TO INVESTIGATE THE STRENGTH PROPERTIES OF CONCRETE MIX HAVING REPLACEMENT OF CEMENT WITH RED MUD WITH ADDITION OF BAMBOO FIBERS

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Abstract - *Modern concrete can be made using coarse aggregates, fine aggregates, cement, water and admixtures. Because of its capacity to be shaped into various shapes and its fresh plastic condition, concrete is the primary material used by the building industry worldwide. Natural limestone is burned to make cement wit evolution of carbon dioxide gas, considered as a greenhouse gas with adversely affects our environment. Waste materials can be used in the manufacture of mortar and concrete to minimize negative consequences and natural resource utilization. In order to increase its tensile strength parameter, we generally use some fibers in the mix. In Present Study, Various strength properties of concrete mix are determined with the effects of replacing the Cement with Red Mud (RM) along with addition of Bamboo Fibers (BF). Red mud is a solid waste that is produced worldwide in aluminum facilities. It is a very difficult task for the designers to determine the economic exploitation and properly disposing of red mud due to its complicated physic-chemical features. The blending of fibers increases the ductility of concrete. In order to provide concrete some desirable characteristics, bamboo fibers are also employed as a natural fiber in concrete to create Bamboo Fibers Reinforced Concrete (BFRC).Various Mechanical properties such as Slump values, Compressive Strength of Cubes, Split Tensile Strength of Cylinders and Flexural Strength of Beams are thus evaluated in this study with the percentage variations of waste materials i.e. Red Mud replaced the cement content by 0%, 5%, 10%, 15% and 20% with Bamboo Fibers addition as 0%, 0.25%, 0.5%, 0.75% and 1.0%. All specimens were cured for 7days and 28 days before testing. The Test results of this study are within acceptable limits.*

Key Words: **Hydraulic lime, Red Mud (RM), Bamboo Fibers (BF), Concrete, Workability, Hardened Properties, Cube Strength, Tensile Strength, Flexural Strength.**

1. INTRODUCTION

Portland cement, fine and coarse aggregates, admixtures, and water are the main ingredients of modern concrete. Because of its capacity to be shaped into various shapes and its fresh plastic condition, concrete is the primary material used by the building industry worldwide. Concrete is used twice as frequently as wood, steel, plastic, and aluminium combined on a global scale, and it is only surpassed in the modern era by the use of naturally occurring water. Large industries and commercial operations are built on the foundational elements used in the manufacturing of concrete. Concrete is renowned for having a high tensile strength but a low compressive strength (about 10% of the compressive strength). Since of this, regular concrete components are very likely to crack because they cannot withstand tensile pressures. Concrete technology has advanced throughout time with the use of chemical admixtures and mineral admixtures like fly ash, slag, etc., increasing compressive strength while maintaining a very low tensile strength. Low tensile stresses cause cracks to start forming under light loads, spread quickly, and enlarge as a result. Furthermore, because to the shrinking phenomenon, fissures are visible even before loading begins. Due to the high cost of steel, labour, and control/monitoring procedures, reinforcing bars are typically used to create reinforced concrete (RC) constructions, which raises overall prices. The need for this research emanates from the numerous durability problems effecting the Indian construction industry[4], such as frequent building collapse [5] confusion on the design strength of reinforcement steel for normal concrete structures due to declining strength of steel bars used in India [6]. The use of fiber-reinforced concrete could, to some extent, compensate for tensile strength deficiencies, reducing the number of building collapses in the nation and enhancing the stability of concrete structures. Therefore, this research carries out various forms of tests and analysis to determine the effect of using red mud and bamboo fibers on the compressive, tensile and flexural strengths of concrete for different percentage volumes. The major aim of this research is to examine the composite effect of red mud and bamboo fibers on the strength of concrete. To realize this aim, laboratory tests were carried on concrete samples to obtain strength properties of concrete using Portland cement, a mix ratio of 1:1.56:3.04, and 0%, 5%, 10%, 15% and 20% percentages of red mud and 0%, 0.25%, 0.50%, 0.75% and 1% bamboo fibers. A correlation between the concrete strength and the percentage of red mud and bamboo fibers was established.

1.1 Red Mud

Compounds that were created during the Bayer process and those that were initially present in the parent mineral may combine to form red mud. Red mud disposal is not simple. Wherever the world removal of red mud is being done either toward land or inside the close by ocean/sea. Disposing of red mud presents a challenge due to the time and effort required to clean up land that has not yet been developed or farmed. The surrounding water, land, and air are harmed by its high pH level. As a result, mineral disposal raises grave and appalling environmental concerns. The production of a large quantity of red mud (bauxite residue) for the assembly of alumina is the most significant effect of the environmental problem on the alumina industry. The super-fine particles characteristic of red mud makes this a promising admixture for mortar and concrete. Clay minerals into pozzolanic admixtures that are able to consume the calcium hydroxide created by cement hydration.

1.3 Bamboo Fiber

Bamboo is one of the oldest building materials used by mankind. The bamboo culms or stem has been made into an extended diversity of products ranging from domestic house hold products to industrial applications. For building the houses our forefathers used Bamboo as basic material. Because of its high strength to weight ratio, traditionally it has been used in varied living facility and tools. The fiber' longitudinal parallelism is responsible for this characteristic. The elasticity modulus of bamboo fibers is stronger than that of any other natural material. The tensile strength of a fiber increases with length. Bamboo fibers applied to material increases its tensile and mechanical strengths.

2. LITERATURE REVIEW

Kavitha S And T Felix Kala (2016) were carried out on test specimens using one basic mix proportion with three variations of aspect ratio of bamboo fibers and different weight fraction of Bamboo fiber. The workability of fresh concrete was found to decrease with an increase in the fiber content and also a decrease in the workability with the increase in the aspect ratio and the addition of bamboo fibers at 1.0% by volume causes a significant enhancement in early as well as long term compressive strength and split tensile strength of concrete.

Tan Manh Do and Young sung Kim(2016) conducted an experimental study on the properties of red mud-infused controlled low strength materials (CLSM). Red mud may substitute cement in combinations to the extent of up to 30%, which would still meet the specifications but result in a modest increase in corrosivity as indicated by pH and a decrease in flowability. In particular, it was discovered that adding more red mud to the mix could enhance the suggested CLSM's stability (bleeding rate) and speed up the setting process. Last but not least, an ideal replacement of 15% red mud to cement might generate CLSM with the highest strength at 28 days. In overall, it is worth noting that red mud could be feasible and potential in use as a partial replacement to Portland cement in CLSM production.

Archila, Hector Kaminski, Sebastian Jonathan Trujillo. Escamilla, Edwin Zea Harries, Kent A. (2018) This study examines such "bamboo-reinforced concrete" as a steel-reinforced concrete substitute, evaluating its structural and environmental performance. The authors come to the conclusion that while bamboo is a material with extraordinary mechanical properties, using it in bamboo-reinforced concrete is a poorly thought-out idea that has serious durability, strength, and stiffness issues and does not live up to the environmental benefits that are frequently associated with it.

Chava Venkatesh, Ruben Nerella, and Madhuru Sri Rama Chand (2020) used red mud to replace up to 15% of the cement in the concrete in increments of 2.5%. Metakaolin was also used as a ternary mineral to boost the pozzolanic reaction; It substitutes for 10% of the cement. When compared to standard concrete, the RM replacement of cement in concrete showed compressive strength enhancements of 0.57 percent, 1.25 percent, 2.70 percent, 3.89 percent, 4.46 percent, and 0.96 percent, respectively. When compared to standard concrete, split tensile showed increases of 5.99%, 12.6%, 15.80%, 28.61%, 37.6%, and 33.24%.

2.1 OBJECTIVES OF THE STUDY

1. To show the advantage of strength gained by red mud usage along with Bamboo.
2. To check the workability of the concrete having partial replacement of cement with Red Mud with addition of Bamboo fibers.
3. To extend and to know the strength properties of red mud concrete in terms of compression, tensile and flexural parameters.
4. The development of alternate low-cost and economically suitable building materials from agricultural and industrial wastes is an economic necessity.

3. MATERIALS USED

3.1 Water

Potable water can be used in this study to a minimum to ensure both constructability and service life. W/c should be between 0.4 and 0.5 for the majority of applications—lower for lower permeability and higher strength.

3.2 Cement

Cement is the binding material in concrete. Ambuja mark 43 grade OPC cement is used in this research. The cement should have a minimum start setting time of 30 minutes and a maximum final setting time of 10 hours.

3.3 Fine Aggregates

Fine aggregate (Sand) Fills voids between aggregates. It forms the bulk and makes mortar or concrete economical. It is collected from local sources.

3.4 Coarse Aggregates

Locally available coarse aggregate having average size of 20 mm was used in this study confirming to IS: 383-1970.

3.5 Red Mud

The Red mud used for the replacement of cement is brought from local industry Jammu, Obtained from manufacturing of alumina from bauxite ore by Bayer's process.

Table 3.5: Chemical Characteristics of Red Mud

Source: Chava Venkatesh et.al. Journal of the KoreanCeramicSocietyhttps://doi.org/10.1007/s43207-020-00030-3

S.No.	Constituents	%age
1	Cao	4.90
2	Fe2O3	23.79
3	SiO2	17.90
4	Al2O3	26.24
5	Na2O	10.83
6	LOI	5.96

3.6 Hydraulic Lime

Lime has ability to set under water thus increases the hydraulicity of the concrete. It is purchased from local area of jammu. It is used in this work in replacement of cement with combination of red mud in concrete mix. It replaced cement a constant rate of 5% in concrete mix design to carry out our work.

3.7 Bamboo Fibers

Bamboo is low cost, fast growing and broad distribution of growth is expected to contribute significantly in earthquake-resistant construction and seismic retrofit technology. The Bamboo used in this work are of length 1.5mm and of aspect ratio of l/d is 40. The various advantages of bamboo fiers in concrete as:

1. Bamboo is a consumer of Nitrogen, which could soon be part of a huge effort to prevent air pollution.
2. Bamboo reinforced concrete is a potential alternative light construction method at a low cost.
3. Modulus of elasticity of concrete increases by addition of bamboo fibres.
4. Bamboo fibre is incorporated to concrete to enhance the tensile properties.

Figure 3.1: Bamboo Fibers

4. RESULTS AND DISCUSSIONS

The results corresponds to concrete design mix of grade M30 using Red mud partially replace the cement with hydraulic lime and addition of bamboo fibers are represented in graphs below.

4.1Slump Test

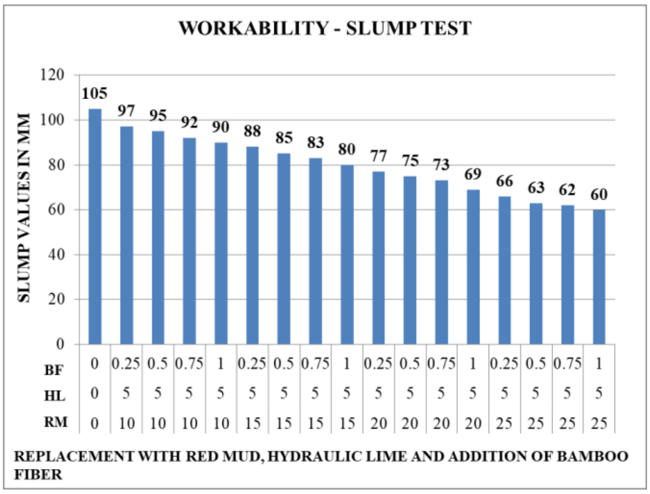

Figure 4.1: Slump Values of Concrete mix in mm

4.2 Compressive Strength Test

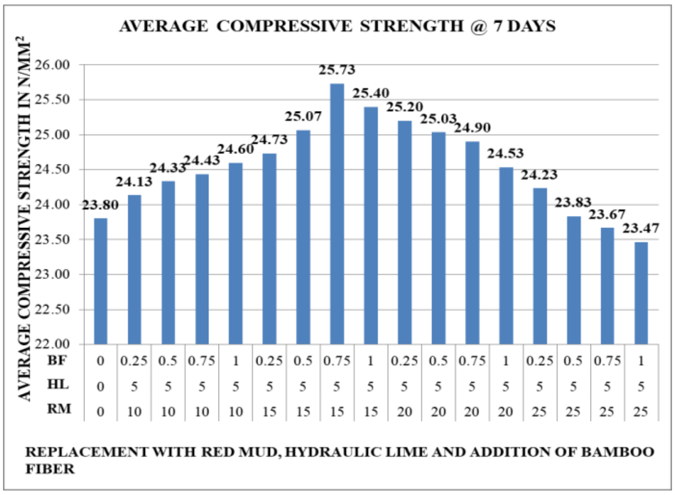

Figure 4.2: Compression Test results after 7 Days

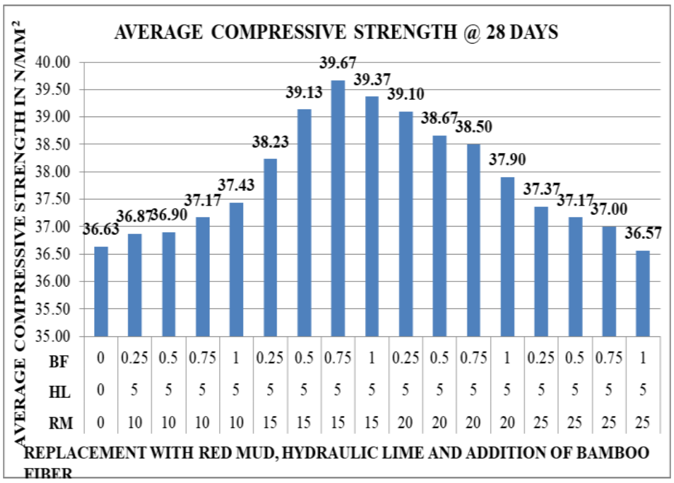

Figure 4.3: Compression Test results after 28 Days

4.3 Split Tensile Strength Test

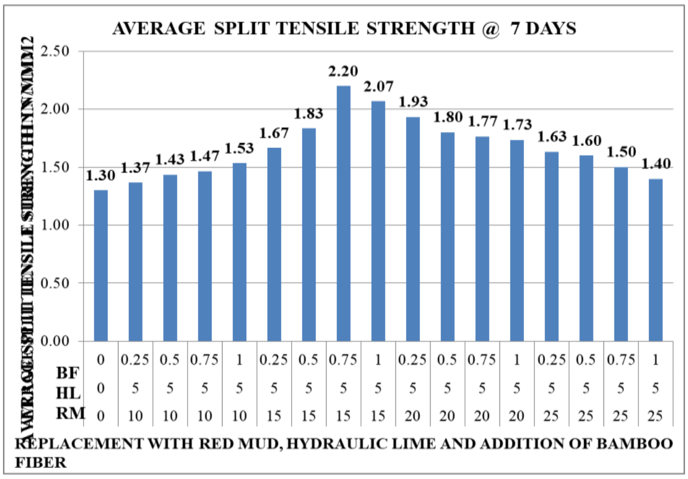

Figure 4.4: Split Tensile Test results after 7 days

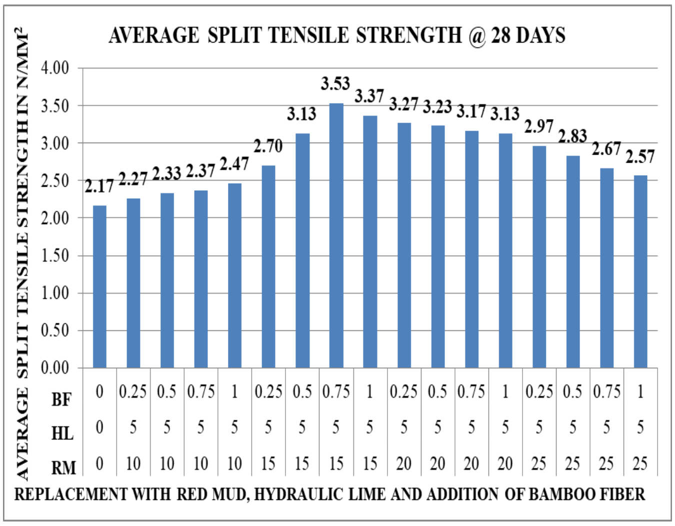

Figure 4.5: Split Tensile Test results after 28 days

4.4 Flexural Strength Test

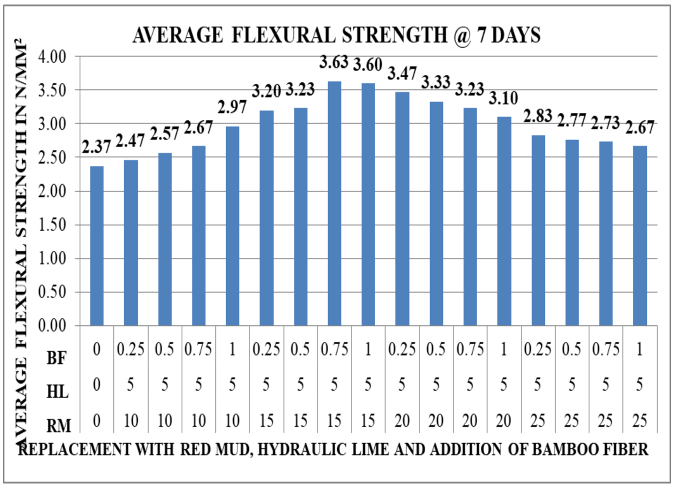

Figure 4.6: Flexural Test results after 7 days

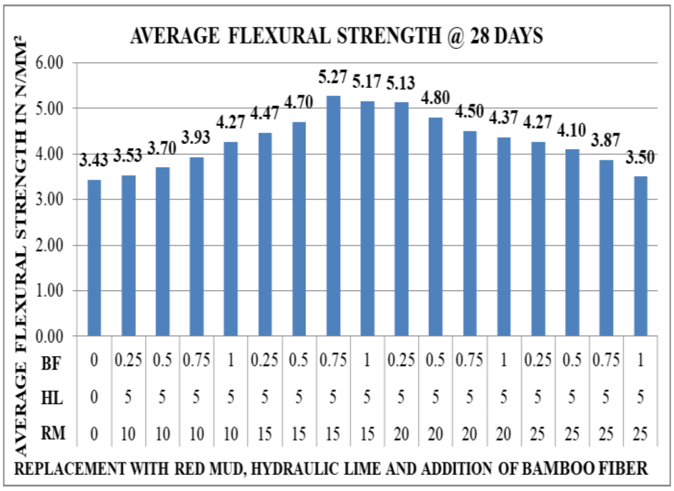

Figure 4.7: Flexural Test results after 28 days

5. CONCLUSIONS

1. The best substitution %age of Red mud, hydraulic lime and bamboo fibers in terms of strength and economy is RM15%HL5%BF0.75%. The value of compressive strength obtained at optimum percentage substitution is 39.67 N/mm^2 after 28 days of curing.

2. The split tensile strength and flexural strength or modulus of rupture shown same nature as that of compressive strength or toughness strength.

3. The partial replacement of the Red Mud and Hydraulic Lime with the Cement and addition of bamboo fibers has shown positive impact on split tensile strength up to RM15%HL5%BF0.75% substitution.

4. The highest value of tensile strength was obtained at RM15%HL5%BF0.75% replacement which is 3.53MPa.

5. The maximum flexural strength at optimum mix of RM15%HL5%BF0.75% is 5.27MPa at 28th day. Both help in increasing strength at low volume replacement.

6. REFERENCES

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