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EXPERIMENTAL INVESTIGATION ON COCOUNT FIBER REINFORCED CONCRETE

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Abstract:

Sustainability is a wide accepted concept in modern construction scenario. Even though the construction industry is revolutionizing in a significant manner in terms of both equipment and materials used, the cost of construction has skyrocketed along with the deteriorative impact on environment. This resulted in the adoption of a more balanced approach with the environment as its nerve centre to create a better world to live in. This has led to the adoption of a natural fibre like Coconut for the strength enhancement in concrete. Coconut fibre is available in abundance at the test site, which makes it quite viable as a reinforcement material in concrete. Further, it acts as a new source of income for thecoconut producer who gets the benefits of the new demand generated by the construction industry. In addition to this, it is an effective method for the disposal of coir mattress waste which will reduce the demand for additional waste disposal infrastructure and decrease the load on existing landfills and incinerators. Moreover the fibres being natural in origin is ecologically sustainable andcan bring down the global carbon footprint quite effectively.. The various strength aspects analyzed are the flexural, compressive and tensile strength of the coconut fiber reinforced concrete at varying percentages (4%,5%,6% by the weight of cement) of fibre. The influence of shape of fibre on strength is also studied by testing on coconut fibre mesh of predetermined dimensions. The optimal percentage of both the processed fibre strands and raw fibre meshes were found out by trial and error and theoptimum percentage of superplasticizerneeded for the required workability was also determined. Keywords : Compressive strength, Tensile strength, Flexural strength, CFRC, Fibre mesh.

INTRODUCTION:

The construction industry is revolutionizing in two major ways. One way is the development of construction techniques, such as using automated tools in construction. The other is the advancement in high-performance construction materials, such as the introduction of high strength concrete. Among these high- performance materials, fibre reinforced concrete (FRC) is gradually gaining acceptance from civil engineers. In recent years, research and development of fibres and matrix materials and fabrication process related to construction industry have grown rapidly. Their advantages over other construction materials are their hightensile strength to weight ratio, ability to be moulded into various shapes and potentialresistance to environmental conditions, resulting in potentially low maintenance cost. These properties make FRC composite a good alternative for innovative construction. Their application in construction includes both upgrading existing structures andbuilding new ones, which can apply to various types of structure, for example offshore platforms, buildings

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and bridges (Thou, 2005). A major roadblock towards development of high performance concrete using steel fibres is the high costs involved, availability and also problem of corrosion. Coconut fibre being the most ductile among all natural fibres (Majid Ali et al.,2012) has the potential to be used as a reinforcement material in concrete. It is biodegradable so the impact on environment will be minimal. This is also a way to dispose off the fibres which are derived as waste materials from coir based manufacturing units to produce high strength materials .They are also non-abrasive in nature ,cheap and easily available. Research work is being carried out to find the possibility of coconut-fibre ropes as a vertical reinforcement in mortar-free interlocking structures. This is believed to be a cost-effective solution to earthquake-resistant housing. The aim of this study was to identify the improvement in strength characteristics of concrete with the addition of oil coated coconut fibre. In the study, coconut fibre is added to concrete and Plain Cement Concrete (PCC) is used as reference to study its effect on flexural, compressive and tensile strength properties and also drying shrinkage. Fibre is coated with oil so as to decrease the water absorption. Some of the 2 advantages being observed are low-cost, low density, reasonable specific strength, good thermal insulation, reduced wear and ability to be recycled with minimal impact on environment (Majid Ali et al.,2011). Thus in addition to the enhancement in the physical properties of concrete, it turns out to be a sustainable waste management technique

OBJECTIVES:

The aim of this study is to investigate the effect of oil coated coir fibre on physical properties of concrete The objectives of this work are:

1. To find out variation in compressive, tensile and flexural strengths of CFRC using processed fibre strands and raw fibre meshes at varying fibre contents and to compare it with that of conventional concrete
2. To determine the influence of shape of fibres on strength of concrete The scope of this project is limited to rural residential constructions

METHODOLOGY:

Based on the previous research work, a comparison of strength properties of fibre reinforced concrete is made with respect to conventional concrete and the influence of shape of fibres on strength are also studied. Tests are conducted using processed coconut fibres of length 5cm and raw fibre meshes of size 5cm x 5cm after coating them with coconut oil at varying fibre contents of 4%, 5%, 6% .Material tests were carried out initially to determine the suitability of materials to be used in concrete.The mix was designed as per IS 10262 : 2009 at a suitable water content and design mix was obtained. The mixing was carried out according to standard procedure given in IS code with sufficient care to ensure that no bleeding occurred throughout the entire process. Slump tests were carried out to ensure that the mix was workable. The cubes were then cured for 7 and 28 days and were properly dried in sunlight before testing. **Organisation Of Report**

The complete work is presented in six chapters as follows:

In Chapter 2, review of literature related to natural fibres, Coconut fibre reinforced concrete and influence of length of fibres on strength are discussed In Chapter 3, a detailed explanation of the methodology used for this research work Chapter 4 gives an overview of various materials used in the test and the material tests associated with them to determine its suitability in this research In Chapter 5, interpretation of results, is a detailed outlay of

different strength tests on specimens along with its justification. Chapter 6 summarizes the study, presents the salient conclusions from the study and its limitations, and discusses scope for future

Standard Consistency The standard consistency of a cement paste is defined as that consistency which will permit the Vicat plunger of 10 mm diameter and 50 mm length to penetrate to a point 5 to 7 mm from the bottom of the Vicat mould Figure . The experiment was done as per IS 4031-Part IV.

Figure 1 : Apparatus for Standard Consistency

Density of Cement Le Chatelier's flask is used to determine density of cement as shown in Figure 2 Kerosene which does not react with cement is used. Experiment is done in Le Chatelier'sflask.

Figure 2 : Le Chatelier's Flask

RESULTS:

Table 5.5 : Compressive Strength of Processed CFRC cubes

Specimen	w/c ratio	Percentage of coconut fibre added	Amount of superplasticizer Used	Slump Value (mm)	Compressive strength(N/mm²)	
					7 day	28 day
1	0.5	4 %	0.2 %	110	14.6	25.7
2		5 %	0.4 %	105	16.3	28.3
3		6 %	0.8%	105	15.02	26.2

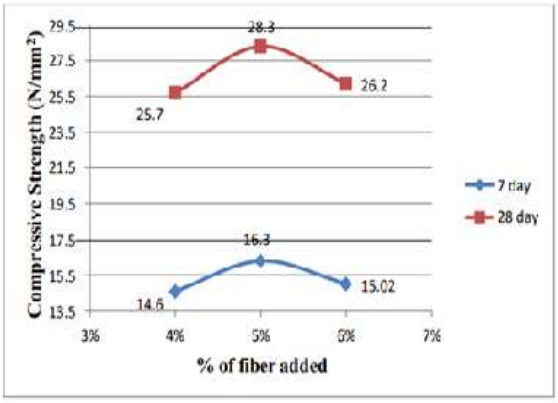

Figure 3 : Finished fibre reinforced concrete cubes

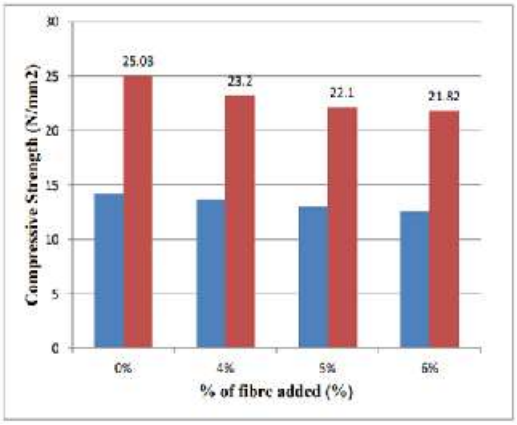

Figure 4 : graph showing variation of compressive strength at varying percentages of fibre

CONCLUSION :

Coconut fibre is available in abundance at the test site, which makes it quite viable as a reinforcement material in concrete. Further, it acts as a source of income for the coconut producer who gets the benefits of the new demand generated by the construction industry. In addition to this, it is an efficient method for the disposal of coir mattress waste which will reduce the demand for additional waste disposal infrastructure and decrease the load on existing landfills and incinerators. Coconut fibres being natural in origin, is ecologically sustainable and can bring down the global carbon footprint quite effectively. The objectives of this work were:

1. To find out variation in compressive, tensile and flexural strengths of CFRC using processed fibre strands and raw fibre meshes at varying fibre contents and to compare it with that of conventional concrete

2. To determine the influence of shape of fibres on strength of concrete The scope of this project was limited to rural residential constructions. The major conclusions from this study are 1. At 5% addition of coconut fibre with a water cement ratio of 0.5, compressive strength tests yielded best results. However, the compressive strength decreased on further fibre addition. This must be due to the fact that when the fibres are initially added to concrete, the finer sized fine aggregates enter into the surface pores in the fibre creating a better bonding between the fibre and mix, however further addition of fibres resulted in formation of bulk fibre in the mix which will lead to decrease in bonding. Hence there is an optimum value of

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fibre to cement ratio, beyond which the compressive strength decreases. Hence 0.5 was taken as the optimum water cement ratio and optimum fibre content was taken as 5% 2. When the fibre content is increased there is an increase in split tensile strength with a maximum at 5%. However when the fibre content is increased beyond this value a reduction in tensile strength is observed. This is due to the fact that 61 tensile failure occurs due to the dislocation of atoms and molecules present in concrete. However when the fibre is added it acts as a binder holding them together. 3. When fibre content is increased there is an increase in flexural strength with a maximum at 5% of fibre. However when the fibre content is increased beyond this value a downward slope of the graph is observed. This is also due to the binding properties of coconut fibre owing to its high tensile strength of 21.5 MPa.

4. A decreasing trend in compressive strength was observed in concrete with mesh shaped fibres. This is due to formation of weak inter transition zone around these fibres, making the entire specimen weak. Moreover the thickness of the fibres can hinder better packing of the constituents of concrete thereby making it weak. The presence of dust and other impurities on the surface of fibres can also be another reason for this reduction in strength which may interfere with the bonding of mix and subsequent strength formation.

5. The tensile properties and cracking pattern of CFRC shows that it can be particularly useful in construction activities in seismic zones due to its high tensile strength and post peak load behaviour, which offers sufficient warning to the inhabitants before complete collapse of the structure.

6. Due to its relatively higher strength and ductility, It can be a good replacement for asbestos fibres in roofing sheets, which being natural in origin pose zero threat to the environment

7. Since higher strength is attained at a lower design mix. It can be used to manufacture building blocks at relatively lower costs in comparison to plain concrete blocks thus making it suitable for rural residential buildings upto 10m height or as protection walls around buildings.

8. It can also be used as the reinforcement material in cement fibre boards which can act as a good backing to tiles thereby improving its impact resistance and also in faux ceilings. The advantage of cement fibre boards is its ability to survive under moist environments unlike paper based gypsum boards

FUTURE SCOPE :

The effect of coconut fibres on high strength concrete should be studied and thus the use of CFRC can be extended to industrial and commercial buildings. Since the corrosion study is not done, the applicability of CFRC in reinforced constructions could be tested. Coconut fibre is a good insulator in itself and as such it can improve the thermal properties of concrete. This is particularly useful in a tropical country like India where the mercury levels are quite high for most part of the year, so as to maintain the room temperatures within comfort levels of its inhabitants. It can also reduce the load on air conditioning systems thus reducing the power consumption. The acoustic properties of concrete reinforced with other natural fibres have been studied in the past using an impedance tube apparatus and the results are fair enough to justify the use of coconut fibres as an alternative which is a good absorbent due to the presence of surface pores.

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