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Performance Evaluation of Concrete by using Sisal Fibre and Bamboo Fibre

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ABSTRACT

Concrete is the most widely used material throughout the world. Concrete is a brittle material which is good in compression but it is weak in tension, this leads to the formation of cracks, these cracks extend and reach the compression phase and finally the member breaks. Cracks are the major reason for the failure of the structure. Many attempts have been made to improve the tensile strength of concrete. It becomes necessary to find a best method to improve the strength of concrete by replacing cement with some natural material. So to increase the tensile strength and compressive strength of concrete, technique of introduction of natural fibres in concrete has been done. The fibres are distributed randomly in a uniform manner. The post cracking response of concrete can be nullified with the addition of natural fibres into concrete. This is known as natural fibre reinforced concrete. Replacement of cement by 0, 0.5, 1, 1.5, 2, 2.5 and 3% of natural fibres. The wet concrete mix will be tested for workability and concrete specimens like Cubes, Cylinders and Beams will be cast to determine the Compressive strength, tensile strength and Flexural strength respectively. Addition of natural fibre were done for M30 and M25 mix. The specimens were tested for 28 days.

The test results showed increment in the all properties of concrete compared to conventional concrete. In M30 Grade concrete there was 18.17% increase in compressive strength compared to conventional concrete, highest value of compressive strength was obtained for 1.5% and for 2% addition of natural fibres for M25 grade concrete has shown a increment by 10.6% compared to conventional concrete. In M30 grade concrete, the highest tensile strength was obtained for 1% addition of natural fibres, compared to conventional concrete there was a increment of 9.75% and in M25 grade concrete the strength was highest for 1.5% addition of fibres, there was 7.63% increment compared to conventional concrete. The highest value of flexural strength was obtained for 1% of addition of natural fibres to M30 grade concrete and the increment was by 10% compared to conventional concrete. In M25 grade concrete the highest value was obtained for 1% addition of fibres and the increment was by 7% compared to conventional concrete.

Keywords-- Fibrers, Concrete, Cubes

I. INTRODUCTION

At present concrete is the most utilized building material in the world, it is the mixture of cement, aggregates, admixtures and water. The material so formed will be stone like, this is due to the hydration reaction. Concrete is a brittle material which is good in compression but it is weak in tension, this leads to the formation of cracks, these cracks extend and reach the compression phase and finally the member breaks. Cracks are the major reason for the failure of the structure. Many attempts have been made to improve the tensile strength of concrete. It becomes necessary to find a best method to improve the strength of concrete by replacing cement with some natural material. So far the work on improving the strength of concrete were confined to adding steel fibres, glass fibre etc very little work is being done on improving structures using naturally available materials, or natural fibres.

So to increase the tensile strength and compressive strength of concrete, technique of introduction of natural fibres in concrete has been done. The fibres are distributed randomly in a uniform manner. The post cracking response of concrete can be nullified with the addition of natural fibres into concrete. This is known as natural fibre reinforced concrete.

Natural Fibre Reinforced Concrete

Natural fibre reinforced concrete is a type of concrete which includes fibrous matter which are naturally available as a result it increases ability of the structure to resist the loads acting upon it.

Natural fibres are naturally available materials which has certain characteristic properties, some of the naturally available fibres are as follows.

- Agawa
- Akwara
- Bamboo

- Coir
- Date Palm
- Elephant Grass
- Hemp
- Jute
- Musumba
- Remie
- Sisal
- Plantain
- Water Reed

Natural fibres are of different shapes, and the diameter of the fibre varies, the usage of natural fibre has shown significant increase in the flexure, impact and fatigue of concrete. Natural fibres are low cost material and it is abundant. They arenonhazardous and renewable. It increases toughness and flexural strength. It also induces good durability in concrete.

Glass fibre is a recently introduced material in fibre reinforced concrete (FRC). Tensile strength of this is very high varying from 1020 to 4080 MPa. This is generally used in exterior facade panels. Glass are less denser compared to steel.

Carbon fibre usage is not much developed. It has a appreciable strength and young's modulus. The usage of carbon fibres increases the durability of concrete. Usage of this is limited and this is mainly used for cladding purpose.

Steel fibres are the most popular among the fibre reinforced concrete as this is used in most of the cases compared to other fibres, Steel fibres are of different shapes like crimpled, round etc and with varying diameter.

Disposal of non biodegradable (NBD) material is a problem, as it creates a lot of problem in the environment. Hence reusing these materials is a better option. These NBD materials are non corrosive, resistant to chemical attack, easy to handle etc.

Fibre Reinforced Concrete

As the construction material is continuously evolving. The concrete which is crack free, high strength and lighter in weight, the demand for these is increasing.

History

Joseph Moneir was the inventor of reinforced concrete in 1849. The most of buildings which are standing is because of this. Reinforced concrete are generally used to produce frames, beams, columns etc. The practice of adding fibres have been implemented from olden times. Horse hair was used to strengthen the bricks. In 1911, porter stated that these fibres can be used in concrete. In 1963, Romualdi and baston published paper on FRC. Since then there were so many other materials came into practice like glass, natural fibres etc in concrete.

Necessity of FRC

As concrete is a brittle material, it is good in compression and weak in tension, poor resistant to impact, fatigue. The brittleness can be counteracted by usage of reinforcement in tensile zone. Concrete surface will undergo with lot of wear and tear and as a result the surface will be damaged and causes deterioration of concrete. The incorporation of fibres into concrete will cause the concrete to hold tight and the material will be held tight and hence it will improve the properties of concrete.

This chapter deals with the literatures that highlights the tests that have been conducted on the natural fibre reinforced concrete. The usage of different types of natural fibres are discussed which are responsible to enhance the properties of concrete.

II. LITERATURE REVIEW

1. Abdul Rahuman et al. (2015) has done a study on workability and strength properties of sisal fibre reinforced concrete by varying different mix proportion and different fibre percentage. This was done to achieve sustainability and enhance structural stability. fibres were cut 4 cm in length. Super plasticizer 0.2% , water cement ratio of 0.45, slump value 53mm. The materials were hand mixed with the addition of different fibre percentage for mix design M20 and M25 to cast in cubes and cylinders. It was noted that the compressive strength increased by 50.53% and tensile strength by 3.416% for 1.5% addition of fibres in M20 mix. Similarly, Compressive strength increased by 52.51% and tensile strength by 3.904% for 1.5% of fibres in M25 mix.

2. M Ramachandran et al. (2016) has done a study of Bamboo using Banana and Linen Fibre Reinforced Polymeric Composites. The paper deals with the usage of bamboo fibres, banana fibres and linen fibres. These fibres are cut into 2-4mm length and coated with epoxy resin of random orientation. Different hardness tests were conducted on the fibres. It was proved that bamboo-banana epoxy resin composite showed better result in Impact test. Compatibility of bamboo-banana were the best whereas bamboo linen epoxy resin composite showed better results in rockwell hardness test.

3. R. Badrinath et al.(2014) has done a comparative study on mechanical properties of banana and sisal fibre composite. In this work the banana and sisal fibre are used are main reinforcing material coated with the epoxy resin to increase the effectiveness. The composites were fabricated by hand layup method. The properties like mechanical and physical were studied for both the fibres, change in orientation was done as uni-directional and bi-directional. It was noted that sisal uni-directional oriented fibres showed hike in compressive strength compared to bi-directional, whereas banana bi-directional showed higher tensile strength compared to uni-directional. Flexural strength of sisal uni-directional exhibit higher strength than banana fibre. It was also noted that percentage of sisal fibre absorb more water compared to banana epoxy resin composite. The percentage of absorption of ordinary water is more compared to sea and distilled water.

4. R. S. P. Coutts et al. (1995) has done a study on autoclaved bamboo pulp fibre reinforced cement. It was noted that foe 14% by mass of autoclaved bamboo pulp fibre reinforced composites have higher flexural

strength. Due to short fibre length and fines, the fracture toughness is very low. By removing the fines by screening the flexural strength can be increased. The properties of beaten bamboo composites do not vary much when compared to unbeaten bamboo composites.

5. ShakeelAhamad et al. (2014) has done a study on mechanical properties of bamboo fibre reinforced concrete. Considering the high cost of steel the bamboo is one of the suitable replacement that can be used, as it is a low cost material, easily available and most important that it is good in compression and tension. To prove the effects on bamboo fibres on concrete, cubes were cast. These were compared with plain concrete cubes. It was observed that the compressive strength got doubled for 50 days compared to plain concrete and there was remarkable increase in flexural strength.

6. Yankai Wu et al.(2014) has done a study on the mechanical properties of sisal fibre reinforced silty clay. The present study was carried out to find the mechanical property by using short, discrete randomly distributed sisal fibres using tri-axial shear tests. The fibres were cut into different length and randomly mixed with silty clay and percentage is varied. It was noted that from the results, for fibre length 10mm, and 1 % of sisal fibre, the mix was 20% stronger compared than nonreinnforcedsilty clay.

7. Bindu M et al. (2016) has done a study on bamboo fibre reinforced concrete. The usage of bamboo has shown increase in the strength. These fibres acts as the crack arrestors and hence the load carrying capacity will be more compared to the conventional concrete. The specimens remain intact even after failure. As the length of the fibre increases the workability decreases and hence superplasticizers are been used.

8. H. RaghavendraRao et al. (2014) has done a study on flexural properties and SEM analysis of bamboo and glass fibres. It was observed that flexural properties of hybrid composite increases with the addition of glass fibre. The properties were higher when alkali treated bamboo fibres were used. The interfacial bonding between Glass and bamboo reinforced epoxy composite and effect of alkali treatment on glass and bamboo fibrewere also studied.

9. R. S. P. Coutts et al. (1995) has explained in their paper regarding the usage of sisal pulp in concrete. The study explained that by using sisal pulp there was drastic increase in flexural strength and toughness of the matrix. The optimum amount of pulp was 8% by mass and it has shown 50-60 fold increase in flexural toughness.

10. Romildo Dias TolêdoFilho et al.(1990) has done a study on usage of sisal fibre as reinforcement in cement based composite. The natural fibres are considered as much effective, economic and the consumption of energy is very less. The research deals with the properties of the composites are describedin relation to fibre content, length, strength and stiffness. A brief illustration of the usage of sisal and other fibres have been included.

III. METHODOLOGY

Experiments were done to understand the properties of materials. Mix design for M30 and M25 were carried out as per IS 10262. After the mix design is obtained the cubes, cylinders and beams will be cast with the addition of varying percentage of the natural fibres. The natural fibre reinforced concrete specimens namely Cubes, Cylinders and Beams will be tested for Compression, Tension and Flexure respectively. The results obtained will be compared and the optimum percentage of fibres required to achieve high strength will be note.

IV. RESULTS AND DISCUSSION

In this chapter, the results of the tests conducted on the natural fibre reinforced concrete have been discusssed. The natural fibreis mixed with concrete for mix M25 and M30, the outcome of the same are compared with normal as well as with each other.

Test Result of Natural fibre reinforced concrete

Compressive Strength for M30 Mix

Graph has been plotted against compressive strength of M30 concrete Mix Vs Percentage of Fibres. It is noted from the results that the compressive strength of concrete has been found highest for 1.5% addition of natural fibres. The graph increases linearly at first till 1.5% and then gradually decreases. It can be noted that at 1.5% thefibres are intact and as a result the load carrying capacity will increase even after the failure load of the specimen. hence it can be seen that the natural fibres have much effect on the compressive strength. It can seen that for the 3% of fibre, the compressive strength of concrete is reduced due to the decrease in workability. It is becauseof bounding between fibre and concrete is low but even after failure the intactness of concrete is more. Compare to conventional concrete the compressive strength increased by 18.17% for 1.5% addition of fibre.

V. CONCLUSION

From the research on introduction of sisal and bamboo fibre into concrete, the experimental investigations, confirming the design mix, the tests on hardened and wet concrete mix, from the various tests conducted the results are drawn, the incorporation of natural fibres into concrete has shown improvement in almost all properties compared to conventional concrete and from the analysis of results following conclusions are made.

- In M30 Grade concrete there was 18.17% increase in compressive strength compared to conventional concrete, highest value of compressive strength was obtained for 1.5% and • for 2% addition of natural fibres for M25

grade concrete has shown a increment by 10.6% compared to conventional concrete.

- In M30 grade concrete, the highest tensile strength was obtained for 1% addition of natural fibres, compared to conventional concrete there was a increment of 9.75% and in M25 grade concrete the strength was highest for 1.5% addition of fibres, there was 7.63% increment compared to conventional concrete.
- The highest value of flexural strength was obtained for 1% of addition of natural fibres to M3o grade concrete and the increment was by 10% compared to conventional concrete.
- In M25 grade concrete the highest value was obtained for 1% addition of fibres and the increment was by 7% compared to conventional concrete.
- Compared to M30 and M25 grade concrete mix, the highest value in strength results like compressive, tensile and flexural has been evident for M30 mix.
- The incorporation of natural fibres has shown increment in the properties of concrete compared to conventional concrete.
- It was observed that, at failure load the beam will not be split into parts, it will stay connected as a result of inclusion of fibres into concrete.
- Durability and deflection study of the natural fibre reinforced concrete can be studied.
- Seepage characteristics of natural fibre can be studied.
- Introduction of natural fibres into geopolymer concrete by using admixtures can be done.
- Fibres with varying diameter and length can be studied.

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