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Preliminary Studies on the Effect of Natural Organic Fibers on Cement

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Abstract: **The main aim of this paper is to investigate the effect of use of organic (natural) fibers in cement. The natural fibers selected in this paper are human hair, jute and palm fibers. The percentage of fibers added is 2% with respect to weight of cement. The casted blocks are tested for its compressive strength, water absorption and density. The test results are compare with the conventional cement blocks casted under same conditions. It is found that cement blocks with jute fibers and hair fibers have more compressive strength than the conventional cement block. The cement block with palm fibers failed to give any compressive strength because of its bond strength with cement is weak.**

Keywords: **Cement, Human hair, Jute fibers and Palm fibers.**

1. INTRODUCTION

Protecting the environment becomes mandatory for the researchers before implementing the new technology to ensure that there is no damage to environment and to be ecofriendly. Utilization of waste materials and renewable resources as alternative building materials have become the popular way to overcome the environmental problem in most countries[1].

The Portland cement concrete is a brittle material. It possesses a very low tensile strength, limited ductility and little resistance to cracking. Internal micro cracks are present in concrete and its poor tensile strength is due to propagation of such micro cracks leading to brittle fraction of concrete [2].

Fiber reinforced concrete (steel fiber or natural fiber) is gaining more attention in construction industry. Adding the short fiber reinforcement in low volumes (less than 2–3%) can increase the fracture toughness of concrete that will help to control the width of crack that form due to the volume changes in concrete [3].

The addition of fibers inside the concrete could increase its ductility. Addition of steel fibers reduced the micro cracks but over a long period it gets corroded due to various actions [4]. According to Saneepini and Krishna murthy[2] study on natural fibers, it is found that vegetable fibers (natural organic) are very much renewable, eco-friendly, economical and production cost is also very low compared to natural inorganic fibers. Natural organic fibers can be produced from a number of solid wastes such as bamboo, coconut, date palm, oil palm, sugarcane, and vegetable wastes. Some of these fibers are chemically more inert than either steel and glass fibers [5].

In general, the percentage of fibers selected vary from 0.5 to 3 % with respect to weight of the cement. Seneviratne et al., (2017)[6] mentioned that the test results with 2 % of coir fiber reinforced concrete gave an enhancement in compressive and flexural strength compared to other percentage of fibers. Hence, in this study, 2 % of fibers are added with respect to weight of cement and the natural organic fibers chosen are jute, palm and human hair. The fibers are added during the dry mix and it is scattered and crumbled. The CO_2 emission from the concrete production is directly proportional to the cement content used in the concrete mix. 900 kg of CO_2 are emitted for the fabrication of every ton of cement [7]. In this paper, an attempt has made to reduce the usage of cement in order to reduce the emission of carbon dioxide to the atmosphere

2. MATERIALS AND TEST SETUP

2.1 Materials

Ordinary Portland cement of grade 25 and well-graded fine aggregates of size 0.06 mm to 2 mm is used in this study. Human hairs are collected from beauty salon, fresh palm fibers are collected from trees and jute fibers are collected from used rice bags. All the three fibers are cut into crumbs of different sizes and are shown in Fig.1. Sieve analysis has been carried out separately for all the three fibers to make sure the fibers are well graded.

2.2 Test Setup

The following tests as per ASTM standards has been conducted on cement block (CB), Cement Hair block (CHB-2), Cement jute block (CJB-2) and Cement Palm block (CPB-2) at the end of 3rd day after casting.

2.2.1Compressive Strength:

A mixture of cement and fine aggregate having ratio of 1:3 is prepared that is one part of cement and three parts of fine aggregate. The weight of cement is 500grams and the weight of fine aggregate is 1500 grams. The amount of water for this ratio is calculated as per the ASTM standards C 39 [8] and is found to be 10% of the weight of total aggregate. A homogeneous mixture of dry ingredients, and water is prepared carefully to make a paste. Three 15 cm cube moulds are taken and clean thoroughly from inside and oil is applied to the inner surface so that during removal of mould the cubes should not damage. One third of the mould is filled with mortar and tamped with 5/8 inch, round-ended tampering rod for 25 times. Second one-third of the mould is filled and tamped 25 times and same is repeated for remaining one-third portion. After 24 hours the cubes are removed from mould and kept in water for curing for three days. On third day the cubes are removed from curing tank and the weight is measured before keeping in the oven. The initial and final weight of the cube is measured and then tested on compression machine of capacity 3000 KN.

The load is applied to the test specimen continuously and uniformly throughout the compression test. As the load is applied on the cube it develops cracks after certain limit. The application of load is discontinued when the cube has been crushed or just cracks are developed in it. The above procedure is repeated for the remaining cubes. The crushing load for each cube is noted separately and compressive strength of each cube is calculated by dividing load with area. The average compressive strength is calculated and are listed in Table 1.

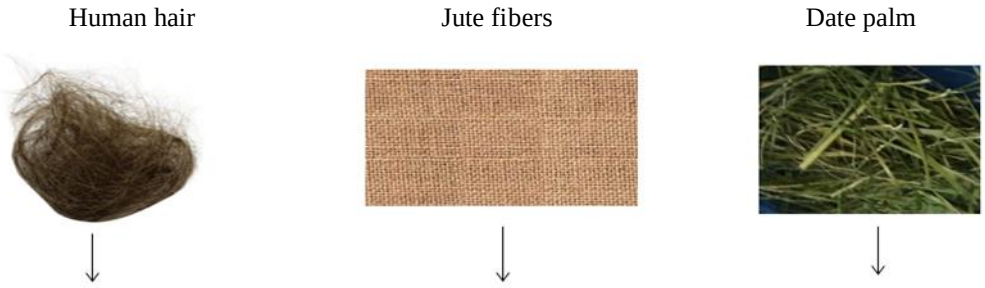


Fig 1: Fibers used in the Experimental Investigation

TABLE 1: Compressive strength of different blocks

Nomenclature of the Specimen	Failure Load (KN	Area of the specimen (mm^2)	Compressive Strength (N/mm^2)
CB	30.4	50 x 50	12.16
CHB	37	50 x 50	14.8
CJB	46.3	50 x 50	18.52
CPB	8	50 x 50	3.2

2.2.2 Density:

Density is measured at the end of 3rd day. The density of the cube is dry weight of cube by its volume in kg/m^3 and is mention in Table 2.

2.2.3 Water Absorption:

The test cubes are immersed in water at room temperature for 24 hours. After 24 hours immersion the cubes are taken out from the water and they are allowed to drain. They are then immediately weighed and the weight is noted as W_1. The specimens are then dried at 107 ^{0} C for 30 minutes and the dry weight is measured as W_2. Heating and weighing is repeated till the constant weight is obtained. The percentage absorption of water is calculated as follows:

% water absorption = $[(W_1 - W_2)/W_2] \times 100$

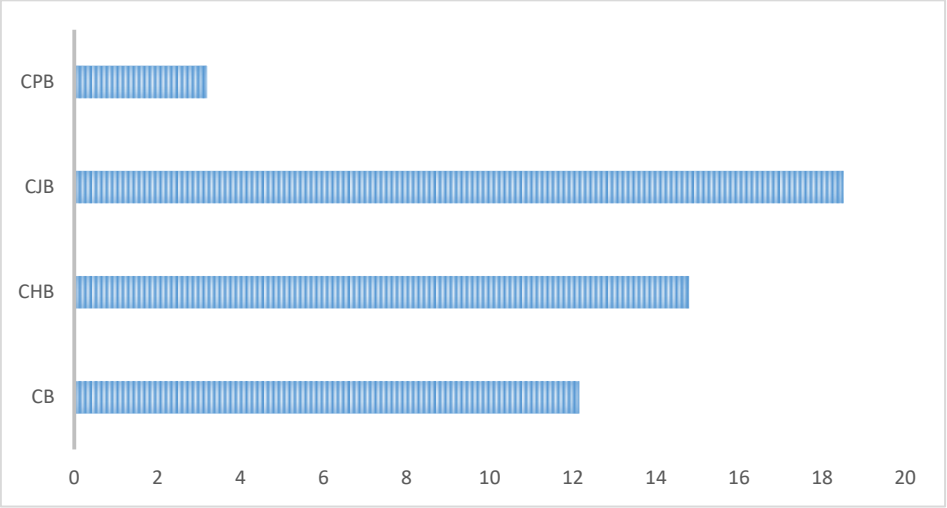
The percentage of water absorption of cement block (CB), Cement Hair block (CHB-2), Cement jute block (CJB-2) and Cement Palm block (CPB-2) are listed in Table 2.

TABLE 2: The percentage of water absorption and density of different blocks

Nomenclature of the Specimen	W_1 (g)	W_2 (g)	% of water Absorption	Density (kg/m^3)
CB	292	285	2.46	22.80
CHB	289	281	2.85	22.48
CJB	277	271	2.21	21.84
CPB	262	252	2.51	22.24

3. RESULTS AND DISCUSSION

1. The compressive strength of different blocks are compared and are shown in Fig.2.The cement jute block(CJB) shows higher compressive strength than cement hair block(CHB), cement palm block (CPB) and conventional cement block(CB).
2. The compressive strength of cement palm block (CPB) is found to be less than conventional cement block due to poor bonding strength. The fresh palm fibers added have tendency to absorb moisture and has weak bond with concrete which is clear from the specimen of cement palm block shown in Fig.3.
3. Jute and hair fibers forms strong bond with cement but jute fibers forms stronger bond than hair fibers.



Compressive Strength in N/mm^2

Fig 2: Compressive Strength of Different Blocks

Fig 3: Casting and Failure of Cement Palm Block

4. The water absorption of different blocks are shown in Fig.4 and it is found that cement block with jute fibers absorbs less quantity of water compared to other fibers. Cement block with palm fibers absorbs more quantity of water.

Conventional cement block (CB) absorbs more water than cement jute block (CJB) but the percentage of water absorption is less compared to Cement hair block (CHB) and cement palm block (CPB).

5. The cement palm blocks have more voids than cement hair blocks followed by conventional cement block. Cement jute block has less voids compare to other three blocks and therefore it has shown highest compressive strength among the chosen fibers and conventional block.

6. From the density of different blocks shown in Fig.5, it is found that cement jute block has least density as compare to other blocks and its self-weight is less than conventional cement block. It is clear from the test result that adding natural fibers (hair, jute and palm), reduces the density compared to conventional cement blocks.

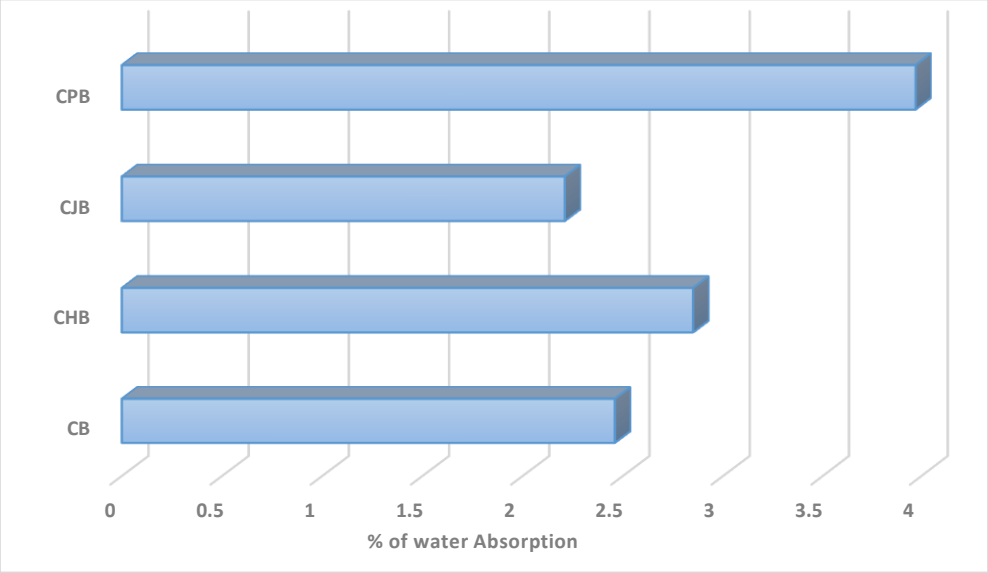


Fig 4: The percentage of Water Absorbed by Different Blocks

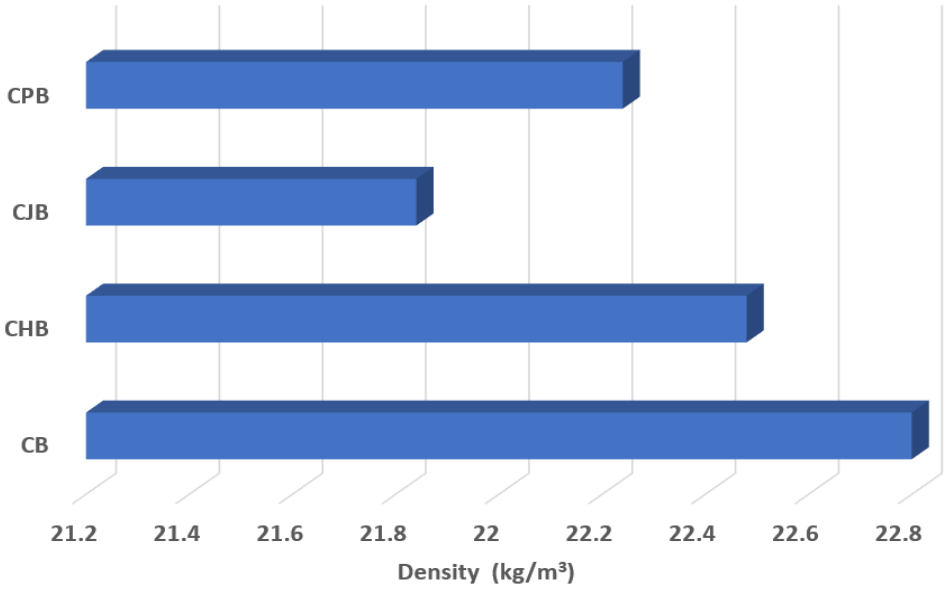


Fig. 5: Density of Different Blocks

7. The percentage increase in compressive strength is found to be 52.14% for cement jute block (CJB) and 21.71 % for cement hair block(CHB) as compared with conventional cement block(CB)

8. It is found that the compressive strength of jute block is 25% higher than the compressive strength of hair block.

9. The amount of cement used to prepare the conventional cement blocks is 500 g. The strength achieved in cement hair block (CHB) and cement jute block (CJB) with 500g of cement are equivalent to conventional cement blocks with 638g and 766 g of cement respectively. This proves that the usage of cement has reduced by 27.4 % with hair and 53.2 % with jute fibers.

10. As per our findings, the cement hair block reduces emission of carbon dioxide with respect to conventional cement block by 1.3 g. If conventional cement block is replace by cement jute block, it reduces emission of carbon dioxide by 2.4 g to the atmosphere.

4. CONCLUSION AND FUTURE WORK

From the preliminary test results, it is concluded that jute fibers perform better compare to other fibers and it bonds well with cement. Fresh palm fibers absorbs more water and has weak bond with cement that reduces the compressive strength compared to conventional cement block. The palm fibers need to dry to expel all its moisture. The hair fibers show more compressive strength than conventional cement block but less compressive strength than cement jute block. In this paper fibers are added as admixtures but in near future as a continuation of this work fibers can be added as supplementary cementitious material or replacement of fine or coarse aggregates and to study the compressive strength, splitting tensile strength, flexural strength and toughness of concrete.

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