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To Study the Partial Replacement of Cement with Bamboo Leaf Ash and Addition of Glass Fiber

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Abstract: ***Concrete could be a material which is a mixture of coarse and fine mixture bonded along with a fluid cement (cement paste) that hardens or cures over time. Once aggregate is mixed with cement & water, the mixture forms a fluid suspension that's simply poured and formed into shape. The cement reacts with the water and different constituents to create a tough matrix that binds all the materials along into a stone-like material that has several uses. Reinforcement material used should have excellent bonding characteristic, high tensile strength and good thermal compatibility. Reinforcement requires that there shall be smooth transmission of load from the concrete to the interface between concrete and reinforcement material and then on to reinforcement material. . Glass fiber-reinforced concrete premix is a mixture of AR glass fiber, sand, cement, water, chemical and mineral admixtures, and aggregate. These fibers reduce crack width and spacing between cracks. They are very high temperature resistant as they absorb high energy thereby providing the property of ductility the content of bamboo ash is constituted of inorganic minerals, which consists mainly silica, potassium and calcium. Magnesium and manganese are other two common minerals. The result shows that concrete workability is fine and within limits after replacing cement with BLA with adding glass fibers. However, workability gets reduced at higher replacement of materials. The strength parameters such as compressive strength, flexural strength, and split tensile strength also increase and show an optimum value at 12% cement replacement and 1.5% Addition of glass fibers respectively. Test results are satisfactory up to 12% and 1.5% replacement. After this, there is a decrease in the strength of concrete.***

Keywords: BLA (BAMBOO LEAF ASH), GF (GLASS FIBER), workability, compressive strength, Split Tensile strength, Flexural strength

I. INTRODUCTION

A French gardener by name Joseph Monier first invented the reinforced concrete in the year 1849. If not for this reinforced concrete most of the modern buildings would not have been standing today. Reinforced concrete can be used to produce frames, columns, foundation, beams etc. Reinforcement material used should have excellent bonding characteristic, high tensile strength and good thermal compatibility. Reinforcement requires that there shall be smooth transmission of load from the concrete to the interface between concrete and reinforcement material and then on to reinforcement material. Thus the concrete and the material reinforced shall have the same strain. The use of concrete as a structural material is limited to certain extent by deficiencies like brittleness, poor tensile strength and poor resistance to impact strength, fatigue, low ductility and low durability. It is also very much limited to receive dynamic stresses caused due to explosions. The brittleness is compensated in structural member by the introduction of reinforcement (or) pre-stressing steel in the tensile zone. However it does not improve the basic property of concrete. It is merely a method of using two materials for the required performance. The main problem of low tensile strength and the requirements of high strength still remain and it is to be improved by different types of reinforcing materials. Further concrete is also deficient in ductility, resistance to fatigue and impact. The importance of rendering requisite quantities in concrete is increasing with its varied and challenging applications in pre-cast and pre-fabricated building element

A. Bamboo Leaf ASH

Bamboo is a major crop in many tropical countries. The stem of the tree is round, smooth and hollow. The tree has no branches in the lower parts which means that one-third of the tree has many spines between the nodules and has light shiny, small, strong, smooth and dark green leaves. During the dry season, most of the leaves are removed and the soil becomes compacted, making the soil or surrounding soil unsuitable for planting. The leaves, when dried and burnt, produce ashes that have been found to be pozzolanic. The carbohydrate content in bamboo plays an important role in its strength and in improving its health. The durability of the bamboo against the attack of mold, mildew and borer is closely related to the chemical composition**.**

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B. Glass Fiber Reinforced Concrete

Russians were the first to realize the potential of glass as a construction material in the 1940's. But since the glass has very low alkali resistance it became very difficult to mix it with concrete which is alkaline in nature. Thus a better glass which is alkali resistant was made by adding Zirconium to the slurry in 1970 by the British. Several manufacturing processes for producing glass fiber reinforced concrete premix products have been developed, such as casting, spray premix, press molding, extrusion, and pultrusion. Glass fiber-reinforced concrete premix is a mixture of AR glass fiber, sand, cement, water, chemical and mineral admixtures, and aggregate.

These fibers reduce crack width and spacing between cracks. They are very high temperature resistant as they absorb high energy thereby providing the property of ductility. Their light weight property makes them very popular for concrete mix. They have found varied use in industry today.

They are used as sound reducers when used in thickness of 10 mm and surface mass of 20 kg/m2. They are used for repair material for historical buildings and also for extension of old buildings. Any shape product can be formed with good binding strength due to their excellent design flexibility. They are used in sewer relining, earth retaining walls, architectural product as building facades, claddings, cable troughs and noise protection barrier.

II. LITERATURE REVIEW

Olofintuyi I.O et. al. The paper entitled as "Structural value of bamboo leaf ash as a pozzolanic material in a blended Portland cement" finds the pozzolanic properties of Bamboo Leaf Ash blended in hydraulic cement. The strength of the bamboo leaf ash in blended hydraulic cement was evaluated considerately for its suitability in concrete. Bamboo leaf ash at 0%, 5%, 10%, 15%, and 20% replaced cement in the concrete mix of 1:2:4. The chemical composition of Bamboo Leaf Ash in comparison with ordinary hydraulic cement (OPC), while tests to work out the pozzolanicity of Bamboo Leaf Ash. Compressive strength of hardened concrete cubes at 7days, 14days, 21days and 28days were tested. This research showed that up to 10%-15% replacement of cement with Bamboo Leaf Ash is possible for lightweight and mass concrete.

John Temitope Kolawole et. al. 2015 This research entitled as "Compressive strength characteristics of bamboo leaf ash blended cement concrete" aims at investigating the compressive strength properties of BLA blended cement concrete with a view to determining the suitability of BLA as a pozzolanic material in concrete. The study determined the characteristics of BLA and also the consequences of varying percentage of BLA and curing age on the compressive strength characteristics of BLA blended cement concrete. Mixes containing BLA contents of 0%, 5%, 10%, 15%, 20% and 25% as partial replacement for ordinary Portland cement (OPC). Water curing of the concrete was done for 7, 14, 28 and 56 days. Three replicates were used. From the research it was determined that the greater the percentage replacement of cement with BLA, the lower the compressive strength characteristics of the resulting concrete. The optimum replacement percentage is 10% and BLA takes maximum effect at the later days of hydration that is at (28 and 56 days).

G. Dhinakaran et. al. 2016 In This research paper entitled as "Compressive Strength and Durability of Bamboo Leaf Ash Concrete" the feasibility of bamboo leaf ash as a partial substitute to cement and its effect on the compressive strength, pozzolanic activity, porosity and sorptivity characteristics in hardened concrete. Cement was replaced with Bamboo Leaf Ash with a percentage of 10% to 30% with a consistent increment of fifty. The grade of concrete was taken in such a way that it'll provide a characteristic compressive strength of 20 MPa. The chemical properties of BLA was obtained by XRF analysis. The nature of Other strength characteristics, such as sorptivity and porosity, have been developed in accordance with ASTM guidelines to test BLA concrete resistance against sorption and volume voids. From the tests performed, it is fully understood that cement can be replaced with a BLA up to 15% and a slight reduction in strength and strength characteristics found in this exchange as the best.

Amit Kumar and Sheo Kumar (2021) presented the Strengthening of M30 grade of Concrete using Glass Fibre Reinforcement. The engineering strength properties of hardened concrete such as compressive strength, flexural strength and split tensile strength can be improved by adding admixtures. These properties can improved by proper grading by weight and proper curing. The demand for glass fibre is increasing in the Indian market due to high construction activities and also because fibre glass offers versatile shape and design. It is an affordable and cost-effective material when compared to other reinforcement materials. A series of compressive strength, flexural strength and split tensile strength test are conducted with varying percentage of glass fibre (0%, 0.4%, 0.8%, 1.2% and 1.6%).

S.Hemalatha et al. (2016) study experiment were done with the Cem-FIL Fibre with the length of 12mm, which has resistance with alkali resistant. The fiber was added in concrete with an increment of 0.33% and added up to 2%. In this experiment ConPlast admixture (Super Plasticizer) is used at a rate of 1% to the weight of cement. In this work, M40 grade of concrete is used.

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The compressive strength of the concrete increases until 1% of glass fiber is added to the concrete after that strength decline gradually. The compressive strength of the concrete increased by (48.88Mpa) 1.22 time of the target mean strength of the concrete. M40 Grade of concrete attains a flexural strength of 6.86 Mpa and Tensile strength of 7.96 Mpa when 1% of glass fiber is added to the concrete.

III. MATERIALS

A. Cement

In this research project Generally use of high grade cement offers many advantages for making stronger concrete. Although they are little costlier than low grade cement, they offer 10-20% saving in cement consumption and also they of for many hidden benefits. One of the most important benefits is the faster rate of development of strength. Ordinary Portland Cement (OPC) of 43 Grade (Saifco Next cement) from a single lot was used throughout the course of the investigation. It was fresh and without any lumps. The physical properties of the cement as determined from various tests conforming to Indian Standard IS: 8112:1989 are listed in Table3.1. Cement was carefully stored to prevent deterioration in its properties due to contact with the moisture. The various tests conducted on cement are initial and final setting time, specific gravity, fineness and compressive strength. The results of above said tests are given below in Table 3.1. and figure 3.1 shows sample of cement.



B. Coarse Aggregates

The graded coarse aggregate is described by its nominal size i.e., 40 mm, 20 mm, 16 mm and 10 mm. Since the aggregates are formed due to natural disintegration of rocks or by the artificial crushing of rocks or gravel, they derive many of their properties from the parent rocks. Grading of coarse aggregate was done according to IS:383-1970. Aggregates of Nominal size 20mm & 10mm to form a graded aggregate. The concerned lab provided the properties of coarse aggregate.



C. Fine Aggregates

In general, river sand is used as a fine aggregate having a particle size of 0.07mm. The extraction is done from rivers, lakes or seabeds. Fine aggregate that was present at the site was extracted from Jammu. Sieve analysis would be done to find out the zone conforming IS: 383-1970. The physical properties of sand were provided by the concerned lab.



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D. Bamboo Leaf ASH

Bamboo is probably the fastest growing and most productive natural resource and building material found in humanity. However, the use of bamboo creates other residues that cant be used as fibers, such as bamboo leaves. In some countries, large amounts of bamboo are processed, producing a large amount of solid waste. These debris are often burned in open landfills, having a detrimental effect on the environment. In the literature, studies on the pozzolanic properties of bamboo waste are rare. The ash found after burning bamboo leaves has an amorphous nature and has pozzolanic properties. The bamboo leaves are dried in the sun, burnt in the open for 2 hours to form a pile of bamboo leaf ash. The ash represented gray and black colour.

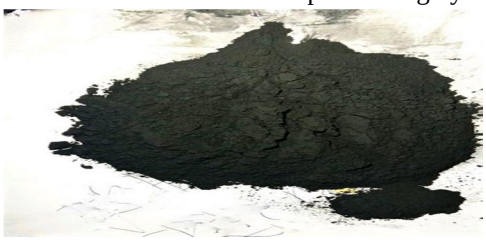


Table no. 1 Properties of CP

S.no	Elemental Oxide	BLA (% by mass)
1.	Calcium Oxide (CaO)	4.23
2.	Silicon Dioxide ($SiO_{2)}$	72.25
3.	Aluminum Oxide (Al_2O_3)	4.08
4.	Magnesium Oxide (MgO)	1.01
5.	Ferric Oxide (Fe_2O_3)	1.97
6.	Potassium Oxide (K_2O)	3.15
7.	Manganese dioxide (MnO_2)	0.22
8.	Phosphorus pentoxide (P_2O_5)	0.74
9.	Sulphur Trioxide (SO_3)	0.15
10.	Titanium Dioxide (TiO_2)	0.35

Glass fibres arecharacteristic for their high strength, good temperature and corrosion resistance, and low price. Alkali resistant E-glass fibres of 12mm length, 0.014mm nominal diameter, specific gravity of 1.9 and density of 2650 kg/m3 were used. Glass wool, which is one product called "fiberglass" today, was invented some time between 1932 to 1933 by Games Slayter of Owens-Illinois, as a material to be used as thermal building insulation. It is marketed under the trade name Fiberglas, which has become a genericized trademark. Glass fiber when used as a thermal insulating material is specially manufactured with a bonding agent to trap many small air cells, resulting in the characteristically air-filled low-density "glass wool" family of products. Glass fiber has roughly comparable mechanical properties to other fibers such as polymers and carbon fiber. Although not as rigid as carbon fiber, it is much cheaper and significantly less brittle when used in composites. Glass fiber reinforced composites are used in marine industry and piping industries because of good environmental resistance, better damage tolerance for impact loading, high specific strength and stiffness.



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IV. METHODOLOGY

A. Mixing Concrete

All the ingredients of concrete are mixed together however this mix should be homogenous and uniform in color and consistency. The mixing can either be done by hand or with the use of mixer.

B. Mixing Concrete

Thorough mixing of the materials is essential to produce uniform concrete. The mixing should make sure that the mass become homogeneous, uniform in consistency and colour. There are two methods adopting for mixing concrete one is hand mixing and other is machine mixing.

C. Curing

Before removing the mould, it is dried for 24 hours, and then specimens are placed in a water tank made to cure specimens. The specimens must be marked for identification so that there must not be any error. The specimens are removed from the tank and dried before putting in the testing machine. The specimens are kept in the tank for 7,14,28 days.

D. Workability Test

It can be used in site as well as in lab. This test is not applicable for very low and very high workability concrete. It consists of a mould that is in the form of frustum having top diameter of 10cm, bottom diameter of 20cm and height of 30cm. The concrete to be tested if fitted in the mould in four layers. The each is compacted 25 times with the help of tamping rod. After the mould is completely filled it is lifted immediately in the vertically upward direction which causes the concrete to subside.

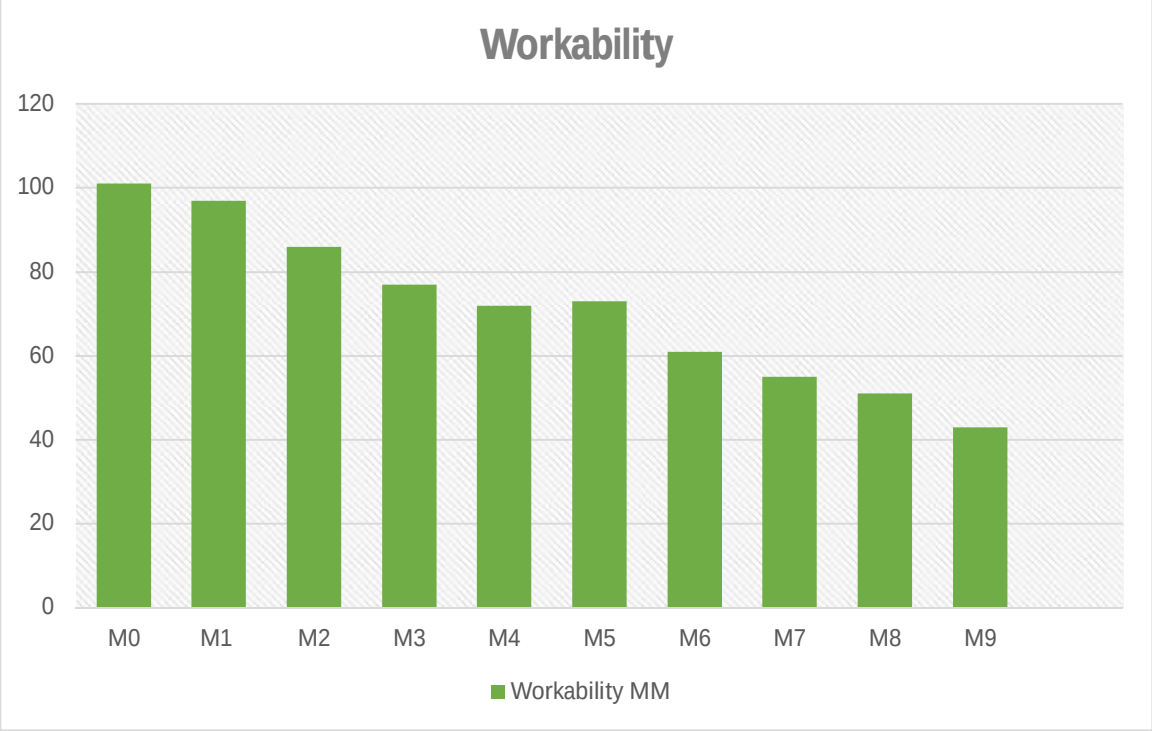


Fig -1: SLUMP CONE TEST

E. Compressive Strength Test

Then fresh concrete is filled in mould in 4 layers and after filling each layer tamping should be done 35 times in case of cube and 25 times in case of cylinder by using standard tamping rod. Once the mould is filled then leveled top surface of concrete with trowel. After the day the mould will removed and specimen are dropped in the curing tank under standard temperature of 27±2° c. After 7,14 days and 28 days in this research.

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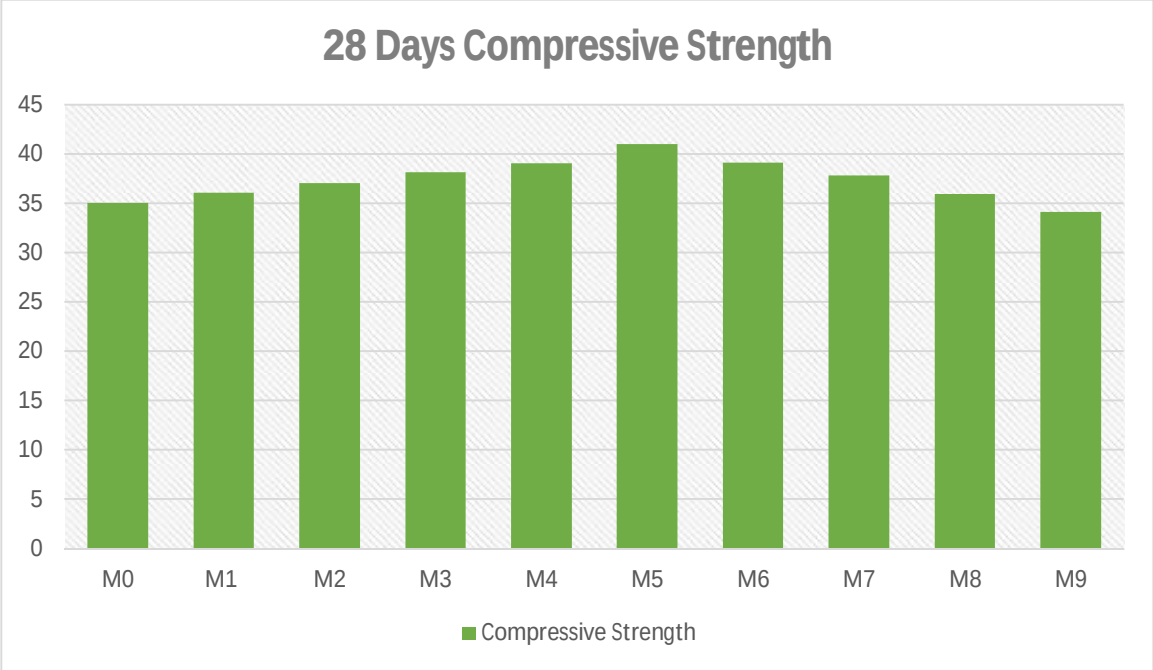


Fig -2: Compressive Strength Test 28

F. Split Tensile Strength Test

The specimen used for this test is cylindrical and its dimension is 150 mm in diameter and 300mm in length. The instrument used for this testing is universal testing machine. The fresh concrete is prepared in according to the required grades and respective mix proportion. The fresh concrete is filled in mould in layers and each layer is tamping with standard tamping rod with 25 blows for each layer. After the day the mould is removed and specimen is placed in the curing tank for 7,14 days and 28 days in this research at the temperature 27+ 2°c. Then draw the line on the specimen.

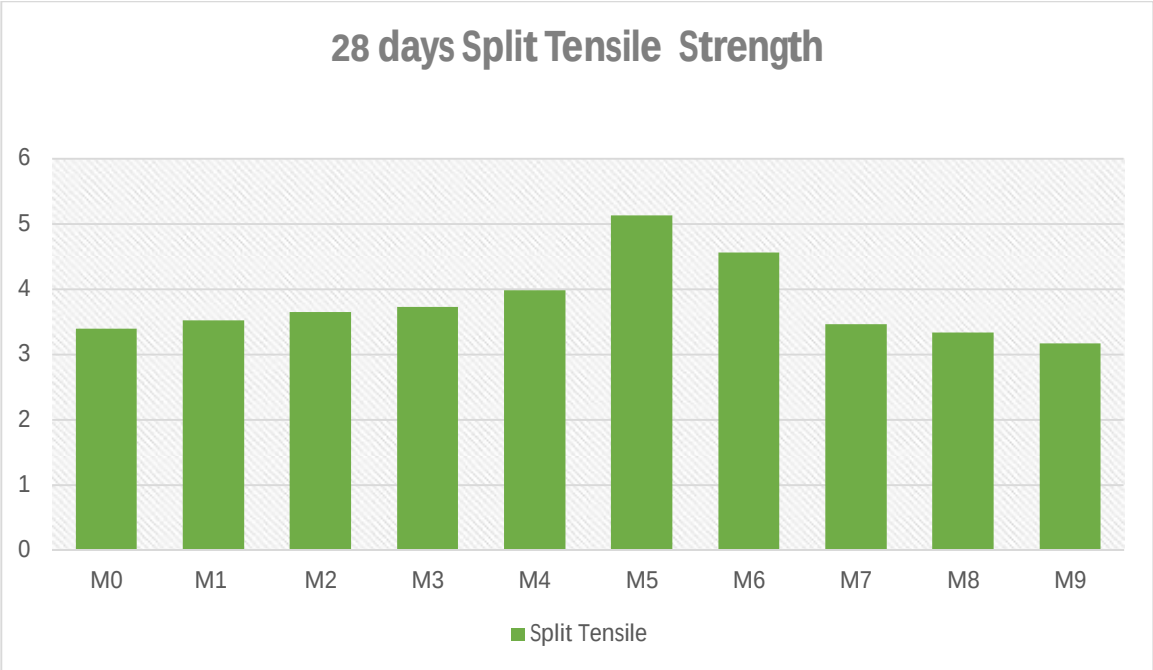


Fig -3: Split Tensile Strength Test 28

G. Flexural Strength Test

The concrete is prepared at required rate of mass element the mould is filled with concrete in layers and blows 25 times with standard tamping rod. After the day or we can say 24 hours the mould is removed and specimen placed in the water tank for curing at a temperature of 27 + 2 C. Depending upon the requirement the test specimen is removed from the water tank and wipe it properly for 7,14 and 28 days for testing.

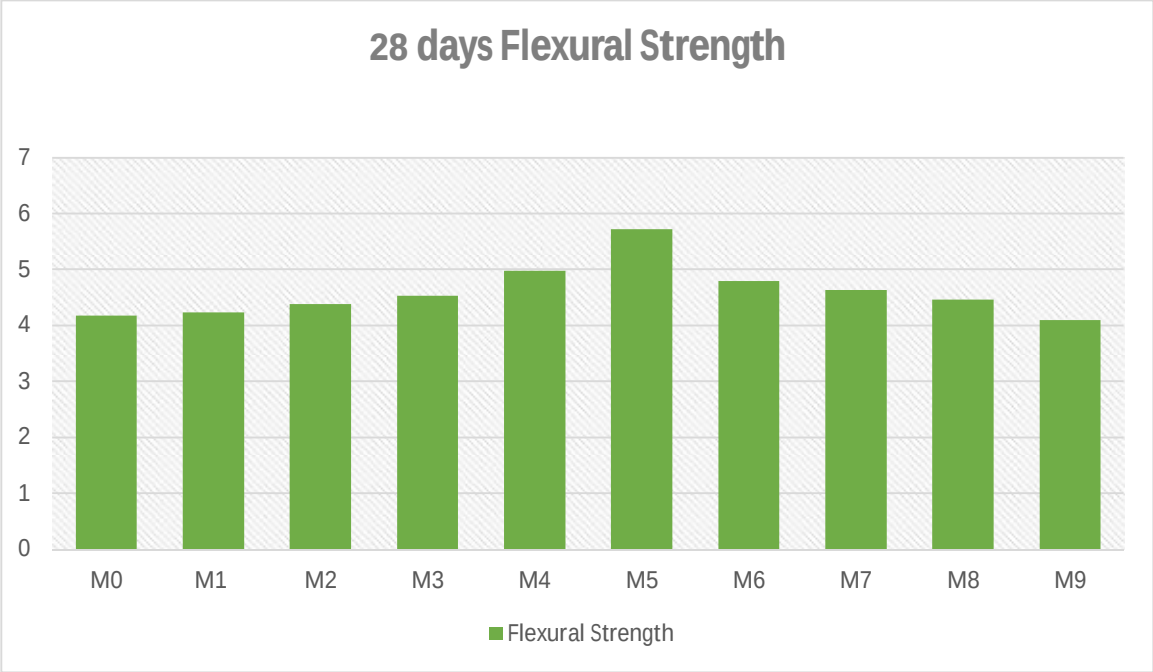


Fig -4: Flexural Strength Test 28

V. CONCLUSION

1) Glass fiber acted as a reinforcement and hence acted as resistance to the cracks, thus increasing the flexural strength.

2) By replacing the cement with the bamboo leaf ash and addition with glass fibers strengths get increased, also the replacement can be taken into consideration up to certain percentage workability factors gets enhanced as well.

3) The compressive strength of the concrete on comparing with conventional concrete gets increased till 12% of cement was replaced bamboo leaf ash and addition with glass fibers for reinforcement 1.5% was used.

4) The flexural strength of the concrete on comparing with conventional concrete gets increased till 12% of cement was replaced bamboo leaf ash and addition with glass fibers for reinforcement 1.5% was used.

5) In case of tensile strength, the optimum percentage that was noticed, was at 12% of cement was replaced bamboo leaf ash and addition with glass fibers for reinforcement 1.5% was used

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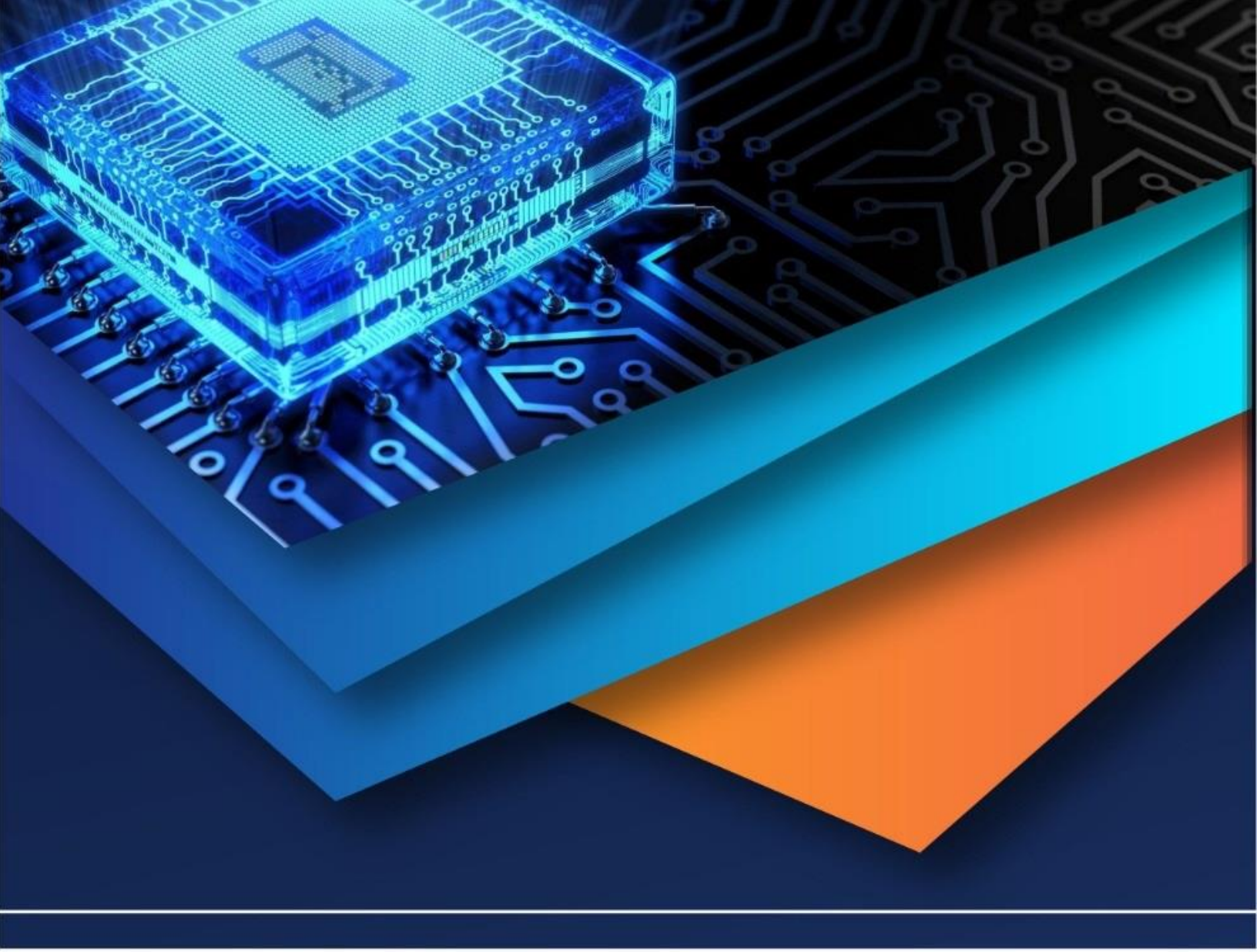
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