EXPERIMENTAL STUDY ON COCONUT FIBER IN CONCRETE

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ABSTRACT-

The aim of this project was to evaluate the performance of M_{25} grade coconut fibre concrete with the normal M_{25} grade concrete. Concrete has a good serviceability, but it is failing in some conditions due to the improper mixing which results in cracking. So the concrete is likely to be get replaced by other material like fibres, to get good serviceability. In the same way the additive material should be economic. Coconut is a naturally available material which will increase the strength of concrete by producing infinite variance in strength compared to normal concrete.

The main aim of this investigation is first to obtain the strength of normal concrete of grade M_{25} with locally available ingredients and then to study the effect of different proportions of coconut fibre in the mix and to find out the effect on various mix proportions of coconut fibres in the mix range to the concrete. And the concrete specimens were tested at different age levels such as 7, 14, 28 for mechanical properties of concrete namely, cube compressive strength. Based on the laboratory experiments cube specimens have been designed for Coconut fibre concrete tests. The Coconut fibres in the concrete mixture have been carried in the range 0 to 6%.

The coconut fibre containing concrete mixtures have been aged at 7, 14, 28 days. When coconut fibres are mixed in the concrete at different percentage values, different densities such as 6kg/m^3, 12kg/m^3, 18kg/m^3, 24kg/m^3, 30kg/m^3, 36kg/m^3 have been obtained.

Keywords *-- Coconut fibre, naturally available material, Cement, partial replacement, extra strength, compressive strength*

I. INTRODUCTION

Advanced cement-based composites and the fundamental understanding of their behavior is an area of civil engineering that is expanding rapidly. Cement-based components (also referred to her generically as ―concrete) can be engineered to have outstanding combination of strength and energy absorption capacity (ductility) that is fundamentally different from plain concrete made with Portland cement. Conventional concrete is brittle nature, which is strong in compression but weak in tension, thus reinforcement is necessary to improve its tensile strength.

The science of incorporating one or more materials in concrete to improve strength and satisfy design requirements is not new. Since the 17th Century, man has been known to make composite materials to achieve the desired design strengths

Mostly concrete is reinforced with steel bars .Over the years scientists have been doing research on reinforcing concrete with fibers. The approach of replacing steel by incorporating the natural fibers in concrete is termed as Natural Fiber Reinforced Concrete (NFRC).The use of fiber reinforced concrete can be dated back since 1870‘s .Since then researchers have been working on concrete reinforced with wood fiber, waste glass, sisal fibers and vegetable fibers such as elephant grass, and many more. In particular, the natural fibers are sometimes used as reinforcement together with steel in concrete so as to reduce cracking and spalling of the structures.

Natural fibers are hair like materials that are continuous filaments which are found in animals or plants. The thickness of most fibers ranges from 12-29 microns. They can be used as component of composite materials, for example concrete and mortar. They can also be twisted or woven into sheets or felt.

Examples of natural fibers are:

- Sugarcane Bagasse,
- Coconut (coir fibers),
- Bamboo fibers,
- Sisal
- Elephant grass,
- Jute
- Human hair,
- Animal hair,
- Fur
- Avian fibers,
- Silk fibers etc.

Coconut fibres:

Natural reinforcing materials can be obtained at low cost and low levels of energy using local manpower and technology. Utilization of natural fibres as a form of concrete enhancement is of particular interest to less developed regions where conventional construction materials are not readily available or are too expensive. Coconut and sisal-fibre reinforced concrete have been used for making roof tiles, corrugated sheets, pipes, silos and tanks (Agopyan, 1988).

Concrete made with Portland cement has certain characteristics: it is strong in compression but weak in tension and tends to be brittle. The weakness in tension can be overcome by the use of conventional steel bar reinforcement and to some extent by the inclusion of a sufficient volume of certain fibres. The use of fibres also alters the behavior of the fibre-matrix composite after it has cracked, thereby improving its toughness. The overall goal for this research is to investigate the potential of using waste and low energy materials for domestic construction. The objective of this research is to experiment on the use of coconut fibres as an enhancement of concrete. Coconut fibres are not commonly used in the construction industry but are often discarded as wastes.

Coconut fibres obtained from coconut husk, belonging to the family of palm fibres, are agricultural waste products obtained in the processing of coconut oil, and are available in large quantities in the tropical regions of the world, most especially in Africa, Asia and southern America. In Ghana, they are available in large quantities in the southern part of the country. Coconut fibre has been used to enhance concrete and mortar, and has proven to improve the toughness of the concrete and mortar (Gram, 1983, and Ramakrishna, et al., 2005). However, the problem of long term durability has not yet been solved. It has also been noticed that the degree of enhancement of concrete by coconut fibres depended on the type of coconut species and the sub-region that the coconut plant was cultivated.

.II. LITERATURE REVIEW

Waweru nancy mugure (April 2014) university of nibori, nibori, kenya.

Waweru nancy mugure was investigated on sugarcane fibre (1%, 2%, 3%) in concrete. He compared oven dried bagasse with sun light dried bagasse that is sun light bagasse is stronger than oven dried bagasse. Studied the fresh concrete properties like workability tests(slump cone test, compaction factor test) and harden concrete properties like compressive strength, split tension test ,flexural strength) slump values are 37 ,15,15,10 and compaction factors are0.95,0.95,0.90,0.85 for 0%, 1%,2%,3% respectively. Harden properties like Compressive strength, split tension test, flexural strengths are obtained at the age of 7,28 days. Compressive strengths at age of 28 days for 0%-15.6, 1% -17.25, 2%-16,3%-7.For 1%-1.65MPa,2%-0.4MPa increased and for 3% it is deceased. split tension strength for 0%-1.41, 1%-1.48,2%-1.27,3%-0.42MPa.Flexural strength are for 0%-0.747,1%-1.676,2%-0.747,3%-0.687MPa.

Plain concrete (control) compared with bagasse fibre reinforced concrete at 7days of curing; addition of bagasse fibre is seen to reduce the compressive strength consistently. Tests after 28days of curing show that the compressive strength increases as fibre is increased to an optimum of 1%, where the strength starts to drop with more increase of the fibre. The compressive strength is increased by up to 10.6% compared to that of the control. The tensile strength was highest at 1.48N/mm2 for a fibre content of 1% at 28days of age.

M. Sivaraja (march 2010): was investigated on natural fibers he was used 0.5%,1%,1.5% in concrete with aspect ratios of 30,60,90.He gives relation compressive strength, flexural strength, split tension for bagasse reinforced concrete

Reis, ferreira (2006): were reported that the chopped sugarcane fibers increase the fracture properties- both fracture toughness and fracture energy of concrete**. S**ugarcane fibres slightly increase the flexural strength (3.5 %).

Natural fibres reinforced in concrete blocks: David stephen (1994) university of durban-westville.

David stephen was used 1%, 2%, 3% of sugarcane fibres in cement mortar . he said that the dry bagasse fibers float on water indicating a bulk density less than one. An approximate value of 0.5 (considered adequate for preliminary purposes) was eventually found by using a density bottle. and he studied that the standard slump cone test gave slumps ranging from 80mm for the unreinforced mix down to 35mm for the mix with 3 percent fibers. He tested compressive strength, tension strength and impact resistance for 14,42,56,84 day for air cured as well as water cured cubes. Compressive strengths are 1.34, 1.37, 1.32, 1.27 for 0%,1%,2%,3% respectively. Impact resistance values are 5.67, 10.3, 12.0, 16.0 and the percentage for plain concrete is 81,211,282 for 1%,2% and3% respectively.

(a) Water cured 14 day strength 0.23, 0.25, 0.17, 0.17. 42 day strength 0.32 0.36, 0.15, 0.21. 56 day strength 0.32, 0.32, 0.19, 0.2. 84 day strength 0.40, 0.38, 0.24, 0.23

(b) Air cured 14 day strength 0.23, 0.34, 0.15, 0.19. 42 day strength 0.29, 0.41, 0.20, 0.18. 56 day strength 0.29, 0.39, 0.20, 0.17.84 day strength 0.32, 0.41, 0.23, 0.21 for 0,1,2,3% respectively.

According to this thesis air cured cubes stronger than water cured cubes for bagasse fibers.control (1.41 N/mm2).The tensile strength also reduces as the fibre content is increased beyond the optimum. The flexural strength results indicate that addition of bagasse fibre increased the flexural strength of the concrete mass by up to 56.2% 9 (i.e. from 0.747N/mm2 to 1.167N/mm2) at 2% bagasse fibre content (for 28days).This is the same as was for 2% coir fibre. It is seen that at 7days of age the optimum fibre content is seen to be 2%.We use the optimum of 1% as concrete is assumed to attain its highest strength at 28days of curing. Just like as discussed above, additional of fibre increase flexural strength up to the optimum.

III. EXPERIMENTAL INVESTIGATION

Experimental Programme

Materials Used:

The materials used in this investigation are…

- ❖OPC.
- ❖Sand
- ❖Coarse aggregate
- ❖Water.
- ❖Coconut fibers

CEMENT:

Properties a)Physical	Requirements as per IS 12269-1987	Cement values
Fineness (sqm/kg)	225(min)	325
	Soundness (mm)	
Lechatlier method	10 mm (max)	1
Autoclave (%)	0.8 (max)	
	Setting time	
Initial (min)	30 minutes	150
Final (max)	600 minutes	260

PHYSICAL PROPERTIES OF FIBRES:

Properties of fiber	Sugarcane
Diameter	1.50mm
Aspect ratio	30
Specific gravity	0.52
Water absorption	286.6
Density(kg/m^2)	260

IV. RESULTS AND DISCUSSIONS

WORKABILITY TESTS ON FRESH CONCRETE:

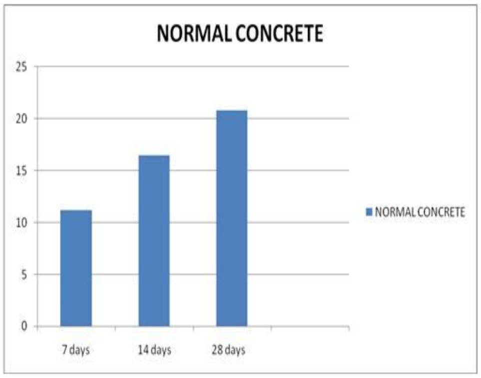
Degree of workability	Slump		Compacting factor	Use for which concrete is useful
	Mm	In		
Very low	0-25	0-1	0.78	Very dry mixes; used in road making. Roads vibrated by power operated machines.
low	25-50	1-2	0.85	Low workability mixes; used for foundations with light reinforcement.
Medium	50-100	2-4	0.92	Medium workability mixes; manually compacted flat slabs using crushed aggregates.
High	100-175	4-7	0.95	High workability concrete; for sections with conjested reinforcement. Not normally suited for vibrations.

COMPRESSIVE STRENGTH:

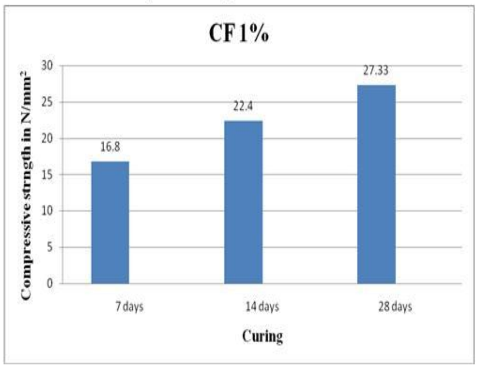
Sl.No	Type of concrete	Age of concrete in days (DAYS)	Failure load in N	Slump (mm)	C.F	Avg. compressive Strength (N/mm2)
1	**Normal Concrete**	7	251000	1100	0.93	11.15
		14	371000	100	0.93	16.48
		28	468000	100	0.93	20.80
2	**1% CFC**	7	378000	70	0.93	16.8
		14	505000	70	0.93	22.4
		28	615000	70	0.93	27.33
3	**2% CFC**	7	360000	60	0.91	16
		14	485000	60	0.91	21.55
		28	580000	60	0.91	25.77
4	**3% CFC**	7	172000	65	0.89	7.64
		14	245000	65	0.89	10.88
		28	280000	65	0.89	12.44
5	**4% CFC**	7	125000	50	0.84	5.55
		14	160000	50	0.84	7.11
		28	195000	50	0.84	8.66
6	**5% CFC**	7	100000	50	0.842	4.44
		14	140000	50	0.842	6.22
		28	170000	50	0.842	7.55

Tabulation of compressive strength results

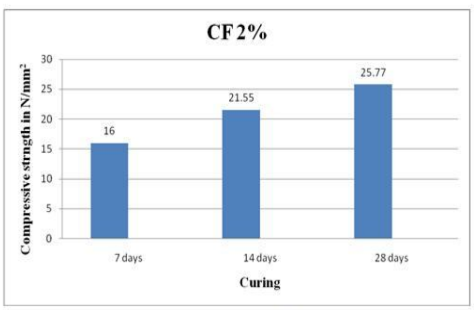
V. GRAPHS



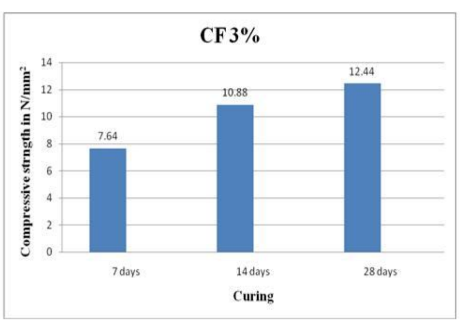
compressive strength of normal concrete



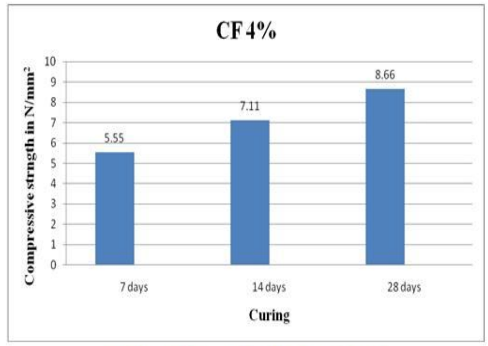
compressive strength of 2% CF concrete



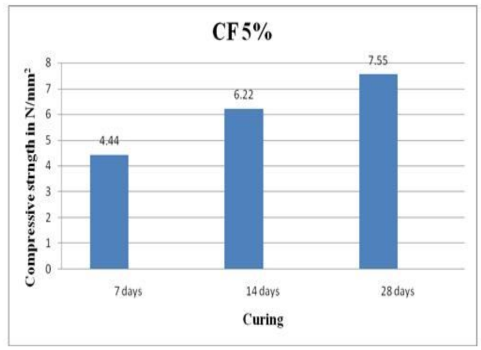
compressive strength of 2% CF concrete



compressive strength of 3% CF concrete



Graph5: compressive strength of 4% CF concrete



Graph6: compressive strength of 5% CF concrete

VI. CONCLUSIONS

Based on the experimental investigation carried out, the following conclusion was drawn:

- Workability of the concrete is reduced when compare with the normal concrete.
- For 1% and 2% of the coconut fibres compressive strength increased 2.33MPa and 1.5 MPa respectively.
- From the 3% of fibre reinforced concrete the fibres are not uniformly distributed in the mix and balling forms.
- The bond between the matrixes is very higher than the normal concrete.
- Density of the coconut fibre concrete is less (i.e light weight concrete).
- Compressive strength for 3% of the fibre reinforced is decreased than the normal concrete.
- Evaporation losses are less, cracks are less after application of the compressive load (i.e micro cracks are reduced).
- Ductility and durability of concrete of the concrete are increased.

- Addition of the 1% of coconut fibres is more suitable for the concrete.

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