists primarily of amorphous (non-crystalline) silicon dioxide (SiO2). The individual particles are extremely small, approximately 1/100th the size of an average cement particle. Because of its fine particles, large surface area, and the high SiO2 content, silica fume is a very reactive pozzolan when used in concrete. The quality of silica fume is specified by ASTM C 1240 and AASHTO M 307. High-strength concrete is a very economical material for carrying vertical loads in high-rise structures. Until a few years ago, 6,000 psi concrete was considered to be high strength.

Today, using silica fume, concrete with compressive strength in excess of 15,000 psi can be readily produced. The structure shown at the above right used silica-fume concrete with a specified compressive strength of 12,000 psi in columns reaching from the ground through the 57th story.

The greatest cause of concrete deterioration in the US today is corrosion induced by deicing or marine salts. Silica-fume concrete with a low water content is highly resistant to penetration by chloride ions. More and more transportation agencies are using silica fume in their concrete for construction of new bridges or rehabilitation of existing structures.

Silica-fume concrete should be transported, placed, finished, and cured following the good concreting practices outlined by the American Concrete Institute. Flatwork containing silica fume concrete generally requires less finishing effort than conventional concrete. The photo shows the "one-pass" finishing process in which the silica-fume concrete is placed, consolidated, and textured with little or no waiting time between operations. To gain the most benefits from using silica fume, the concrete must be cured effectively. The SFA or your concrete supplier can provide any necessary assistance concerning construction operations.

Table No. 1.2 Chemical Composition of Silica Fume

Chemical Composition	**Percentage**
SiO_2	91.40
Al_2O_3	0.09
CaO	0.93
MgO	0.78
Na_2O	0.39
K_2O	2.41
MnO	0.05

CHAPTER 2

LITERATURE REVIEW

2.1 LITERATURE ON CONCRETE AND THEIR PROPERTIES INCORPORATED WITH SUGARCANE BAGASSE ASH AND SILICA FUME AS REPLACEMENT FOR CEMENT:

Víctor Alberto Franco-Luján , Marco Antonio Maldonado-García

The corrosion of reinforced ternary concretes containing fly ash (FA) and untreated sugarcane bagasse ash (UtSCBA) was evaluated. Chloride-ion diffusion at 28 and 90 days, as well as microstructural properties,percentage of voids, and compressive strength (CS) in cylinders were evaluated at 2500 days of age.Moreover, corrosion was monitored in prismatic specimens exposed to a NaCl solution by corrosion potentials and linear polarization resistance techniques. Results show that the combination of FA plus UtSCBA decreased the chloride-ion diffusion and did not affect the compressive strength (CS) of the concrete. For the studied concretes, the combination of FA plus UtSCBA appears a suitable option against chloride-induced corrosion.

Prashant O Modania, M R Vyawahareb

Today researches all over the world are focusing on ways of utilizing either industrial or agricultural wastes as a source of raw materials for the construction industry. These wastes utilization would not only be economical, but may also help to create a sustainable and pollution free environment. Sugar-cane bagasse is one such fibrous waste-product of the sugar refining industry, along with ethanol vapor. Bagasse ash mainly contains aluminum ion and silica. In this paper, untreated bagasse ash has been partially replaced in the ratio of 0%, 10%, 20%, 30% and 40% by volume of fine aggregate in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken along with hardened concrete tests like compressive strength, split tensile strength and sorptivity. The result shows that bagasse ash can be a suitable replacement to fine aggregate.

V. Nežerka, P. Bílý, V. Hrbek, J. Fládr

The interfacial transition zone (ITZ) has a major detrimental impact on the structural performance of concrete.This negative impact can be modulated by introducing mineral admixtures to a concrete mix, which fill the excessive voids within ITZ and react with portlandite to form more compact products. The approach described here, consisting of characterization of phases and micromechanical modeling, enabled assessment of the effect of silica fume, fly ash, and metakaolin on ITZ thickness and strength. The proposed model was based on the MoriTanaka scheme coupled with an estimation of deviatoric stress within ITZ. This study suggests that silica fume is efficient in reducing ITZ thickness, while the addition of fly ash more significantly contributes to ITZ strength.Moderate replacements of Portland cement for silica fume or fly ash, up to 20%, can positively influence concrete performance; in case of metakaolin, replacement up to 10% is recommended.

Venustiano Ríos-Parada, Víctor Guillermo Jiménez-Quero

The effects of the addition of a Mexican sugarcane bagasse ash to binary concrete prepared with blended Portland cement (CPC) and fly ash (FA) were studied. The sugarcane bagasse ash was used practically as received (UtSCBA), with the only post-treatment application sieving through a No. 75 mm (ASTM) mesh for four minutes. The characterization of the materials used for the concrete preparation was carried out using RXFE, XRD and SEM/EDS, and the BET methods. Besides the control mixture, three ternary concrete mixtures were prepared: the control mixture (C) with 100% CPC; a mixture with 80% CPC, 20% FA and 0% UtSCBA (T0); a mixture with 70% CPC, 20% FA and 10% UtSCBA (T1); and a mixture with 60% CPC, 20% FA and 20% UtSCBA (T2). The properties of the concretes in fresh and hardened states were studied. In the fresh state, slump, volumetric weight, air content and temperature were estimated, while in the hardened state microstructure, mineral phases, compressive strength, moduli of elasticity and Poisson ratios were investigated. The results indicate that UtSCBA can be considered as a pozzolan even though the LOI content is higher than the maximum allowed in the Standard. UtSCBA particles are heterogeneous (in shape and size) with a specific surface area similar to that of the CPC. Because it has a larger volume of total pores, the use of UtSCBA leads to a reduction of workability and volumetric weight; however, the air content and the temperature in the fresh state are not affected. The results of XRD and SEM/EDS suggest that at early ages both a physical effect of dilution of the CPC and the high carbon content in the SCBA negatively affect the compressive strength of the concretes. However, the pozzolanic reaction of the SCBA is beneficial at later ages. The combination of 10% UtSCBA plus 20% FA did not affect either the development of the strength of the concrete or its modulus of elasticity. On the other hand, the addition of 20% UtSCBA decreased the strength of the concrete at early ages, but after 90 days it was similar to the strength of the control mixture.

José da Silva Andrade Neto , Mavisson Júlio Santos de França

Ashes from biomass burning, such as from sugarcane bagasse, have great potential as supplementary cementitious materials. The sugarcane bagasse ash (SCBA) possesses high pozzolanicity. However, limited studies have investigated the influence of SCBA on the durability of concrete. A knowledge gap exists regarding the influence of these ashes on the lifetime of reinforced concrete in terms of chloride migration and carbonation. Moreover, additional studies on the effects of SCBA on the alkali–silica reaction (ASR) are essential because this ash generally has a high alkali content. In this study, the effects of adding 5%, 10%, and 15% SCBA on the properties and durability (chloride migration, carbonation, and alkaliaggregate reaction) of concrete were investigated. Furthermore, the SCBA pozzolanicity was evaluated and lifetime estimations in terms of chloride ingress and carbonation were performed. The studied ash demonstrated high pozzolanic activity, which reduced the porosity and water absorption by capillarity and increased the mechanical strength of the concrete. However, because the alkaline reserve was reduced, the concrete with SCBA exhibited a higher carbonation rate (up to 69%) and a shorter lifetime regarding carbonation. Nevertheless, all concrete specimens had a lifetime of more than 50 years in an industrial environment, except for that with 15% SCBA. Adding SCBA also reduced the chloride diffusion coefficients, increasing the lifetime by up to 97.3%. SCBA addition of up to 5% mitigated the ASR owing to the pozzolanic reaction and additional C-S-H formation.

P.K. Akarsh, Shriram Marathe , Arun Kumar Bhat

This paper reveals the study on the use of graphane oxide (GO) in the high strength concrete containing silica fume (SF). The current investigations are mainly focused on the suitability of GO in SF based concretes designed for pavement applications. Initially, using the Indian Standard guidelines, the concrete mixes were designed to achieve a Pavement Quality Concrete of compressive strength 50 MPa using conventional OPC concrete. Then, to understand the exact effect of GO, three types of concretes were systematically developed, namely, silica fume concrete, Graphene oxide concrete and the blended concrete containing both GO and SF; the results were compared with that of the conventional concrete. Initially, the workability, compressive strength and flexural strength tests were conducted on trial mixes and based on the results the best combinations were selected for the further investigations. The various other tests such as compressive strength, split tensile strength, modulus of elasticity, static flexural strength, microstructure (using SEM, EDAX, XRD), durability (acid and sulphate attack test, water absorption, volume of permeable voids tests), and flexural fatigue performances were studied on selected concrete mixes. The results show that compressive strength of about 77 MPa with a flexural strength of 8.0 MPa could be achieved for a concrete mix

with 7% SF and 0.15% GO i.e., CS3G3 mix, which is way higher than the other three reference test mixes. This mix has shown considerable performance even with other mechanical and durability performances. The microstructure of CS3G3 mix had shown denser hydration products showing stronger bonding while compared it with that of the other selected mixes. The results of flexural fatigue tests revealed that the usage of GO-based concretes in association with SF can be used effectively as a pavement quality concrete applications.

Muhammad Jahanzaib Khalil , Muhammad Aslam

Concrete is one of the important material being used in construction industry. Rapid reduction of natural resources, huge amount of energy consumption, and environmental degradation involved in the production of cement has motivated researchers to investigate the suitable alternatives to partially or fully replace the cement. The research performed over the last two decades concerning the use of Sugarcane Bagasse Ash (SCBA) as a cement replacement to produce structural concrete is summarized in this paper. Firstly, general information about SCBA production, effect of burning temperature on the SCBA structure, physical and chemical properties of SCBA and reaction mechanism of SCBA are briefly discussed. Then, the influence of SCBA on the fresh state properties is presented and finally, the hardened state characteristics i.e. strength and rate of strength gain, modulus of elasticity, chloride ion penetration and aggressive environment effect on SCBA concrete are presented.

Ankur Laxman Yadav , V. Sairam

Recent researchers are giving more importance to cut the practice of ordinary Portland cement (OPC) by replacing the cementitious properties with industrial by-products in construction materials as supplementary cementitious materials (SCM). Many researchers are using Sugarcane Bagasse Ash (SCBA) as SCM which is an industrial by-product. Generally, SCM are pozzolanic materials which are rich in alumina and silicate. Naturally these pozzolanic materials may not be cementitious, but had tendency to react with calcium hydroxide and water in order to form cementitious compounds. The present paper reviews the processing adopted on sugarcane bagasse ash in order to transform it into supplementary cementitious material. The procedure to develop the sugarcane bagasse ash as a pozzolanic material is planned through a structure. The chemical compositions and physical properties of SCBA from the various sources are has been discussed. Furthermore, the influence of grinding and calcination on the characterization of sugarcane bagasse ash has been discussed.

Basically, in characterization of sugarcane bagasse ash were on base of physical, chemical and microstructural studies. This review paper focuses on micro analytical studies of SCBA samples with respect to X-ray powder diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), Transmission electron microscopy (TEM), and Scanning electron microscope (SEM). The micro analytical investigation reveals that grinding made SCBA finer and calcination process had reduced the carbon the content in SCBA along with there is an increase in the amorphous reactivity as due to the increment in pozzolanic oxides, observed in X-ray fluorescence (XRF).

Bayapureddy Yogitha , M. Karthikeyan

Cement is a non-replaceable, versatile component of concrete which is highly used in world in all construction works. Demand for cement has been increasing day by day where emission of CO2, over-useof natural resources like lime stone, shale has become environmental problems. To balance this, supplementary cementitious materials are encouraged which involves less use of cement in concrete.Agricultural wastes like bagasse ash, rice husk ash, palm oil ash have been tested for their performancein concrete with partial replacements of cement. Countries like Brazil, India are largest producers of sugarcane, faces scarcity of land due to dumping of raw bagasse. Processing of sugarcane bagasse collectedfrom factory scrap by cleaning and incinerating alters the morphological characters of sugarcane bagasse ash making it fit for using as pozzolanic admixture. It is proved that desired workability, gain in strength,reduction in permeability, resistance to thermal and electrical conductivity are observed in sugarcane bagasse ash replaced concrete when compared with conventional concrete.

Pooja Jha, A.K. Sachan, R.P. Singh

Sugarcane Bagasse Ash (ScBA) is a waste material widely used in concrete industry. It can be used as partial replacement of cement in concrete mixes and can be a suitable alternative in preparation of concrete mixes due to its good pozzolanic properties. In order to examine the characteristics, composition and morphology of bagasse ash, X-ray fluorescence (XRF), X-ray diffraction (XRD) and scanning electron microscope (SEM) analysis of ScBA were performed. In order to optimize the percent replacement of cement by ScBA, the cement has been partially replaced by ScBA in proportions of 0%, 10%, 15%, 20% and 25% by weight in concrete mixes. The various outcomes of replacement by ScBA have been analyzed through evaluation of different properties like workability (WkA), compressive (CS) and split tensile strength (STS) for 7 days, 28 days, 90 days and 180 days.

A durability property of concrete was also evaluated by the method of sulphate resistance. The results further reveal that the CS of concrete mix was relatively higher at 10% replacement of cement by ScBA and was observed decreasing beyond 10% replacement. It was also found that addition of ScBA in the replacement percentage significantly enhanced the sulphate resistance. The minimum strength loss obtained were 1.24% and 5.02% for 90 days and 180 day at 10% ScBA replacement. The results indicate that ScBA is a pozzolanic material possessing good binder properties and can potentially be used in concrete mixes as a partial replacement of costly cement.

Romildo. Berenguera, Ana Paula

The objective of this work is to analyze the mechanical strength of mortars with the partial replacement of Portland cement by ashes from the sugar cane bagasse, obtained in a sugar mill, in the region of Palmares-BR, and in a pizzeria, in Recife-BR. For the research the characterization of ashes was made by means of X-Ray powder diffraction analysis, demonstrating that the ashes of the pizzeria and the ones of the sugar mill had around 61 % and 62 %, respectively, of amorphous material. The analysis of the mechanical and chemical behavior (XRD and thermogravimetry) of cement pastes, both dosed with 15 % of substitution of Portland cement by the collected ashes, was also made. The essays were made until 91 days of age of the materials. Results indicated a possible use of 15 % of substitution of Portland cement by the sugar cane bagasse ash, since the mechanical strength was equivalent to the one of the reference series. The chemical analysis of the cement pastes confirmed the consumption of Portlandite and, in consequence, the pozzolanic potential of the studied ashes.

K. Ganesan , K. Rajagopal , K. Thangavel

The utilization of waste materials in concrete manufacture provides a satisfactory solution to some of the environmental concerns and problems associated with waste management. Agro wastes such as rice husk ash, wheat straw ash, hazel nutshell and sugarcane bagasse ash are used as pozzolanic materials for the development of blended cements. Few studies have been reported on the use of bagasse ash (BA) as partial cement replacement material in respect of cement mortars. In this study, the effects of BA content as partial replacement of cement on physical and mechanical properties of hardened concrete are reported. The properties of concrete investigated include compressive strength, splitting tensile strength, water absorption, permeability characteristics, chloride diffusion and

resistance to chloride ion penetration. The test results indicate that BA is an effective mineral admixture, with 20% as optimal replacement ratio of cement.

Muhammad Hamza Hasnain , Usman Javed , Ather Ali

Self-compacting concrete (SCC) is largely used construction material worldwide, uplifting the demand for river sand along with all of its constituents due to the recent construction boom. Rice husk ash (RHA) and Bagasse ash (BA) are the biomass waste of the abundantly produced crops in Pakistan, which causes several cardiovascular diseases to humans and poses threats to degrade air quality as well. Characterization of both RHA and BA was performed at the macro and microstructural level to study their suitability as fine aggregate in SCC. This research aims to study the effect of environmentfriendly substitution of river sand with blended waste ashes of RHA and BA on microstructural, fresh, physicomechanical and sulfate resistant properties of SCC. The results of microstructural characterization revealed the pozzolanic nature of ashes is evident in Chapelle activity test and the adsorptive natured siliceous micro-sized ash particles contribute toward higher water demand in SCC. The scanning electron microscopy (SEM) analysis of SCC mixes containing blended ashes of RHA and BA revealed that the formation of secondary calcium silicate hydrate (CSH) gel occurred at a calcium to silica (Ca/Si) ratio of 1.41 as evident in Energy Dispersive X-ray Spectroscopy (EDX) analysis. The results of rheological properties revealed that the fluidity of SCC mixes reduced due to the porous nature of incorporated ashes, whereas the viscosity of the mixes improved upon the incorporation of blended ashes. The physicomechanical properties include water absorption, hardened density, compressive strength, and split tensile strength. The physicomechanical properties depicted that the 20% collective incorporation of waste ashes produced structural lightweight concrete confirming ACI 213R with the compressive strength and hardened density values of 20 MPa and 1816 Kg/m3 , respectively. Conclusively, the eco-friendly utilization of blended ashes of RHA and BA improved the microstructure, viscosity, physicomechanical properties, and sulfate resistance of SCC.

Mohammad Iqbal Khana, Rafat Siddique

With increased environmental awareness and its potential hazardous effects, utilization of industrial byproducts has become an attractive alternative to disposal. Silica fume (SF), which is byproduct of the smelting process in the silicon and ferrosilicon industry. Silica fume is very effective in the design

and development of high strength high performance concrete. This paper covers the physical, chemical properties of silica fume, and its reaction mechanism. It deals with the effect of silica fume on the permeability, freezing and thawing resistance, corrosion, sulfate resistance, carbonation, and alkali-aggregate resistance of concrete.

Mohammed Ikramullah Khan , Mohd Abbas Abdy Sayyed

India is the largest producer of sugar in the world and thereby produces tremendous amount of bagasse. Sugar industries utilize the bagasse to recover energy and the waste byproduct commonly termed as sugarcane bagasse ash (SBA) is discarded in landfills that impacts the environment at large. The SBA primarily contains calcium oxides, silica and aluminium ion that has the potential for developing sustainable building material. This study aims to find the effect of the industrial byproducts, micro silica (MS) and SBA on the durability and strength properties of M40 grade of concrete. In this study, the cement was partially substituted with varying percentages of SBA while MS was replaced by 10% of weight of cement. The durability of the blended concrete against sulphate and chloride attack was assessed by immersing the cured concrete cubes in 5% diluted (v/v) acids (sulfuric and hydrochloric). The loss in weight of the concrete cubes and compressive strength was examined at the end of 56 days and 90 days distinctly in both the acids. The blended concrete gives optimal resistance to sulphate and chloride attack when cement is replaced in the concrete with 10% SBA and 10% MS by weight.

Duc-Hien Le , Yeong-Nain Sheen , My Ngoc-Tra Lam

This study focuses on combined usage of agro and industrialwastes in developing environment-friendly concrete. Fresh and hardened characteristics of self-compacting concrete (SCC) made of blended cement with sugarcane bagasse ash (SBA, an agro-waste generated during sugar manufacture), granulated blast furnace slag (BFS) and Ordinary Portland cement were examined through an experimental program. Three SCC mix groups (BA10, BA20, and BA30) corresponded with three cement replacing levels of SBA (10%, 20%, and 30%) were developed. For each group, four mixtures associated with four replacement ratios of cement by slag were further employed (0%, 10%, 20%, and 30%).Totally, 12 mixtures incorporating SBA and BFS blended-cement and one reference mix were developed for experiment. Fresh properties of the proposed SCC were evaluated through measurement of the density, slump, slump-flow, V-funnel test, T500 slump, Box-test, and setting time. In addition, testing of compressive strength, ultrasonic pulse velocity, sulfate attack,

water absorption as well as electrical resistivity were conducted for hardened concrete. The testing results indicated that replacing either SBA and/or BFS to OPC in mixtures led to lesser flowability. Compressive strength of sample made of 30% SBA and 30% BFS substituting to OPC were comparable to that of control after 91 days. Moreover, both of SBA and BFS strongly enhanced sulfate attack resistance; and almost SCC samples had a negligible corrosion rate after 28-day ages.

S.Mahmoud Motahari Karein,A.A.Ramezanianpour

Silica fume as partial replacement in concrete for cement increases the durability of reinforced concrete and reduces cement usage. However, the low bulk density and high specific surface area of silica fume offer challenges in its application and transport. In this study, the density of silica fume was increased by producing silica fume granules mixed with a solid super plasticizer. The effects of silica fume granulation on durability and mechanical properties of concrete were tested. Results indicated an increase in strength and surface electrical resistivity, and a decrease in permeability for both slurry silica fume and granule, compared to the control sample.

Arun Kumar Parashar, Ankur Gupta

In the present work, investigations have been done to study the effect on the mechanical properties of concrete by partial substitution of the binder with bagasse ash and inclusion of hooked steel fibers and glass fibers at optimum bagasse ash replacement in concrete. Bagasse ash concrete samples were cast for M30 grade at replacement percentages of 5, 10, 15, and 20. Hooked steel fibers and glass fibers were included in proportions of 0.50% to 1.25% with increment of 0.25% and 0.5% to 2% with increment of 0.5% respectively. The test results have shown that the mechanical properties improved upto10% BA replacement and thereby started decreasing. The optimum enhancement in flexural, compressive and split tensile strength of 6.50%, 13.09% and 8.13% respectively were determined for BA10 specimen after 28 days. On adding hooked steel fibers, the optimum strength is obtained for BASF-C sample with increase in flexural, compressive and split tensile strength of 8.89%, 18.44% and 18.80% respectively. However, the maximum strength with glass fibers was obtained for BAGF-C with increase in flexural, compressive and splittensile strength of 8.12%, 14.29% and 10.03% respectively.

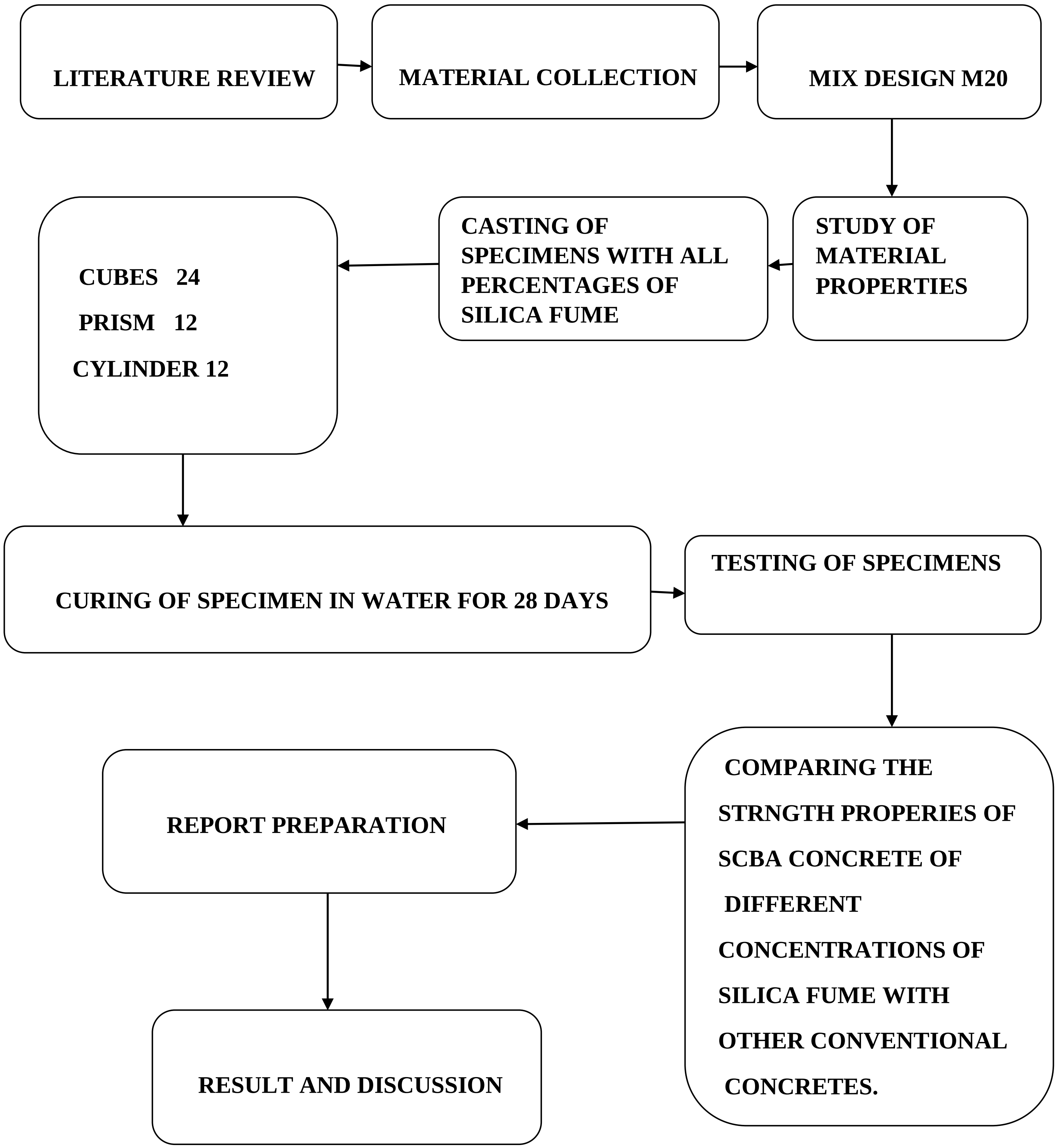
The workability decreased as the proportion of bagasse ash increased in the mix. Therefore, the bagasse ash concrete can be developed with an optimized proportion of 1% steel fibers or 1.5% glass fibers at 10% bagasse ash replacement.

A. Rajasekar , K. Arunachalam , M. Kottaisamy

This paper discusses the feasibility of utilizing sugarcane bagasse ash as a pozzolanic material in the production of Ultra High Strength Concrete (UHSC). Ordinary Portland Cement was replaced with TreatedBagasse Ash (TBA) in this investigation. The replacement dosage varied from 5% to 20% by weight of cement. The effect of bagasse ash on workability, compressive strength, chloride penetration resistance and sorptivity was examined. In addition to this, the effect of different curing regimens on hardened properties of UHSC was carried out. The results proved that it is possible to produce UHSC with cylinder compressive strength more than 160 MPa by incorporating bagasse ash. Optimum replacement ratio of15% yielded better performance in all the tests, without having any adverse effects on hardened concrete.Convincingly, 20% substitution of sugarcane bagasse ash is good enough for producing UHSC.

CHAPTER 3

METHODOLGY



CHAPTER 4

MATERIAL PROPERTIES

In the study raw materials used are cement fine aggregate natural coarse aggregate sugarcane bagasse and silica fume. Binding material like PPC 53 grade cement of compressive strength 54 N/mm^2 in 28 days meeting the standard of 12269 2013.Sugarcane bagasse ash is purchase from sivagiri and silica fumes is purchased from kangeyam was used as an admixture in cement. Fine aggregate such as river sand from zone 2 grading as per 383 1970 is used.

Table No. 4.1: Properties of cement, sugarcane bagasse ash,silica fume

	CEMENT	SUGARCANE BAGASSE ASH	SILICA FUME
Specific gravity	3.12	1.94	2.23
Consistency	30%	30%	-
Initial setting (mins)	80	140	-
Fineness modulus	5	-	-
Specific surface (cm2/g)	-	4710	15000-30000

Table No. 4.2: Properties of sand

CONTENTS	SAND
Moisture content	4.25%
Specific gravity	2.61
water absorption (24HRS)	1.12%
Fineness modulus	2.52
Bulking	28%
Sieve analysis	Zone II

CHAPTER 5

QUANTITY OF MATERIALS

5.1 DIMENSION OF SPECIMENS

Table no 5.1 DIMENSION OF SPECIMENS

Specimen	Length (m)	Breadth (m)	Depth (m)
Cube	0.15	0.15	0.15
Prism	0.5	0.1	0.1

Specimen	Height (m)	Diameter (m)
Cylinder	0.3	0.15

5.2 TOTAL QUANTITY OF MATERIALS

Table no 5.2 total quality of materials

Total Quantity of Cement	72	kg
Total Quantity of Silica Fume	14	kg
Total Quantity of Coarse Aggregate	270	kg
Total Quantity of Fine Aggregate	140	kg
Total Quantity of SCBA	18	kg

5.3 QUANTITY OF SPECIMENS

Cube		
Quantity of Cement	1.2	kg
Quantity of Coarse Aggregate	4.5	kg
Quantity of Fine Aggregate	2.25	kg
Quantity of Baggase ash	0.3	kg
Cylinder		
Quantity of Cement	1.92	kg
Quantity of Coarse Aggregate	7.2	kg
Quantity of Fine Aggregate	3.6	kg
Quantity of Baggase ash	0.48	kg
Prism		
Quantity of Cement	1.76	kg
Quantity of Coarse Aggregate	6.6	kg
Quantity of Fine Aggregate	3.3	kg
Quantity of Baggase ash	0.44	kg

Cube with 5% silica fume		
Quantity of Cement	1.2	kg
Quantity of Coarse Aggregate	4.5	kg
Quantity of Fine Aggregate	2.25	kg
Quantity of Baggase ash	0.3	kg
Quantity of silica fume	0.25	kg
Cylinder with 5% silica fume		
Quantity of Cement	1.92	kg
Quantity of Coarse Aggregate	7.2	kg
Quantity of Fine Aggregate	3.6	kg
Quantity of Baggase ash	0.48	kg
Quantity of silica fume	0.25	kg
Prism with 5% silica fume		
Quantity of Cement	1.76	kg
Quantity of Coarse Aggregate	6.6	kg
Quantity of Fine Aggregate	3.3	kg
Quantity of Baggase ash	0.44	kg
Quantity of silica fume	0.25	kg

Cube with 10% silica fume		
Quantity of Cement	1.2	kg
Quantity of Coarse Aggregate	4.5	kg
Quantity of Fine Aggregate	2.25	kg
Quantity of Baggase ash	0.3	kg
Quantity of silica fume	0.5	kg
Cylinder with 10% silica fume		
Quantity of Cement	1.92	kg
Quantity of Coarse Aggregate	7.2	kg
Quantity of Fine Aggregate	3.6	kg
Quantity of Baggase ash	0.48	kg
Quantity of silica fume	0.5	kg
Prism with 10% silica fume		
Quantity of Cement	1.76	kg
Quantity of Coarse Aggregate	6.6	kg
Quantity of Fine Aggregate	3.3	kg
Quantity of Baggase ash	0.44	kg
Quantity of silica fume	0.5	kg

Cube with 15% silica fume		
Quantity of Cement	1.2	kg
Quantity of Coarse Aggregate	4.5	kg
Quantity of Fine Aggregate	2.25	kg
Quantity of Baggase ash	0.3	kg
Quantity of silica fume	0.75	kg
Cylinder with 15% silica fume		
Quantity of Cement	1.92	kg
Quantity of Coarse Aggregate	7.2	kg
Quantity of Fine Aggregate	3.6	kg
Quantity of Baggase ash	0.48	kg
Quantity of silica fume	0.75	kg
Prism with 15% silica fume		
Quantity of Cement	1.76	kg
Quantity of Coarse Aggregate	6.6	kg
Quantity of Fine Aggregate	3.3	kg
Quantity of Baggase ash	0.44	kg
Quantity of silica fume	0.75	kg

CHAPTER 6

CASTING AND CURING OF SPECIMEN

6.1 CASTING OF SPECIMEN

All concrete samples are casted in steel moulds. They were cleaned and oiled before casting. The fresh concrete was placed inside the moulds with approximately three equal layers and compacted. Were a liquid material is usually poured into a mold, which contains a hollow cavity of the desired shape, and then allowed to solidify. Care was taken to avoid segregation of mixes. The cubes of dimension are 150 x 150 x 150 mm, cylinder of 150 mm diameter; 300mm height and prism of 100 x 100 x 500mm were casted. The specimen was left in the mould for over 24 hours and then it is de - moulded. The de - moulded specimens are taken over for curing.

Fig. No.6.1 Casting of Specimen

6.2 DE – MOULDING OF SPECIMENS

The specimen was left in the mould for over 24 hours for its setting and then it is de - moulded. The de - moulded specimens are taken over for curing.

6.3 CURING OF SPECIMEN

Cubes can be cured before they are tested**.** All the specimens are de moulded after a period of 24 hours and allowed them for curing purpose. In order to provide adequate circulation of water, adequate space should be provided between the cubes, and between the cubes and the sides of the curing tank.

Fig. No. 6.2 Curing of Specimen

CHAPTER 7

EXPERIMENTAL METHODS

7.1 Compression strength Test

Compression test are used to find the material properties under load .The compression testing machine gives maximum stress that the specimen can withstand. Here the size of the specimens are of size 150 mm3 SCBA concrete as per is 516:1959. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Figure. 7.1 compression test

7.2 Flexural strength Test

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. It is measured by loading 100mm x 100 mm concrete beams with a span length at least three times the depth. The load is applied and increased gradually until the specimen is fails.

Figure. 7.2 flexural test

7.3 Split Tensile test

Split tensile test is the indirect method of testing the tensile strength of concrete which is done by applying load vertically across the diameter of cylinder. The test provides the safety and integrity of the specimen. The dimensions of the specimen are 150mm diameter and 300mm long.

Figure. 7.3 splitting test

7.4 Sorptivity test

In order to find sorptivity coefficient water absorption test is carried out. The specimens are preconditioned in the oven at 105 degree Celsius for 24 hours and then cooled down for 24 hours. The four sides of the specimen is sealed by electrician tape to avoid evaporation effect and the opposite sides are left open. Before immersion in water the initial weights were recorded. With one side immersed in the water, the water absorption at predefined intervals was noted. The sorptivity coefficient is calculated by S= (Q/A) $t^{1/2}$.

CHAPTER 8

RESULTS AND DISCUSSION:

8.1 Compression strength test

The compression strength results for all the mixtures at 7 days and 28 days are given in figure 5. Result shows that the compressive strength of 20% SCBA concrete with 10% silica fume is higher when compared to other mixes. It also indicates the increase of strength of mixtures at later days is due to its pozzolanic properties.

Table no. 8.1 compressive strength of SCBA concrete

SF %	0	5	10	15
at 7 days	10.36	11.72	13.36	12.11
at 14 days	15.54	17.58	20.4	18.16
at 28 days	19.64	21.23	25.37	23.18

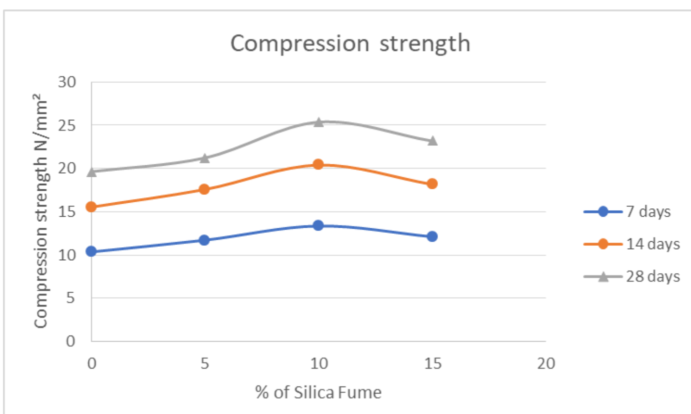


Figure. 8.1 compressive test of sugarcane bagasse ash concrete

8.2 Flexural strength test

The flexural strength results for all the mixes at 28 days are given in figure 6. The result shows that 20% SCBA concrete with 10% of silica fume is higher when compared to other mixes.

Table no. 8.2 flexural strength of SCBA concrete

SF %	0	5	10	15
at 7 days	2.32	2.5	3.11	2.78
at 14 days	3.04	3.28	4.08	3.65
at 28 days	3.62	3.91	4.86	4.35

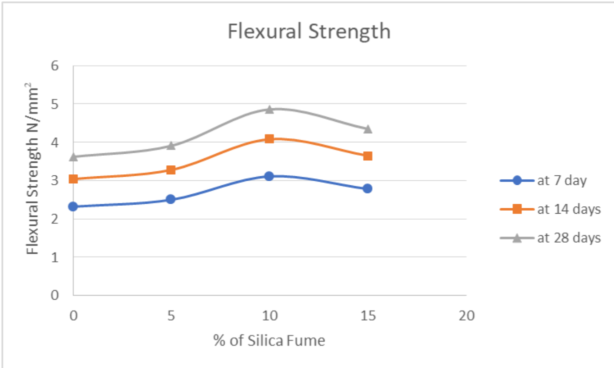


Figure. 8.2 flexural strength of sugarcane bagasse ash concrete

8.3 TENSILE STRENGTH*:*

The tensile strength result for all the mixes at 28 days are given in figure 7. The strength of mix with 0% silica fume is the highest whereas the mix with 15% is the lowest. The result shows that, when percentage of silica fume increases the tensile strength decreases.

Table no. 8.3 split tensile strength of SCBA concrete

SF %	0	5	10	15
at 7 days	2.32	2.5	3.11	2.78
at 14 days	3.04	3.28	4.08	3.65
at 28 days	3.62	3.91	4.86	4.35

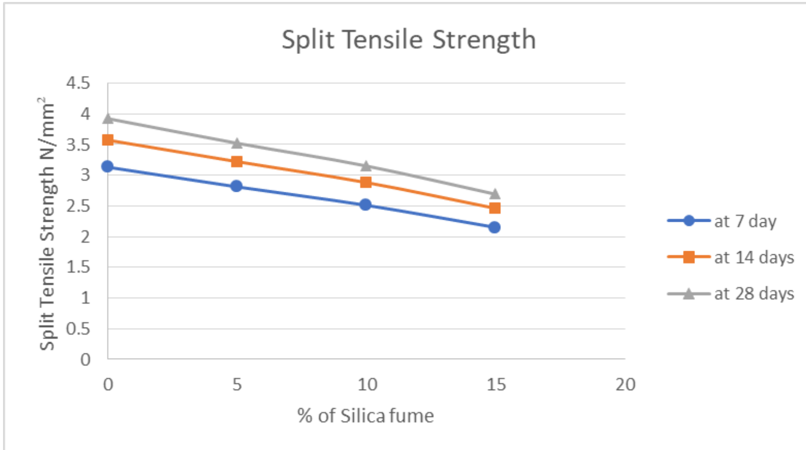


Figure. 8.3 tensile strength of sugarcane bagasse ash concrete

8.4 SORPTIVITY:

The sorptivity results for all the mixtures are given in figure 8. The results shows that sorptivity increases as a percentage of silica fume increases. Silica fume being high pozzolanic material it absorbs more water and it is reflected as high sorptivity in results.

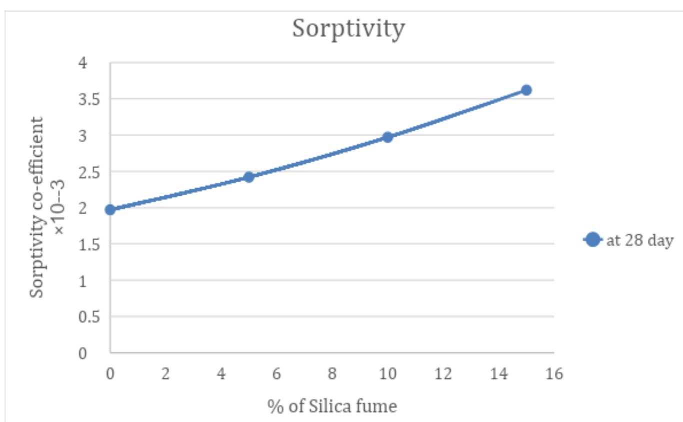


Figure. 8.4 sorptivity test of sugarcane bagasse ash concrete

CHAPTER 9

CONCLUSION

This experimental investigation indicates that the adding silica fume in concrete increases Mechanical properties.

1) While adding 10% of silica fume and 20% SCBA, concrete increases both compressive and flexural strength.
2) Split tensile strength decreases with increase in silica fume percentage.
3) Sorptivity increases with increasing silica fume percentage.

From the above conclusion we can see that adding 10% of silica fume is optimum, which have a direct bearing on durability of concrete.

REFERENCES

[1] Sugar cane bagasse ash as a partial substitute of Portland cement: Effect on T mechanical properties and emission of carbon dioxide.Romildo A. Berenguera, Ana Paula B. Caprarob, Marcelo H. Farias de Medeirosb, Arnaldo M.P. Carneiroa, Romilde A. De Oliveirac.UFPE - Programa de Pós-GraduaçãoemEngenharia Civil, Av. Prof. MoraesRego, 1235, CidadeUniversitária, Recife, PE, CEP: 50670-901, Brazil.2020.

[2] Durability characteristics of Ultra High Strength Concrete with treated sugarcane bagasse ash. A. Rajasekar , K. Arunachalam , M. Kottaisamy , V. Saraswathy. Department of Chemistry, Thiagarajar College of Engineering, Madurai 625015, Tamil Nadu, India.2018 .

[3]Evaluation of high-performance concrete with recycled aggregates: Use of densified silica fume as cement replacement.D. Pedro , J. de Brito , L. Evangelista.CERIS-ICIST, IST – University of Lisbon, Av. RoviscoPais, 1049-001 Lisbon, Portugal.2017

[4]Impact of silica fume, fly ash, and metakaolin on the thickness and strength of the ITZ in concrete.V. Nežerka, P. Bílý, V. Hrbek, J. Fládr.Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7, 166 29, Praha 6, Czech Republic.2019.

[5]. Akshay Suryavanshi, Siddhartha Nigam, Dr. Mittal. S. K. and Dr. Ram Bharosh, “An Experimental Study on Partial Replacement of Cement in Concrete by Using Silica Fume”, International Research Journal of Engineering and Technology, Volume 05 Issue 02, Feb - 2018, e - ISSN : 2395 - 0056, p - ISSN : 2395 - 0072.

[6]. N. K. Amudhavalli and Jeena Mathew, "Effect of Silica Fume on Strength and Durability Parameters of Concrete", International Journal of Engineering Science and Emerging Technologies, August 2012, ISSN : 2231 - 6604, Volume 3, Issue 1, pp : 28 – 35

.

[7]. Dhiyaneshwaran. S, Ramanathan. P, Baskar. I and Venkatasubramani. R, "Study on Durability Characteristics of Self - Compacting Concrete with Fly Ash", Jordan Journal of Civil Engineering, Volume 7, No. 3, 2013.

[8]. Dilip Kumar Singha Roy and Amitava Sil, "Effect of Partial Replacement of Cement by Silica Fume on Hardened Concrete", International Journal of Emerging Technology and Advanced Engineering, ISSN : 2250 - 2459, Volume 2, Issue 8, August - 2012.

[9]. Hiren Patel, Piyush Jain, Kaizad Engineer and Mohammed Vasim M Kaijalwala, "The Experimental Investigation of Durability Test on Concrete Cubes", International Journal of Advanced Engineering and Research Development, Volume 4, Issue 5, May - 2017.

[10]. Lakhbir Singh, Arjun Kumar and Anil Singh, "Study of Partial Replacement of Cement by Silica Fume", International Journal of Advanced Research (2016), Volume 4, Issue 7, pp : 104 - 120.

[11]. Er. Magudeaswaran. P and Dr. Eswaramoorthi. P "Experimental Study on Durability Characteristics of High Performance Concrete", International Journal of Emerging Technology and Advanced Engineering, ISSN 2250 - 2459, ISO 9001: 2008 Certified Journal, Volume 3, Issue 1, January - 2013.

[12]. Md Athar Kazmi, Mirza Ali Baig and Md Hesamuddin, "Investigation on Micro Silica (Silica Fume) as Partial Replacement of Cement in Concrete", International Journal of Science and Research, ISSN (Online) : 2319 - 7064, Index Copernicus Value (2015) : 78.96, Impact Factor (2015) : 6.391.

[13]. Pazhani. K and Jeyaraj. R, “Study on Durability of High Performance Concrete with Industrial Wastes”, Peer - Reviewed and Open Access Journal, ATI – Applied Technologies and Innovations, ISSN: 1804 - 1191, Volume 2, Issue 2, August 2010, pp : 19 - 28.

[14]. Roshni. K. G. and Vineeth. P. C, “Strength and Durability Studies on Concrete Containing Foundary Sand and GGBS”, International Journal of Research in Advent Technology, e - ISSN: 2321 - 9637, Special Issue, International Conference on Technological Advancements in Structures and Construction “TASC - 15”, 10 - 11 June - 2015.

[15]. Senthamarai. RM, Devadas Manoharan. P and Gobinath. D, “Concrete made from Ceramic Industry Waste: Durability Properties”, 0950 - 0618, doi:10.1016/j.conbuildmat.2010.11.049.

[16]. Prof. Vishal S. Ghutke and Prof. Pranita S. Bhandari, “Influence of Silica Fume on Concrete”, IOSR Journal of Mechanical and Civil Engineering, e - ISSN : 2278 - 1684, p - ISSN : 2320 - 334X, pp : 44 - 47.