A Study based on combination of coconut fibre and human hair mixed with concrete

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Abstract: - *Natural fibres have nowadays become eye-catcher to researchers, engineers and scientists as an alternative reinforcement for FRC (Fibre Reinforced Concrete) due to their low cost, fairly good mechanical properties and high aspect strength. Among them, human hair and coconut coir are most easily available and cheap fibre. On the whole much amount of human hair and coconut coir is produced by India as a waste product. Hair is elastic material due to presence of Cortex Keratin. Whereas coconut fibre is ductile in nature and can withstand strain 2-3 times more than other fibres. The objective of this research is to make a concrete mix with coconut coir and human hair as composite materials in concrete and their effect on compressive strength and flexure strength. Trial methods are done to achieve the strength at an interval of 7 and 28 days with 1%, 2% and 3% replacement of cement in concrete mix.*

Keywords: - Coconut fibre, human hair, fibre reinforced concrete, advanced fibres, natural fibres.

1. Introduction

Mortar is used all over for construction purpose. It consists of cement paste and fine aggregates and admixtures if required are also used to modify some of its properties. In this study coconut fibre along with human hair used as additive materials in the mortar and its effects on flexure and compressive strength of the mortar are investigated. Coconut fibres and human hair in waste materials that produced in millions of tons every year which creates not only biodegradability problems but cause pollution. Several problems have evolved because of increasing temperature on use of mortar and concrete in recent few years where it has sufficiently threatened the performance of mortar and concrete. Coconut fibres are long thread-like structures which are obtained from outer shells of coconut. These fibres are very strong and tough. Coconut fibres have the highest toughness among natural fibres. They act as excellent insulators against heat and sound and are light in weight acting as a fire-resisting material. They have rough structure and so form proper and strong bond with concrete. They have water absorption ability. Hair is used as a fibre reinforcing material in concrete for following reasons: -

- It has high tensile strength which is equal to that of copper wire with a similar diameter.
- Hair, a non-degradable matter is creating environmental problem so it is used as fibro reinforcing material.
- It is also available in abundance and at a low cost.
- It reinforces the mortar and prevents it from spalling.

Concrete is weak in tension and has a brittle character. Use of fibres in concrete may provide a better solution. Addition of fibres to concrete makes a homogeneous and isotropic material that arrests crack formation and propagation, and thus improve strength. Fibre-reinforced (FRC) is concrete containing fibrous material which increases its structural integrity. Hence, fibres have been used as reinforcement since ancient times as stated (Arisoy, 2002). The main challenge for structural engineers is to provide sustainable, environmental friendly and financially feasible structures to society. Most of the researcher agreed for a major reason for performance of fibre into concrete structures;

- Improve tensile or flexural strength.
- Improve the shear strength.
- Improve the impact strength.
- Improve flexibility.
- Improve ductility.
- Control cracking and
- Change mode of failure from shear mode to a more ductile one.

Researchers observed that on testing for compressive strength Fibre-reinforced concrete showed very less formation of cracks, therefore, use of fibre reinforced concrete using human hair as a fibre can be done efficiently for seismic zones and for a construction free from cracks is desired as in case of pavement construction [1].

Some researchers found out by experimentation that: -

- Strength of concrete increases with the addition of hair fibre.
- Addition of 2% hair fibre gives maximum strength to concrete.
- Beyond 2% there is a reduction in strength. Further suggesting that hair fibre reinforced concrete can be used as a replacement of plain cement concrete in minor works i.e.:- non-structural components such as floors, pavements, sunshades lofts [2].

Some researchers did an extension work on use of blended materials under the effect of using coconut fibre and human hair so that strength can be increased and also the adverse effects of these waste materials can be reduced to keep our environment clean from effect of such wastes. By experimenting following conclusions were made by them:- Coconut fibres at 4% into the mix gave high 3 days strength and 6% gave high compressive strength at 28 days of curing at room temperature.n By increasing the percentage of coconut fibres strength of mortar increased at all days of curing. The use of human hair up to 2% initially gave high strength. However, with further increasing the percentage of human hair into the mix showed reduction in compressive strength of mortar at all days of curing. Addition of 6% of mix fibres into cement mortar showed higher compressive strength at third day for 2% and 4% while compressive strength of mortar was found higher for 2% at 28th day than compressive strength of mortar for 4% and 6% of mix fibres [3].

Many researchers studied the compressive and flexure strength of coconut fibre reinforced concrete using destructive and non-destructive test methods. From the results and analysis of this research work, they concluded that addition of 0.5% coconut husk fibre as a constitutive material of concrete affected the rheological properties of fresh concrete, increased the compressive and flexure strength of concrete by 35.8% and 22.15% respectively. It was verified that coconut fibre with 0.75% usage reduces the workability and drastically weakens the compressive and flexure strength. The presence of coconut fibre significantly improves the toughness and ductility behaviour of concrete. Based on test results obtained, the integration of coconut fibre in making FRC composites would be one of the promising strategies to improve the performance of concrete. The greater improvement in flexure and toughness behaviour of FRC is highly encouraging as the tensile strength enhancement has been one of the biggest challenges of concrete material behaviour over the years [4].

2. Methodology and experimental discussion

2.1 Compressive strength:-

The current study is taken with the objective of studying and analyzing the effect of human hair in properties of plain cement concrete based on the parameters of compressive strength and resistance to formation of cracks and crushing strength to control cracks as well as to curb the environmental problems being non-biodegradable in nature. For carrying out this experimentation concrete cubes of size (150mm x 150 mm x 150 mm) were created having grades M20 and M30 for both plain cement concrete and for fibre reinforced concrete using human hairs. For each type of grade and concrete, a set 3 cubes was prepared and was tested after curing for 7, 14 and 28 days. For preparing the concrete cubes having human hair as a fibre, hairs were used in varying percentage by weight of cement replacing the amount of cement. Here we have used the human hairs as 1%, 1.5%, 2% and 8% by weight of cement for preparing the specimen cubes of M20 and M30 for testing [1].

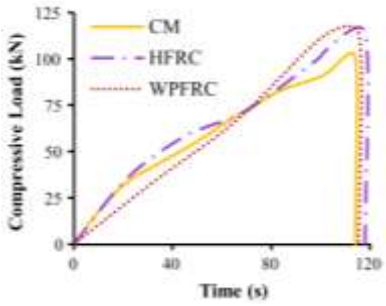

Fig. 1 Compressive load-time curves of CM, HFRC and WPFRC. CM [5]

[5] The load-time curves of CM, HFRC and WPFRC under compressive loading are presented in Fig. 1. The first crack and cracks at peak load of CM, HFRC and WPFRC specimens during testing are shown in Fig. 2. During testing the behaviors of CM, HFRC and WPFRC are observed. However, in this work, certain information like length of first crack and number of cracks at peak load is shown. In CM, HFRC and WPFRC specimens, the first crack appears at 89%, 88% and 98% of their own peak load. In CM specimen, the length and width of the first crack are more as compared to that of HFRC and WPFRC. The first crack length in CM is approximately 10 cm and it is 5 cm in both HFRC and WPFRC **Error! Reference source not found.**.

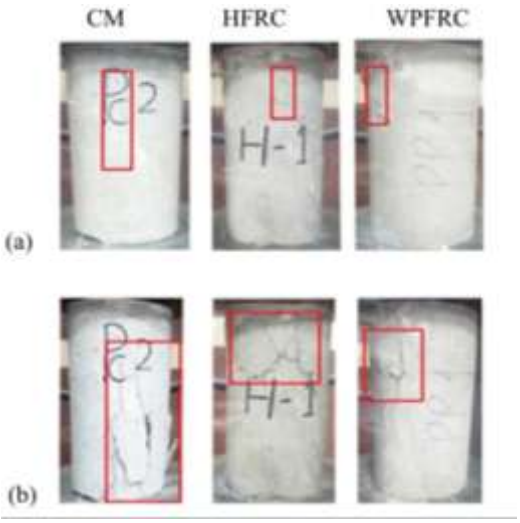

Fig. 2 Crack development under compressive load for CM, HFRC and WPFRC specimens: (a) first crack (b) cracks at peak load [5].

In CM specimen, the number of cracks, crack length and width at the peak load is more than that in HFRC and WPFRC. In CM, HFRC and WPFRC specimens, the maximum length of crack are propagated up to 15 cm, 8 cm and 7 cm, respectively, at their respective peak load **Error! Reference source not found.**. At the peak load, in CM sample, some concrete pieces are chipped off from the cylinder; while the pieces are not chipped off in HFRC and WPFRC specimens. The inclusion of hair and wave polypropylene fibers in matrix results in bridging effect. In CM broken specimens, the maximum failure is observed along the interfacial transition zone (ITZ). The HFRC and WPFRC specimens are broken intentionally which show the predominant failure of de-bonding of fibers; and uniform distribution of hair and wave polypropylene fibers in concrete. The failure due to de-bonding of hair fiber is 80% at the broken face; whereas 20% hair fiber failure is due to fracture. At the broken surface of WPFRC cylinder, ? all the wave polypropylene fibers are debonded.

2.2 Tensile and flexural test: -

Fig. 3 clearly shows the tensile and flexural strength by varying the fibre content (30%, 40% and 50%). It is understood from these figures up to 40% weight of fibre shows an increasing trend for both tensile and flexural strength[6].

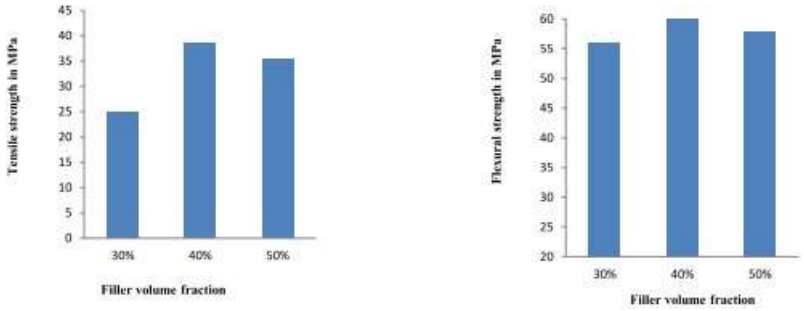

Fig. 3 Tensile strength for hybrid composite and Flexural strength for hybrid composite[6]

[7] The split tensile strength for different percentage of human hair added to concrete were tested at the end of 28 days using compressive strength testing machine as shown in Fig. 4. The percentage of human hair was taken as 1%, 1.5%, 2%, 2.5%, 3%. Three cubes of each percentage of human hair are cast. The concrete cubes were cured at room temperature.

Fig. 4 Tensile testing machine with specimen[7]

Better split tensile strength was achieved with the addition of the human hair in concrete. The strength has increased when compared to that of the conventional concrete specimen[7].

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