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A Study on Effect of Bamboo Fiber in Self Compacting Concrete Partially Replacing Cement with Ggbs and Alcofine

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ABSTRACT: -An attempt has been made in the present investigation to study the effect of Ecobamboo fibers on the strength behavior of FRSCC partially replacing cement with GGBS and Alccofine. An innovative natural plant bamboo fiber where more atmospheric CO2 could potentially be sequestered and it is extracted by using mechanical method was used in this study and cement being costly, replaced by waste material GGBS, ALCCOFINE is added to produce high strength and performance concrete. A mix proportion of SCC was arrived by using trial and error method and w/c ratio was maintained constant for all the mixes. The bamboo fibers of 1% (l/d ratio=40 which already evaluated by experiment) of 4.9mm length to the weight of cement are added to the SCC which cement is partially replaced by 30% GGBS and 10% of Alccofine. The outcome of using bamboo fibers in the compressive strength, split tensile strength and the flexural behavior has been studied. The addition of bamboo fibers also made the concrete very resistive in flexure and maximum improvement in 28 days strength was observed to be 6.1 N/mm2, hence addition of bamboo fiber content increases the flexural strength in scc also with the replacement of GGBS and alccofine.

KEYWORDS: -Bamboo fiber; Alccofine; GGBS; fiber reinforced concrete; high strength; Self-compacting concrete.

I. INTRODUCTION

1.1 General

A Shelter is an essential basic need for the humans. Concrete is the most preferred materials forbuilding, which has a high compressive strength and high flexibility. Concrete has a history ofover a thousand years. Earthquake is the immense problem which causes excessivedamage to the buildings and structures which results in loss of human lives, loss of economic andenvironmental issues. An attention has to be paid towards the design of longitudinal andtransverse reinforcement to avoid brittle failure due to shear in joints. In order to reduce this effect and to ensure adequate ductility to the members, a large amount of lateral reinforcement isrequired. Hence, it is important to develop new types of materials which enhance the ductilityproperties of the structural elements. Recently studies shown that strengthening of structuralelements in many ways, they are

• Introducing micro and macro or combination of both fibers in the beam-column joints
• Using FRP wraps in the critical joints

It is also possible to reduce the amount of transverse reinforcement steel and improve the performance of the structural elements against lateral loading by using fibers in those criticalregions. By considering the global warming issues, to produce the sustainable concrete wastematerials like GGBS is used to replace the cement which produces an excess of carbon while

1.2 Fiber Reinforced ConcreteThe Egyptians had established the idea of usage of fibers in the concrete as a strengtheningmaterial. Formerly, straw and hair of creatures are mixed as reinforcing material for the settingup of blocks in walls. The making of different fibers was very less in percentage and land shouldrequire to offer potentiality to the improvement. Presently the idea of FRC is anincredible extension to enhance the efficiency and more prominent performance of the concrete.

It is required to yield the highly strength, workable and durable concrete through appropriate length to diameter ratio. The main motivation of using the natural fibers is to produce thesustainable fiber reinforced concrete which provides the strength,

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better crack resistance capacityto structures in order to attain the better performance by building the structures rigid. In light ofnormal concrete retains less tensile, ductile and crack resistance. In brittle materials like plainconcrete, structural flaws (micro cracks) develop even afore loading, mainly due to dryingshrinkage and volume variations. Hence, to overwhelm all these difficulties, another way likefiber reinforced concreting technique has been used. FRC is a composite material contains fibersin the cement matrix are distributed orderly or randomly. Its characteristics depend on theeffective transmission of stress between the fiber and matrix. The main considerations are kindof fiber, geometry, orientation, and scattering of the fibers. Dimension and shape of the aggregateused in concrete and mixing, compaction methods of concrete.1.3 Bamboo Fiber Reinforced Self Compacting ConcreteBFRSCC is a composite material, where natural fibers are used in SCC. The concrete involvesbamboo fibers of different lengths and different diameters with different fractions. Jute and kneafplant strands are ordinarily being used for automobiles as substitutes for glass strands. Due tosmaller amount of land accessibility to develop the common plants, increase in those fiberproductions on the earth was too difficult. So, we have to identify an alternative solution to extractthe similar fibers. For that the Bamboo is best alternative, it isn't grass neither wood, it ensurestwo of their features and it is too strength because of alignment tough fiber bundles in itslongitudinal direction.

The bamboos are popular plants in the subfamily Bambusoideae of the grass family Poaceae.Bamboo constitutes, intermodal segments of the stalk are typically hollow and the vascularbundles are distributed in the cross-section all over the stalk instead of in a cylindricalorganization. No presence of dicotyledonous woody xylem. Hence, deficiency growth of woodmakes the stem of palms, monocot, and huge bamboo, to be columnar other than tapered.

1.4 Self Compacting ConcreteSCC is one of the latest development in the concrete industry. It's first introduced during 1980by Okamura from Japan. From that point forward it is the topic of various examinations toaccomplish the preferred characteristics of new concrete structures. It was emerged as an advanced technology which has an ability to achieve the best concept in the field of concretefield. It has the main benefit that it flows under its self-weight which attains full compaction and completely fills formwork, even in the presence of crowded reinforcement. It is the best solutionfor both normal and precast concrete construction because of advanced construction practice, performance, and safety and health benefits. The latest application of SCC focusses on greatperformance and uniform quality.1.5 Need of SCCUsing self -compacting concrete in structural elements will results in the compaction of theconcrete as well as the reduction in the cost of vibrating compaction. Greatly improvedconstruction structures are achieved by self - compacting concrete. The real-world applicationsshowed that SCC can reduce the casting noise, enhance efficiency of the construction anddurability of concrete, hence fore SCC commonly used in practice.

Advantages of SCC

• In case of crowded reinforcement, tough access etc. situations, SCC produces consistentconcrete.
• Even in the case of heavy reinforcement, SCC achieves a good bond between concreteand reinforcement
• It has good filing ability, mainly all over the reinforcement and also resists the segregation
• Total concrete pouring time is reduced because of fast and more effectiveplacement of concrete
• It is used to create different structural and architectural shapes where surface finishing forthose is difficult to achieve by conventional concreteIt guarantees the enhanced quality in case of in-situ pile foundation
• The Noise level of the construction site is reduced as a result of not using a vibrationmachine.
• The required number of workers on construction sites can be minimized as well as theenergy consumption
• Safer and healthier working environment is obtained
• In the precast industry construction time is reduced with acceleratingconstruction process.

3. Disadvantages of SCC

• More experience and care should be taken for the Production of SCC than theconventional vibration. an unrestrained moisture content difference of even 1% in the fineaggregate ought to greatly affect the SCC rheology at a less water- cement ratio
• The formwork should be designed for resisting the concrete liquid pressure which isgreater than normal concrete
• Because of potential leakage along the way which create environmental andcontamination hazards, practically, the full mixer of SCC is possible.

1.5 Applications

1. Self-healing bacterial concrete can be used for sectors such as tunnel-lining structure basementwall, Highway Bridge, concrete floors and marine structures.

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1.6 OBJECTIVE OF THE STUDY

The objectives of the present study are as follows:The present research investigates the effectiveness of bamboo fibers in concrete elementsby improving the conventional concrete. The main objectives of the study are:

•To investigate whether innovative bamboo fiber of different ages can be used in the concretesince it is a natural fibrous plant having high tensile strength which imparts good strength as well
as carbon sequestrate will be considering as ecofriendly fiber

•To evaluate the fiber length to the fiber diameter ratio (l/d) of bamboo fibers in concrete based
on mechanical properties, since the mechanical properties mainly depends on the aspect ratio,fiber type, volume loading percentage, orientation, dispersion of fiber and fiber-matrix adhesion

• To evaluate the optimum percentage of alcidine that replaced the cement in SCC mix withGGBS to produce sustainable and highly durable SCC

• To study the effectiveness of the natural bamboo fibers in the SCC with GGBS andalccofine based on strength characteristics, since SCC was emerged as an advanced technologycombining with fibers, GGBS and alccofine can produce a high srength and durable concrete (i.e. BFRSCC with GGBS and alccofine)

• To study the durability characteristics of BFRSCC with GGBS and alccofine like fireresistance, acid attack, alkaline attack

• To assess the real performance of the BFRSCC with GGBS and alccofineperipheral beam - column joint by experimentally and analytically

II. LITERATURE REVIEW

Saandeepani and Krishna Murthy (2013) has led examinations utilizing distinctive natural strandsto the field of concrete in the mandate to estimate the strength characteristics and furthermore forwatch the lessening in the propagation of shrinkage crack issues. He presumed that Slump wasdiminishing with the expansion of strands. Increasingly the fiber- powder proportion, additionalis the reduction in slump on account of receptiveness of water by filaments. The adding offilaments improved the compression strength with 0.5% fiber- powder proportion and slightincrement for 1% of the fiber- powder proportion contrasted with normal concrete. In any case,at the fiber cement proportion of 1.5%, however SP is included, the compression strength isdiminished contrasted with normal concrete. The major observation from this research is theusage of fibers increases the strength and decreases the workability, it can mitigate by addingsuper plasticizers.Majid Ali (2012) has investigated distinctive natural fibers utilized as a part of the most recentcouple of decades, and accordingly, it can be utilized as a source of perspective for the prospectiveresearch of a specific fiber. The consumption of natural filaments, as reinforcing content forcomposite is economical for increment of their specific properties like strength, durability andadditionally blends of these. On account of varieties exist in properties of natural fibers,deviations ought to be appropriately tended to as we need to sort the gradation of aggregates. Themajor observation from this research is the usage of natural fiber increases the strength and forimproving durability properties we need to add some materials and protective coatings.Ashik and Sharma (2015) has reasoned that there is a probability to upgrade the properties of jutefiber reinforced polyester composites. But only a few investigations examinations carried onGJFREHC and properties. To locate the dynamic properties of the composites utilizing modaltest technique, there was no much data accessible. It drives the way for the examination of mechanical and dynamic behavior of GJFREHC. Both static test techniques and dynamic teststrategies were conducted and validated the outcomes through FE simulation. The important
observation from this work is the usage of natural fiber leads to the increment in strength but inorder to asses real ime performance we need to conduct both static and dynamic test by experimental and can validate with numerical simulation.Mohammad Adnan Farooq and Mohammad Shafi Mir (2011) has presented the research todetermine the effect of steel fibers, aspect ratio, optimum volume fraction and also mechanical characteristics of the steel fibers. After conduction of different experiments, it inferred that theyoung's modulus of concrete is altogether enhanced by the utilization of fibers of steel with the optimum fiber volume fraction for both the aspects ratios 71 and 50 was 1.5%. The importantinformation from this work is to assess the effect of fibers, aspect ratio and optimum volume fraction are the major parameters.

Rama Krishna and sundarajan (2005) announced the experimental examinations on the differentfiber such as coir, sisal, jute, and hibiscus cannebinus cement mortar slabs of mortar 1:3 and ofsize 300 mm × 300 mm × 20 mm. a simple projectile test was conducted to study effect of impactloads. Four different fiber contents 0.5%, 1.0%, 1.5% and 2.5% by weight of cement and threefiber lengths (20 mm, 30 mm and 40 mm) were considered. The test outcomes inferred that the increase of impact resistance for the inclusion of the natural fibers increases parameters likeresistance of impact (Ru), ratio of impact crack-resistance (Cr), a

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ratio of residual impact strength(IRS) and the condition of fiber at ultimate failure by 3–18 times than that of the conventionalmortar slab. The coir fiber reinforced mortar slab has demonstrated the best performance.

Zakikhani et al. (2014) stated that bamboo fibers can be utilized in construction industries ascomposite because of its ecological supportability, mechanical properties, and a reinforcedpolymer matrix. Examinations gave the structure of bamboo and diverse techniques for extractionof bamboo, for example, mechanical, chemical and combination of mechanical and chemicalextraction and furthermore they contrasted with glass fiber on account of its lightweight,biodegradability and low cost. The research work gave different methods of extraction of bamboo fibers and when it resembles the glass fiber in terms of its properties and cost.

FRC is the broadly used construction material by adding the different material andvolume of fibers the strength of the concrete can be improved. This chapter presentsthe details of materials used and selection of bamboo, extraction process, prevention methods and properties of bamboo fibers used, concrete mix design,details of the specimen for conducting the tests.

Materials

The different materials utilized in the investigation are explained briefly below

- Cement
- Fine aggregates
- Coarse aggregates
- Alccofine
- Ground Blast furnace slag
- Bamboo fiber

Cement

OPC grade of 53 tested according to IS: 4031-1988 and confirmed to IS: 12269-
2004 was used in the investigations. Table 3.1 indicates Physical characteristics of
cement.

Alccofine

Alccofine is slag with high reactivity and high glass content product specifically processedattained by the process of controlled granulation. The raw materials chiefly constitute smallquantity of calcium silicates. The controlled particle size distribution is attained by processingwith other select ingredients. Alccofine 1203 provides good workability and utilized as a highrange water reducer to increase compression strength. Due to the accurate procedure of thisdistribution of particle size, this alccofine gives the greater results and reduces the content ofwater.

GGBS

GGBS is using because of its overall economy in making and as worthy as their enrichedperformance in aggressive environments. It's obtained by quenching melted iron slag from a blastfurnace in water to provide a granular glassy product. After that it is dried and grinded into thepowder. Table 3.3 indicates Physical characteristics of GGBS.

Fine Aggregates

The materials smaller than 4.75 mm size is called fine aggregates.The code to be referred to understand the specification for fine aggregates is: IS 383:1970.
The criteria to classify fine aggregates are:

- If they are Natural/ Man-made.
- According to their size.
- According to the IS specification

Fine aggregate may be described more clearly according to their availability as:

- Natural Sand– it is the aggregate resulting from the natural disintegration of rock and which hasbeen deposited by streams or glacial agencies
- Crushed Stone Sand– it is the fine aggregate produced by crushing hard stone.Crushed Gravel Sand– it is the fine aggregate produced by crushing natural gravel.According to size the fine aggregate may be described as coarse sand, medium sand and finesand.IS specifications classify the fine aggregate into four types according to its grading as fineaggregate of grading Zone-1 to grading Zone-4. The four grading zones become progressivelyfiner from grading Zone-1 to grading Zone-4. 90% to 100% of the fine aggregate passes 4.75 mm
IS sieve and 0 to 15% passes 150 micron IS sieve depending upon its grading zone.In this project Natural sand is used of following properties.

Coarse Aggregates:

Locally available well graded granite aggregates of normal size greater than 4.75 mm and lessthan 16mm. The code to be referred to understand the specification of the coarse aggregates fromnatural sources is: IS 383:1970.Coarse aggregate may be further classified as:

- Uncrushed Stone– it results from natural disintegration of rock.

Crushed Stone– it results from crushing of gravel or hard stone.

- Partially Crushed Stone– it is a product of the blending of the above two aggregate.In this project Crushed stone used as coarse aggregate of following properties

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Bamboo Fibers

Bamboo fibers are natural plant fibers which has numerous benefits such as environmentallyfriendly, sustainable, less cost, less density, extraordinary growth rate, strength, and good CO2 sequestrate. It's compared with glass fiber for the reason that of its lightweight, biodegradability,and less cost. Bamboo is primarily a type of huge grass with wooded stems. The stems of theplant are young called "shoots" and when the plant completely mature called "culms".The bamboo plant comprises of two parts – the "Culm"or stem which grows above the ground and below ground that bears the roots called "rhizome". "A bamboo culm yields up to 15 km ofa pole and diameter of 30cm approximately in its whole life. These possessions made it to use by tradition for the massive utilization in building construction and living tools, and also used ascomposite reinforced material based on the extraction of fibers in a well-ordered manner. Even though, there may be some problems that provide obstructions to an extensive usage of fibers ofbamboo.They are as below

•Mechanical and chemical possessions of bamboo are insufficient at thefundamental phase and moisture resistance is low

•The existing method of extraction of fibers from bamboo Culm is not suitable for engineeringand marketable production

EXPERIMENTAL INVESTIGATIONS

• Tensile test

The tension assessment is perhaps the most essential kind of mechanical test that can conduct onmaterials. These are simple, inexpensive and fully standardized. As the material is pulled in itslength direction we can find the strength based on how much it. To perform the test, bamboosamples should prepare. Firstly, the suitable size and shape of the samples were cut. The distance between the nodes gives the length of the specimen. Usually the 9 and 12 inches (229 and 305mm) long samples were tested. So, we have taken 9 inches (230mm) sized specimen bamboostrips as shown in the figure 3.9. Some of the samples were too strong to brake, widths of thesamples were reduced. The thickness along with the widths are differed between the samples.Since it is a natural material whose physical characteristics are varied and careful sampledimensioning to be done before testing.

• Compressive streng

thindicates compressive strength of bamboo fiber reinforced concrete cubes of size150mmx150mmx150mm using fibers of diameters (D1) 700 µ and (D2) 1.156 mm for M30grade of concrete for 28 days for the aspect ratio of 30, 40 and 50. it is shown that thediameters 700µ and 1.156 mm fibers at 1% aspect ratio (l/d) of 40 gave the maximumcompressive strength. The diameter 1.156 mm fibers at 1% gave the maximum compressivestrength of 41N/mm2with an aspect ratio (l/d) of 40 when mixed with concrete. Both thediameters of fibers showing the decrement in the strength at the 1.25% addition of fibers.

• Splitting tensile strength indicates splitting tensile strength of BFRC cylinders of size 150mmx300mm using twodifferent diameters (D1) 700 µ and (D2) 1.156 mm for M30 grade of concrete for 28 days forthe aspect ratio of 30, 40 and 50. It is shown that the diameter of 1.156 mm fibers at 1% gavethe maximum split tensile strength of 4.8N/mm2with an aspect ratio (l/d) of 40 when mixedwith concrete. Both the diameters of fibers showing the lesser decrement in the strength atthe 1.25% addition of fibers.

• Flexural strength

indicates the flexural strength of BFRC beam of size 150mmx150mmx1200mm using twodifferent diameters (D1) 700 µ and (D2) 1.156 mm for M30 grade of concrete for 28 days forthe aspect ratio of 30, 40 and 50. It is shown that the diameter of 1.156 mm fibers at 1% gave

the maximum split tensile strength of 8.5N/mm2with an aspect ratio (l/d) of 40 when mixedwith concrete. Both the diameters of fibers showing the very less decrement in the strength,at the 1.25% addition of fibers.

CONCLUSION

General

The conclusions are drawn by conducting the research on the bamboo fibers, Alccofine,GGBS,SCC with GGBS and Alccofine, BFRSCC and BFRSCC with GGBS and Alccofine are shownbelowEvaluation of length to diameter ratio of bamboo fibers

•Bamboo fiber is an inventive ecofriendly fiber and is acquainted to the field of concrete toenhance the tensile and flexural properties, which is of minimal effort and to deliver highstrength concrete. Maintaining center around substitution for natural plants fiber, as they havingthe favourable circumstances, for example, very less cost, density is lower, friendly withenvironment

•The bamboo fibers extracted by mechanical method has been selected and SEM test is carriedout to study the diameters of the fibers, orientation of the longitudinal strands, pore sizes offibers, and micro structure to assess the failure.

•Tension test is also carried on the specimen to find out the tensile strength of the bamboo stripswhich are

used for extracting fibers. The maximum value of tensile strength for 8 mm widthstrip is 116 N/mm2

•The FRC with fibers of different diameters, 700µ and 1.156mm was extracted using mechanicalmethods with various aspect ratios of 30,40,50 with different fiber percentages such as 0.5%, 0.75%, and 1.25% and treated with Boric Acid- Borax of proportion 2:5 are effectively counterto lyctus borers has given tremendous results than normal concrete.

• The FRC with various fiber ratios has given huge outcomes contrasted with normalconcrete. More prominent strength has been gotten when 1% of fiber mixed with concrete ofaspect ratio (l/d) = 40 of diameter 1.156mm is 38.1 N/mm2 when compared to 0%, 0.5%, and 0.75%, and 1.25%.

• The greatest Split tensile strength is acquired with 1% of fiber diameter 1.156mm withaspect ratio of (l/d) 40 when contrasted with to 0%, 0.5%, and 0 .75%, and 1.25%.

• The greatest flexural strength is acquired with addition of fibers. From the experimentalinvestigations aspect ratio (l/d) 40 has given the most extreme outcomes with 1% of fibercontent.

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