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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: -

Modern multi-storey buildings are constructed with irregularities such as soft storey, vertical or plan irregularity, floating column and heavy loads. These type of structures have become a very common construction practice in urban India. It is observed that most of the RC structures with such irregularities constructed are highly undesirable in seismically active areas from the results of past earthquake studies. These effects occurred due to various reasons, such as non-uniform distribution of mass, stiffness and strength. This study explains the seismic analysis of a multi-storey building with floating column constructed in seismically active areas observing its reactions to the external lateral forces exerted on the building in various seismic zones using the software ETABS. Thus highlighting the alternative measures involving in improvising the non-uniform distribution in the irregular building such as multi-storied building with floating column, and recommended the safer design of such building in seismically active areas considering the results observed from storey drifts, story displacements, when compared to Response Spectrum method shows best results.

KEYWORDS: - *multi-storey buildings, earthquake, seismic, software ETABS, floating column*

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1.1 INTRODUCTION

1.1 General

A Shelter is an essential basic need for the humans. Concrete is the most preferred materials for building, which has a high compressive strength and high flexibility. Concrete has a history of over a thousand years. Earthquake is the immense problem which causes excessive damage to the buildings and structures which results in loss of human lives, loss of economic and environmental issues. An attention has to be paid towards the design of longitudinal and transverse 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 is required. Hence, it is important to develop new types of materials which enhance the ductility properties of the structural elements. Recently studies shown that strengthening of structural elements 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 critical regions. By considering the global warming issues, to produce the sustainable concrete waste materials like GGBS is used to replace the cement which produces an excess of carbon while

1.2 Fiber Reinforced Concrete The Egyptians had established the idea of usage of fibers in the concrete as a strengthening material. Formerly, straw and hair of creatures are mixed as reinforcing material for the setting up of blocks in walls. The making of different fibers was very less in percentage and land should require to offer potentiality to the improvement. Presently the idea of FRC is an incredible 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 the sustainable fiber reinforced concrete which provides the strength, better crack resistance capacity to structures in order to attain the better performance by building the structures rigid. In light of normal concrete retains less tensile, ductile and crack resistance. In brittle materials like plain concrete, structural flaws (micro cracks) develop even afore loading, mainly due to drying shrinkage and volume variations. Hence, to overwhelm all these difficulties, another way like fiber reinforced concreting technique has been used. FRC is a composite material contains fibers in the cement matrix are distributed orderly or randomly. Its characteristics depend on the effective transmission of stress between the fiber and matrix. The main considerations are kind of fiber, geometry, orientation, and scattering of the fibers. Dimension and shape of the aggregate used in concrete and mixing, compaction methods of concrete. 1.3 Bamboo Fiber Reinforced Self Compacting Concrete BFRSCC is a composite material, where natural fibers are used in SCC. The concrete involves bamboo fibers of different lengths and different diameters with different fractions. Jute and kneaf plant strands are ordinarily being used for automobiles as substitutes for glass strands. Due to smaller amount of land accessibility to develop the common plants, increase in those fiber productions on the earth was too difficult. So, we have to identify an alternative solution to extract the similar fibers. For that the Bamboo is best alternative, it isn't grass neither wood, it ensures two of their features and it is too strength because of alignment tough fiber bundles in its longitudinal 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 vascular bundles are distributed in the cross-section all over the stalk instead of in a cylindrical organization. No presence of dicotyledonous woody xylem. Hence, deficiency growth of wood makes the stem of palms, monocot, and huge bamboo, to be columnar other than tapered. 1.4 Self Compacting Concrete SCC is one of the latest development in the concrete industry. It's first introduced during 1980 by Okamura from Japan. From that point forward it is the topic of various examinations to accomplish 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 concrete field. 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 solution for both normal and precast concrete construction because of advanced construction practice, performance, and safety and health benefits. The latest application of SCC focusses on great performance and uniform quality. 1.5 Need of SCC Using self -compacting concrete in structural elements will results in the compaction of the concrete as well as the reduction in the cost of vibrating compaction. Greatly improved construction structures are achieved by self - compacting concrete. The real-world applications showed that SCC can reduce the casting noise, enhance efficiency of the construction and durability of concrete, hence fore SCC commonly used in practice.

Advantages of SCC

- In case of crowded reinforcement, tough access etc. situations, SCC produces consistent concrete.
- Even in the case of heavy reinforcement, SCC achieves a good bond between concrete and 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 effective placement of concrete
- It is used to create different structural and architectural shapes where surface finishing for those is difficult to achieve by conventional concrete It 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 vibration machine.
- The required number of workers on construction sites can be minimized as well as the energy consumption
- Safer and healthier working environment is obtained
- In the precast industry construction time is reduced with accelerating construction process.

3. Disadvantages of SCC

- More experience and care should be taken for the Production of SCC than the conventional vibration. an unrestrained moisture content difference of even 1% in the fine aggregate 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 is greater than normal concrete
- Because of potential leakage along the way which create environmental and contamination 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 basement wall, Highway Bridge, concrete floors and marine structures.

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 elements by 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 concrete since 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 with GGBS to produce sustainable and highly durable SCC

• To study the effectiveness of the natural bamboo fibers in the SCC with GGBS and alccofine based on strength characteristics, since SCC was emerged as an advanced technology combining 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 fire resistance, acid attack, alkaline attack

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

2.1 LITERATURE REVIEW

Saandeepani and Krishna Murthy (2013) has led examinations utilizing distinctive natural strands to the field of concrete in the mandate to estimate the strength characteristics and furthermore for watch the lessening in the propagation of shrinkage crack issues. He presumed that Slump was diminishing with the expansion of strands. Increasingly the fiber- powder proportion, additional is the reduction in slump on account of receptiveness of water by filaments. The adding of filaments improved the compression strength with 0.5% fiber- powder proportion and slight increment 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 is diminished contrasted with normal concrete. The major observation from this research is the usage of fibers increases the strength and decreases the workability, it can mitigate by adding super plasticizers. Majid Ali (2012) has investigated distinctive natural fibers utilized as a part of the most recent couple of decades, and accordingly, it can be utilized as a source of perspective for the prospective research of a specific fiber. The consumption of natural filaments, as reinforcing content for composite is economical for increment of their specific properties like strength, durability and additionally 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. The major observation from this research is the usage of natural fiber increases the strength and for improving 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 jute fiber reinforced polyester composites. But only a few investigations examinations carried on GJFREHC and properties. To locate the dynamic properties of the composites utilizing modal test 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 test strategies 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 in order 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 to determine 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 the young'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 important information 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 different fiber such as coir, sisal, jute, and hibiscus cannebinus cement mortar slabs of mortar 1:3 and of size 300 mm × 300 mm × 20 mm. a simple projectile test was conducted to study effect of impact loads. Four different fiber contents 0.5%, 1.0%, 1.5% and 2.5% by weight of cement and three fiber 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

like resistance of impact (Ru), ratio of impact crack-resistance (Cr), a ratio of residual impact strength (IRS) and the condition of fiber at ultimate failure by 3–18 times than that of the conventional mortar 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 as composite because of its ecological supportability, mechanical properties, and a reinforced polymer matrix. Examinations gave the structure of bamboo and diverse techniques for extraction of bamboo, for example, mechanical, chemical and combination of mechanical and chemical extraction 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 and volume of fibers the strength of the concrete can be improved. This chapter presents the 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 processed attained by the process of controlled granulation. The raw materials chiefly constitute small quantity of calcium silicates. The controlled particle size distribution is attained by processing with other select ingredients. Alccofine 1203 provides good workability and utilized as a high range water reducer to increase compression strength. Due to the accurate procedure of this distribution of particle size, this alccofine gives the greater results and reduces the content of water.

GGBS

GGBS is using because of its overall economy in making and as worthy as their enriched performance in aggressive environments. It's obtained by quenching melted iron slag from a blast furnace in water to provide a granular glassy product. After that it is dried and grinded into the powder. 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 has been 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 fine sand.IS specifications classify the fine aggregate into four types according to its grading

as fine aggregate of grading Zone-1 to grading Zone-4. The four grading zones become progressively finer 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 less than 16mm. The code to be referred to understand the specification of the coarse aggregates from natural 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

Bamboo Fibers

Bamboo fibers are natural plant fibers which has numerous benefits such as environmentally friendly, 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 the plant 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 of a 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 as composite 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 of bamboo. They are as below
•Mechanical and chemical possessions of bamboo are insufficient at the fundamental phase and moisture resistance is low
•The existing method of extraction of fibers from bamboo Culm is not suitable for engineering and marketable production

EXPERIMENTAL INVESTIGATIONS

• Tensile test
The tension assessment is perhaps the most essential kind of mechanical test that can conduct on materials. These are simple, inexpensive and fully standardized. As the material is pulled in its length direction we can find the strength based on how much it. To perform the test, bamboo samples 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 305 mm) long samples were tested. So, we have taken 9 inches (230mm) sized specimen bamboo strips as shown in the figure 3.9. Some of the samples were too strong to brake, widths of the samples 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 sample dimensioning to be done before testing.
• Compressive strength indicates compressive strength of bamboo fiber reinforced concrete cubes of size 150mmx150mmx150mm using fibers of diameters (D1) 700 μ and (D2) 1.156 mm for M30 grade of concrete for 28 days for the aspect ratio of 30, 40 and 50. it is shown that the diameters 700μ and 1.156 mm fibers at 1% aspect ratio (l/d) of 40 gave the maximum compressive strength. The diameter 1.156 mm fibers at 1% gave the maximum compressive strength of 41N/mm2with an aspect ratio (l/d) of 40 when mixed with concrete. Both the diameters 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 two different diameters (D1) 700 μ and (D2) 1.156 mm for M30 grade of concrete for 28 days for the 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 4.8N/mm2with an aspect ratio (l/d) of 40 when mixed with concrete. Both the diameters of fibers showing the lesser decrement in the strength at the 1.25% addition of fibers.
• Flexural strength

indicates the flexural strength of BFRC beam of size 150mmx150mmx1200mm using two different diameters (D1) 700 μ and (D2) 1.156 mm for M30 grade of concrete for 28 days for the 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 mixed with 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 shown below Evaluation of length to diameter ratio of bamboo fibers
•Bamboo fiber is an inventive ecofriendly fiber and is acquainted to the field of concrete to enhance the tensile and flexural properties, which is of minimal effort and to deliver high strength concrete. Maintaining center around substitution for natural plants fiber, as they having the favourable circumstances, for example, very less cost, density is lower, friendly with environment
•The bamboo fibers extracted by mechanical method has been selected and SEM test is carried out to study the diameters of the fibers, orientation of the longitudinal strands, pore sizes of fibers, and micro structure to assess the failure.
•Tension test is also carried on the specimen to find out the tensile strength of the bamboo strips which are used for extracting fibers. The maximum value of tensile strength for 8 mm width strip is 116 N/mm2
•The FRC with fibers of different diameters, 700μ and 1.156mm was extracted using mechanical methods 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 counter to lyctus borers has given tremendous results than normal concrete.
• The FRC with various fiber ratios has given huge outcomes contrasted with normal concrete. More prominent strength has been gotten when 1% of fiber mixed with concrete of aspect 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 with aspect 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 experimental investigations aspect ratio (l/d) 40 has given the most extreme outcomes with 1% of fiber content.

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