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Assessement of Partial Replacement of Cement with Sugarcane Bagasse Ash as Replacement Material – A Review

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Abstract:

Nowadays researchers existing all over the globe including India are concentrating more on the minimization of renewable resources in order to make resources available for future generation. The alternative material should be economically viable in order to use it as a replacement for renewable materials. Sugarcane bagasse ash(SCBA) is one such replacement material which is available in abundance in sugar production industries. This study aims to show a limelight on various tests to determine themechanical behavior of high strength concrete with SCBA as a partial replacement material with cement.

Keywords: *SCBA,Fillermaterial,Physical and chemical Analysis,Eco-Friendly*

I. INTRODUCTION

India is marching towards sustainable development in all the sectors. Construction industry plays a keen role in it. Renewable construction materials has to be identified to reduce the exploitation of natural resources. Industrial byproducts can be used in order to safeguard the available resources as an alternate.

ISMA reports that sugarcane cultivation of India in 2018-19 is around 55 lakh hectare, which has been a used in 350 lakh tonnes of sugarproduction.India is one of the hubs for manufacture of sugarcane[14].Major part of sugarcane is used in sugar manufacturing plants.Whilemanufacturing sugar, over 30 million tons of waste is generated in a year.These sugarcane bagasse ash is dumped in open fields as these does not contain any reusable properties. About 40-45% of SCBA is used as a burning material in sugar industries. The SCBA usually has high content of silica material as well as oxides of calcium.But ash which has been gathered from the industries does not contain much of the properties because they are burnt on open fields at high temperature.Generally the SCBA materials are very hard to dispose.

Sources of SCBA

The sugarcane bagasse ash is produced during the burning of Sugarcanes for the manufacture of sugar in sugar industries.Thebagasse is usually obtained from two different sources from the industry.The first source where the bagasse is obtained is from the foot of the tanksand these are the dustattainedafter the burning process.Second source of SCBA is attained directly fromsmokestackfumes.SCBA constitutes cellulose content of 50%,Hemicelluloses content of 25%,Lignin content of 25%.For every one ton of sugarcane,Bagassecontentis of 26% [27]. The major reason for the usage of SCBA as an alternate for cement is due to its pozzolonic properties.Hence many researchers have comeup with the studies about pozzolonic properties of SCBA.So that they can find a way to use those ash in construction sector.[27] This test includes the partial usage of SCBA in construction.This experimental study involves two different types of tests taken and it is classified as two and they are fresh and hard concrete tests.The test of slump cone comes under fresh concrete test,while compression test,flexuraltest,carbonation test and RCPT test comes under hard concrete test.The cement was replaced by 10%,20% and 30% from the volume of total cementious material respectively.

TEST Engineering & Management

May – June 2020
ISSN: 0193-4120 Page No. 1860 - 1866

II. MATERIALS

A. Cement

Overall the manufacturing of OPC is much greater than PPC.The chemical composition of OPC includes various types of minerals notably Calcium,Iron,Alumina and silica in major and also in traceable proportions.Although the OPC varies in many grades notably OPC 53 and OPC 43.The 53 grade cement is used widely as it shows desirable results of consistency and fineness respectively.The Cement to be used should have a consistency value of more than 90% [11],So that it is suitable for usage in Construction.In research works,OPC 53 grade of cement is used as per IS standards [9].

B. Fine aggregate

The fine aggregate may be classified into two different types as river sand and M-sand.Due to the increase use of river sand an alternative M-sand has been used for the past 10-15 years.The main cause for the use of M sand is it is easily available and it reduces environmental degradation.M sand is free from elongation and flaky particles.The cubical shaped particles provide greater durability and high strength for the concrete.The particle size of M-sand should be from 150 micron to 4.75 mm [9].The M-sand reduces voids in concrete and it also prevents bleeding and segregation.

C. Coarse aggregate

Course aggregate increases the bonding in concrete.The aggregate should be of desirable characters including the size and shape.It should be either angular,flaky or elongated.And these shaped aggregates are more suitable and more sought out for the concrete mixes.The material used as a coarse aggregate should have a size of about 20 mm [9].

III. TEST ON CONCRETE

Tests were conducted in concrete in two different forms one in fresh state and other in hardened state. Workability of concrete was determined in fresh state. The collapse cone test is for workability and hardened test includes the study of compression,flexural,water absorption,carbonation,chloride ion penetration and content of alkali in concrete.

A. Fresh concrete Test

The fresh concrete experimental tests are carried out to regulate the workability and the uniformity of cement to be used.One of the fresh concrete test includes Slump cone test on concrete.It is one the best economically viable test carried to determine the workability and consistency.It helps us to find the desired water content as well as the setting capacity of the concrete.If the slump stands erect then it is true slump,incase of failure of slump happens then it is a shear slump.

B. Hardened concrete test

1. Test for compression

Test for compression on concrete is one of the basic tests for hard concrete [10].Compression test can be taken with the help of cube specimen.It is a mandatory procedure followed by engineers and technicians to obtain accurate test results for compression strength for concrete [17]. The test block was put midway between the platens of a pressure testing machine, with trowelled face sideways. Compressive quality fc is resolved as the most extreme burden (disappointment heap) of the sample that can withstand over the contact load region. The data obtained from the tests are very much helpful to come to a conclusion about the obtained mixes.The trial should beconceded out for7 and 28 day after preserving of the cube sample [9].

Fc=Failure Load/Area

2. Flexural strength Test

The strength of tensile on concrete can be easily obtained from the test of flexure.It is a basic mechanical test to find out total bending of beams.The loads can be applied as a pointed load [5].The results of flexural tests on concrete can be expressed in mega Pascal or psi [3]. In the point flexural stacking test, a 100x100x500 mm solid shaft is stacked at a pace of 400 Kg/min. The flexural quality of the sample will be communicated as the modulus of crack R [7]. The moulds were demoulded after 7^{th} day and 28^{th} day respectively.Universal Testing Machine is used to obtain the test results.

May – June 2020
ISSN: 0193-4120 Page No. 1860 - 1866

$$RL=pl/bd^2$$

Where R is the modulus of break, P the most extreme showed load, L the range length, b the width and d the profundity of the sample. The equation is legitimate just if break in the strain surface is inside the center third of range length. In the event that the crack is outside by not over 5% of the range length, an altered equation is utilized [7].

$$R=3pa/bd^2$$

3. Carbonation Test

Carbonation test is one of the tests that is done in order to check the concrete durability and it relates the corrosive properties[4].To prevent the corrosion of steel reinforcement, Carbonation test is the mandatory test[4,8,19,23,29].It involves the measuring of depth of carbonation happened in the concrete.Specimen of cube mould is taken for carbonation test and four different mixes were taken as 0%, 10%, 20% and 30% of SCBA [19].Indicator phenolphthalein is used for the testing of carbonation of Concrete. The technique for carbonation profundity estimation incorporates acquiring 10 information focuses from different sides of every sample, which sums 30 focuses from various edges of each from three cases for apiecesample, and afterward acquiring profundity of carbonation for apiecesample and gathering together to the adjoining half mm. [23]

4. Water absorption Test

The good type of concrete is known by one of the tests called absorption of water test.It is used to find the permeability value as low [4].Injection of water can be found out.The thawing mechanism as well as freezing mechanism can be identified [21, 22]. The test estimated the limit of water to infiltrate into the mortar. The measure of water retained was determined and standardized concerning the cross-segment zone of the samples presented to the water at different occasions [22], for sample, 0, 5, 10, 20, 30, 50 and 60 min respectively. Water ingestion test estimations on the solidified samples were completed at 28 First, the samples were set in a stove at a 105°C for 24 hours [4]. A while later, they were expelled from the broiler, cooled, and were weighted (Md). The samples were submerged in water for 48 hours and weighted [21]

5. Rapid Chloride Penetration Test

Resistivity property of concrete can be obtained by the test called Rapid Chloride Penetration Test.The apparatus can consist of salt solution and hydroxide of sodium solutions [13].On a whole the test of RCPT can be done to find the resistance of penetration of ions of chloride. The pace of entrance of chlorides into concrete relies upon the pore structure of the solid, which is influenced by factors including materials, development practices, and age [28]. This will be impacted by the water-concrete proportion of the solid. The more seasoned the solid, the more prominent measure of moisture content that has happened and hence the additional exceptionally created will be the pore structure [13]. This is particularly valid for concrete containing more slow responding beneficial solidifying materials, for sample, fly debris that require a more extended time to hydrate. The pace of chloride entrance into concrete is subjectiveto the chloride controllingboundary of the concrete [12]. Concrete isn't dormant comparative with the chlorides in the holeprocedure. Some of the chloride elementsreacts with the solid frame turning out to be either artificially or truly bound, and this coupling decreases the pace of dispersion

6. SEM analysis

The ability and sustainable properties of the concrete can be obtained from SEM analysis method.The behavior of Micro structure of the particles can be analyzed.The c-s-h gel was obtained as a byproduct from oxides of calcium [20]. The arrangement and conveyance of hydration results of hydrated concrete glue of seven distinctive blend extents are presented beneath. The microstructure of the seven blends were analyzed and contrasted and the ostensible blend. The microstructure and quality properties of all the seven blends were related dependent on the hydration items shaped following 28 days [2]. The purpose for the quality of the solid was broke down and clarified dependent on the development of hydration items in the microstructure of cement blends.These development and dissemination of mineral components was one reason for the successful quality of the blend [1]. Supplanting of fine total with fabricated sand didn't uncovered any imperfection in quality at the same time, the scope

May – June 2020
ISSN: 0193-4120 Page No. 1860 - 1866

of dispersion of minerals was changed because of supplanting of fine total with produced sand [2].

7. Acid attack Test

The constituents which are easy for the attack of acids can be identified from the acid attack test.Mainly the test can be done on hard concrete which poses hydroxides of calcium ions [8].The capillary porosity may see a rise in acid attack tests.The tests were done on round and hollow samples which are kept in anunpollutedcorrosion lessflexiblevessels with sufficient corrosive answer for drench the uncovered surfaces totally [24]. The trialextent was constrained to 120 mins and the surfaces of the trialsections were washedafter 20, 40, 60 and 120 mins respectively during course of time.The compressive quality of solid shapes and chambers diminishes with increment in centralization of corrosive.The activity of acids on concrete is the change of calcium mixes into calcium salts of the assaulting corrosive [25]. These responses demolish the solid structure.The weight reduction of sampleimmersedinsulphuric corrosive following 28 days is lessened to 20% slag of copperreplacement [26]. Preceding that extent, the loss of weight sample is expanded. The utmostgreatmassdrop is acquired for the combinationcomprising 10% of GGBS, as well as 10% of Metakaolin,including 40% of slag of copper alternative. The utmost great weight increase is accomplished for the mixtureenclosing 5% of GGBS, as well as 5% ofMetakaolin and 20%of slag of copper as substitution. For the mixturecomprising 20% of slag of copper has the inferiorbulkadversity than control concrete. Be that as it may, the minimumquantity lossis accomplished for the mixturecomprising5% of GGBS, 5% of metakaolin and 20% of slag of copper. Anyhow the bulkadversity is greater for the mixturecomprising 40% of slag of copper [26]. The activity of GGBS and metakaolin makesgradually thick concrete. This is recognized to compete with the corrosive section into the solid. Comparable conduct is acquired for hypo chloric corrosive drenching.

IV. DISCUSSION ON EXPERIMENTAL RESULTS

1. Compression Test

NirupChama et al. tested the concrete cubes of both nominal mix as well the replaced mix.The compressive strength of typical or nominal mixis 28Mpa, as when bagasse ash is supplanted with concrete in rates, the compressive strength increments with increment in level of bagasse ash up to the ideal worth that is 10%. Further increment in bagasse ash in concrete mix, it lessens the compressive strength of the replaced mix. [15]

Prashant O Modaniet et al. also tested the cubes of both nominal mixes as well as replaced mixes.The strength of compressive values of samples of 10% replacement of bagassewere greater than those at 0% of bagasse. Further raise in bagasse rate brings about diminishing compressive strength alongside massivedescent in stuffs of fresh solid. Likewise it ispresented that the pace of increment of cohesion of blends with bagasse is greaterbyadvancedtimes that might be expected to pozzolonic possessions of bagasse. [18]

2. *Flexural Strength Test*

Nirup Chama et al. tested the strength of flexure with nominal mixes and replaced mixes.The flexural strength of ordinary mixes is 3.13MPa, as the concrete is supplied with bagasse, the flexural strength increase with increment in level of bagasse debris up to 10%. After 10% there is a continuous abatement in flexural quality worth. [15]

M.Bharath and M.Anjali also tested the flexural strength of concrete with nominal mixes as well as replaced mixes.The flexural strength of nominal mixes is 2.85Mpa as the concrete is supplied with baggase,the flexural strength increases with increase in baggasecontent.After 20% there is a continuous abatement in flexural strength values. [6]

3. Carbonation test

Measuring the depth of carbonation at the different sections of the sample with different percentages [29].Phenolphthalein is used as an indicator and specimen tests turns pink color and it was denoted as uncarbonated and if it is colorless it implies that the specimen is carbonated.

A Pravalika and N Venkat Rao tested the cubes of both nominal as well as replaced mix.According to their works the depthof carbonation gradually increases from 0% to 15% mixes and after that it falls drastically for 20% and 30% mixes [19]

M.A.Sanjuan et al. tested the cubes of both nominal as well as replaced mixes.According to their works

May – June 2020
ISSN: 0193-4120 Page No. 1860 - 1866

the depth of carbonation takes a fluctuation upon increasing the percentage of ash.For 0% it ranges 8mm and for 10% it ranges 5.5mm and for 20% it ranges 8.7mm. [23]

4. Water absorption test

The amount of water absorbed in percentage which is the difference in weight of specimen and oven dried weight.

SalmabanuLuharet et al. tested the water absorption test by keeping the cube under monitration for 28 days and it was subjected to accelerate curing for that it is preserved underwater of 85°c for 24 hours and the wet load as well as dry load was calculated. The water absorption increases from 0% to 15% and after that it faces a decline or depletion. [22]

Rushab H et al. tested the water absorption test by keeping the cube moulds under monitration for 28 days and it was subjected to accelerate curing for that it is preserved under water of 85°c for 24 hours and the wet load as well as dry load was calculated.The water absorption increases from 0% to 20% and after that it faces a decline. [21]

5. Rapid Chloride Penetration Test

Jemimah Carmichael et al conducted the RCPT investigation on material.It may be perceived that supplanting of concrete bynanomaterials diminishes entrance of chloride element. In the event of substitution of concrete with nano concrete and nano fly debris, the decrease in entrance of particles of chloride proceeds uniform upto half substitution level. It tends to be realized the expansion in of nano concrete lessens chloride vulnerability upto 90% when contrasted and Normal concrete cement. Anyway in instance of supplanting of concrete with nano silica and nanosilica rage, most extreme decrease in the chloride particle entrance is found at 20% and 30% substitution level individually[13]

6. SEM analysis Test

Praveen kumar S, et al. conducted the Scanning Electron Microscopy (SEM) analysis on the desired cubes and they replace the cement with SCBA by 10%, 20% and 30% respectively and they arrived with a result, the development of gel of C-S-H is seen with thesamples at 28 days. The shape is defined as fibrous uninterrupted system. An exceptionally thick system is seen in test ofmaterial with 10% of SCBA on 28 days by no essentially obvious pores. The sample of material with 15% bagasse likewise demonstrated a profoundly thick system consisting C-S-H. [20]

Andreãoet.,al also conducted the Scanning Electron Microscopy(SEM) analysis on the desired cubes and they obtained the results,adhesivesusinguppermost and base ash showed densification of microstructure inferable from development of C-S-H. Thick C-S-H liniment grid should be joined by portlandite as announced somewhere else The concrete glue consolidating the debris unveiled less holes all throughout desiredsample. At the crossing point of holes, nearness of powdery needle likeelements identified with calcium arrangements. sulfo-aluminate items should be watched. Other sporadic and harsh surface particles showed up, which speak to silica and inorganic mixes, for sample, potassium [2]

7. Attack of acid test on concrete

Sravanet al.piloted the Acid attack test on concrete cubes to find out the weight loss as well the chemical attacks on concrete. They found that The most extreme misfortune in weight was seen with 0% and 30% SCBA content blends for all soluble base introduction period conditions. The base misfortune in weight was seen with 15% SCBA content at 7d, 28d and 56d introduction period. For all introduction periods, the misfortune in weight was seen to be diminishing with increment in SCBA content from 0% to 15%, while above 15% SCBA content the weight was seen to be diminishing up to 30% SCBA content. The buildup weight at 56d antacid introduction was seen as 94%, 96% and 93% for 0%, 15% and 30% SCBA individually. Consideration of SCBA as concrete substitution in concrete demonstrated improvement in the resultsunder soluble base introduction condition. [26]

ShripadUmale et al. conducted the acid attack test on concrete and found that concrete blocks for 5 % application of several acids while exposed to scattering for 30 and 60 days respectively. At

May – June 2020
ISSN: 0193-4120 Page No. 1860 - 1866

greater introduction days of 60, greatest decrease of about 0.8 % is seen while solid squares are scattered with HCL corrosive, likewise at lesser presentation of 30 days, most extreme decrease of 0.6 % is watched for HCL corrosive. Inthe case including Sulphuric corrosive, a turnaround pattern is seen where load is expanded by 30 days presentation time, and it is viewed as strange. [25]

V. CONCLUSION

Major conclusions drawn from this study are presented as below.

1. SCBA when partially mixed with concrete it gives more result than the nominal mix
2. The water absorption and permeability decreases with increase in SCBA.

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