A Study of Effect of Coconut Fibre in Rcc Beam Subjected To Combined Bending And Shear

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Abstract- *Reinforcement of concrete is necessary to enhance its engineering properties. For this study, coconut fibres are used as they are freely available in large quantities. The study comprises of comparative statement of properties of coconut fibre reinforced concrete with conventional concrete based on experiments performed in the laboratory. The use of coconut fibres will also lead to better management of these waste fibres. The addition of coconut fibres improved the flexural strength of concrete by about 12%, they also formed good bonding in the concrete. The study found the optimum fibre content to be 30% from litrature review. Further work is required by changing the fibre content and aspect ratio to determine the optimum range of fibre content so that fibre reinforced concrete can be used where high flexural strength is required. For more detail analysis ANSYS workbench is used for further analysis important design parameter such as total deformation,normal stress,bending stress,principal stresses are studied.*

Keywords- coconut fibre, ansys

I. INTRODUCTION

Researchers have used natural fibres as an alternative to steel or synthetic fibres in composites such as cement paste, mortar and concrete. These natural fibres include coconut, sisal, jute, hibiscus cannabinus, eucalyptus grandis pulp, malva, ramie bast, pineapple leaf, kenafbast, sansevieria leaf, abaca leaf, vakka, date, bamboo, palm, banana, hemp, flax, cotton and sugarcane fibres. Natural fibres are cheaper than artificial fibres (Paramasivam et al. 1984) and are locally available in many countries. Their cost as a construction material for improving the properties of composites is only a fraction of the total cost of composites. Compared to steel fibres, they are also easier to handle because of their high flexibility, especially when a large volume of fibres is involved. However, insuch a case, a methodology for casting needs to be developed. Terms such as volume fraction and fibre content are often used for expressing the quantities of fibres Volume fraction of fibres is the percentage of fibres by volume of composite materials or any of its ingredients, e.g. 1% fibre per m3 of concrete. Similarly, fibre content is the percentage of fibres by mass of composite materials or any of its ingredients, e.g. 1% fibres by mass of concrete materials or 5% fibres by mass of cement. Researchers often investigated the optimum quantity and length of fibres to achieve maximum strength of the composite, as any increase or decrease in volume fraction and/or fibre length over the optimum level may be detrimental.

Fig 1: Coconut fibre

Coconut fibre is extracted from the outer shell of a coconut. The common name, scientific name and plant family of coconut fibre are coir, cocos nucifera and arecaceae (Palm), respectively. There are two types of coconut fibres: brown fibres extracted from matured coconuts and white fibres extracted from immature coconuts. Brown fibres are thick, strong and have high abrasion resistance, while white fibres are smoother and finer, but also weaker. Coconut fibres are commercially available in three forms, namely bristle (long fibres), mattress (relatively short) and decorticated (mixed fibres). These different types of fibres have different uses depending upon the requirement. In engineering, brown fibres are mostly used (Gu, 2009). Of the 55 billion coconuts harvested every year in the world, only 15% of the coconut fibres are recovered for use (Wei and Gu, 2009). According to the official website of International Year for Natural Fibres 2009, approximately 500,000 tonnes of coconut fibres are produced annually worldwide, with an approximate value of $100 million. India and Sri Lanka are the main exporters, followed by Thailand, Vietnam, the Philippines and Indonesia. Around half of the coconut fibres produced is exported in the form of raw fibre. The general advantages of coconut fibres are that they are moth-proof, resistant to fungi and rot, provide excellent insulation against temperature and sound, flame-retardant, unaffected by moisture and dampness, tough and durable, resilient, and spring back to shape even after constant use.

II. METHODOLOGY

For developing concrete mix, it is important to select proper ingredients, evaluate their properties and understand the interaction among different materials. CONCRETE will normally contain not only Portland Cement,Aggregate and Water, but also Super plasticizer and Retarders.

2.1 THE MAIN INGREDIENTS ARE AS FOLLOWS

- Cement.
- Fine aggregates (i.e. sand).
- Course aggregate.
- Super plasticizer
- Steel bars
- coconut fibre

2.2 MATERIAL PROPERTIES

2.2.1 Cement

Ordinary Portland cement, 53 grade shall be manufactured by intimately mixing together Calcareous and argillaceous and/or other silica, alumina or iron oxide bearing materials, burning them at a clinkering temperature and grinding the resultant clinker so as to produce a cement capable of complying with this standard. No material shall be added after burning, other than gypsum, water, performance improver(s), and not more than a total of 1.0 percent of air-entraining agents or other agents including coloring agents, which have proved not to be harmful. Among the chemical constituents of cement, the most important ones are C_3A, C_3S and C_2S. The C_3A portion of cement hydrates more rapidly, thereby reducing the workability of fresh concrete. It also adsorbs the chemical admixtures quickly which leads to reduction in availability of those admixtures for comparatively slower settingcomponents of cement viz., C_2S and C_3S. This further affects the workability of fresh concrete and also its rate of retention of workability.

Regarding particle size distribution, it may be noted that finer particles hydrate faster than coarser particles and hence contribute more to early age strength concrete; however, at the same time, the faster the rate of hydration may lead to quicker loss of workability due to rapid and large release of heat of hydration. Cement used and tested in laboratory and its results are as follows; Brand Name **:** Ultra tech Cement 53 Grade O.P.C.

Conforming IS Codes **:** IS: 12269-1987

Table 2.1 Chemical Properties of Cement

Sr. No.	Chemical Requirement	UltraTech OPC53grade	As per IS: 12269-1987
1	Loss on ignition, percent by mass	2.78	4.0 Max
2	Insoluble residue, percent by mass	1.80	3.0 Max
3	Magnesia, percent by mass	1.0	6.0 Max
4	Alumina iron oxide	1.32	0.66 Min
5	Sulphuric anhydride, percent by mass	2.5	3.0 Max
6	Alkalies	-----	0.05Forprestressed structures
7	Total Chloride, percent by mass	0.050	0.10Max

2.2.2 Fine Aggregate (Sand)

Fine Aggregate plays an important role in concrete as it help in practical packing in high strength concrete. It bound together with cementing material. The strength of concrete depends on the bond between the cement and the aggregate. If the bond between aggregate and cementious material is poor then the concrete will give poor strength.

Hence for making concrete the naturally available strong aggregate with particular size and shape are required for making normal concrete.

Also the fine aggregate greatly influence on the workability of the concrete. Hence natural aggregate of locally available are used for the present work.

Fineness modulus (As Per IS 383-1970)

Table 2.2 Sieve Analysis for Fine Aggregate (As Per IS 383-1970)

Sr .No	IS Sieves (mm)	Wt. Retained (gm)	Percentage Wt. Retained (%)	Cumulative Percentage Wt. Retained (%)	Cumulative Percentage Wt. Passing (%)
1	4.75	15	1.5	1.5	98.5
2	2.36	67	6.7	8.2	91.8
3	1.18	199.4	19.94	28.14	71.86
4	600	352	35.2	63.34	36.66
5	300	279.1	27.91	91.25	8.75
6	150	74.3	7.43	98.68	1.32
7	75	11	1.1	99.78	0.22
8	PAN	2	0.2	99.98	0.02

Fineness Modulus =

$$\frac{\text{sumofCumulative \%ofWt. Retainedfrom 4.75 mmto 150 µm}}{100}$$

$$= \frac{291.11}{100}$$

= 2.91

Specific Gravity of Fine Aggregate: (As per IS 2386:1963 Part-III)

To determine the specific gravity of F.A. pycnometer is used and the specific gravity of sand were found to be 2.50 and are shown in table.

Table 2.3 Physical Properties of Fine Aggregate

Sr. No.	Property	Results
1	Particle shape and size	Round, Below 4.75 mm
2	Fineness Modulus	2.91
3	Silt Content	3.5 %
4	Specific Gravity	2.54
5	Water Absorption	1.2%

2.2.3 Coarse Aggregate

Coarse aggregate plays an important role in case of high strength concrete, because as the grade of concrete increases the mix of concrete becomes more cohesive and the fine aggregate play an important role of only particle packing. Hence as the grade of concrete increases the quantity of coarse aggregate are increases and quantity of fine aggregate decreases. The load taken in case of high strength concrete by bonding of cement paste and coarse aggregate. Hence high strength concrete only possible when the aggregate of higher specific gravity are used. Hence in the present work samples aggregate from different sources are collected and tested. After collecting samples the properties of good aggregate that found in local area of 20 mm size aggregate confirming to IS 383-1970 are taken and the test results are as follows,

Fineness modulus (As Per IS 383-1970)

Table 2.4 Sieve Analysis of 20 mm Coarse Aggregate

Sr. No	IS Sieves (mm)	Wt. Retained (gm)	Percentage Wt. Retained (%)	Cumulative Percentage Wt. Retained (%)	Cumulative Percentage Wt. Passing(%)
1	40	0	0	0	100
2	20	453	22.65	22.65	77.35
3	10	1466	73.3	95.95	4.05
4	4.75	67	3.35	99.3	0.7
5	2.36	12	0.6	99.9	0.1
6	1.18	0	0	99.9	0.1

Fineness modulus = Sum of cumulative % mass retained on the sieve / 100

= 717.4/100

= 7.17

Table 2.5 Physical Properties of Coarse Aggregate

Sr. No.	Property	Results
1	Particle shape and size	Angular, 20 mm
2	Fineness Modulus	6.78
3	Specific Gravity	2.6
4	Water Absorption	1.29

2.2.4 Admixture

As the grade of concrete increases water cement ratio decreases hence for proper mixing of cement with other ingredients the water per cubic meter decreases. Because of that workability of concrete also decreases the grade of concrete increases.

Hence for increasing workability of a concrete a super plasticizer **"MasterGlenium"** of a poly-carboxylic ether base by FOSROC Chemicals is used in his experimental work. Confirm to IS 9103-1993.

Table 2.6 Physical Properties of admixture

Sr No.	properties	value
1	Aspect	Light brown liquid
2	Relative Density	1.12*0.02 at 25
3	pH	*6
4	Chloride ion content	*0.2%
5	Specific gravity	1.12

2.2.5 Water

Water plays an important role in concrete as the addition of water in cement paste the hydration reaction start. The water used in the concrete should be portable. When water mix with cement paste forms and cement paste bound the other ingredients of concrete. The C-S-H gel binds the other ingredients of concrete.

As per IS 456-2000 water used for the mixing and curing shall be clean and free from injuries amounts of oils, alkalis, salts, sugars, organic materials or other substances that may deleterious to concrete or steel. In this work, available tap water is used for concreting.

III. PERFORMANCE ANALYSIS

3.1 General:

In this chapter A RCC beam of size 500x100x100mm is analysed in ANSYS software and following models are proposed

MODEL NO.1	RCC BEAM M25 WITHOUT COCONUT FIBRE
MODEL NO.2	RCC BEAM M25 WITH 30% COCONUT FIBRE
MODEL NO.3	RCC BEAM M 30 WITHOUT COCONUT FIBRE
MODEL NO.4	RCC BEAM M 30 WITH 30% COCONUT FIBRE

3.2 ANSYS MODELLING

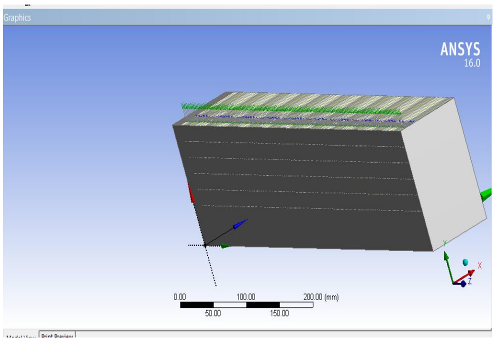


Fig 3.1:RCC MODEL IN WORKBENCH

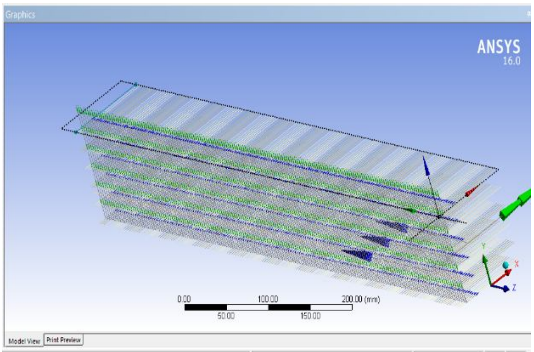


Fig 3.2:COCONUT FIBRE MESH

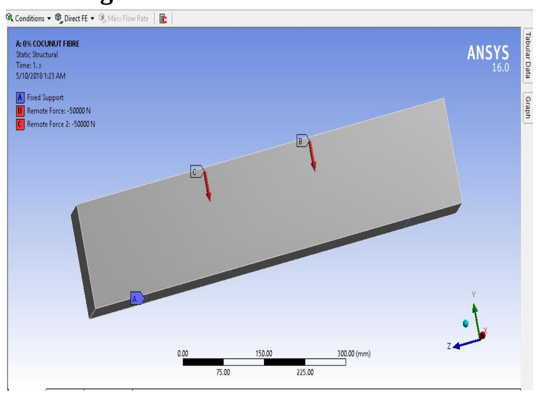


Fig 3.3:2 POINT LOADING IN ANSYS

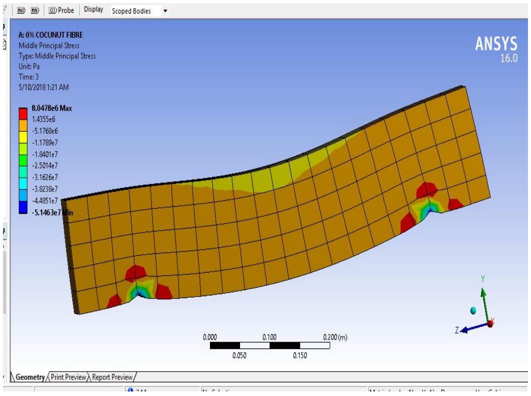


Fig 3.4:MIDDLE PRINCIPAL STRESS

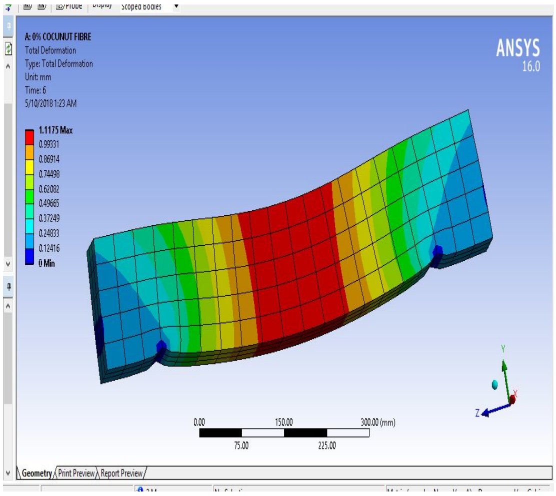
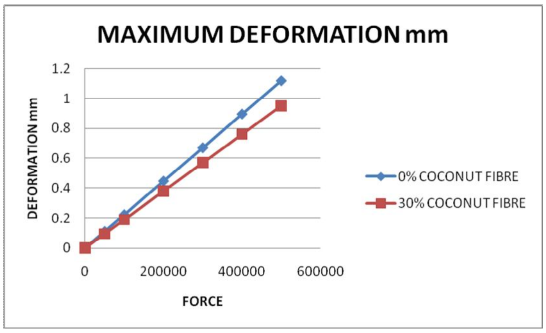


Fig 3.5:MAX. DEFORMATION

M30 RESULTS

Table 3.1:MAXIMUM DEFORMATION

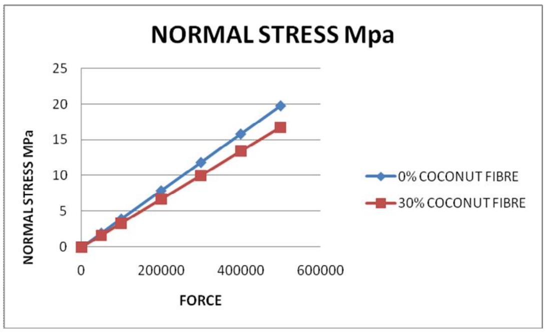
MAXIMUM DEFORMATION		
FORCE	0% COCONUT FIBRE	30% COCONUT FIBRE
0	0	0
50000	0.11175	0.0949875
1.00E+05	0.22349	0.1899665
2.00E+05	0.44699	0.3799415
3.00E+05	0.67048	0.569908
4.00E+05	0.89397	0.7598745
5.00E+05	1.1175	0.949875



Graph 3.1: In this graph the max. Deformation is in coconut fibre.

Table 3.2:NORMAL STRESS

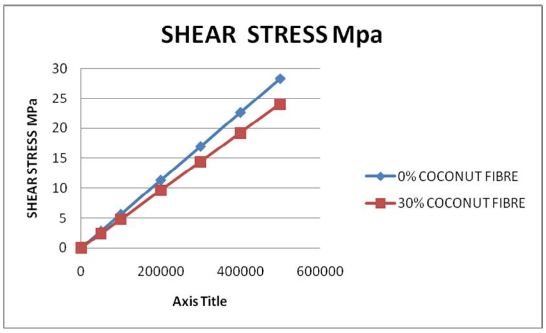
NORMAL STRESS Mpa		
FORCE	0% COCONUT FIBRE	30% COCONUT FIBRE
0	0	0
50000	1.9729	1.676965
1.00E+05	3.9457	3.353845
2.00E+05	7.8915	6.707775
3.00E+05	11.837	10.06145
4.00E+05	15.783	13.41555
5.00E+05	19.729	16.76965



Graph 3.2:In this graph the max. Normal stress is in coconut fibre.

Table 3.3:SHEAR STRESS Mpa

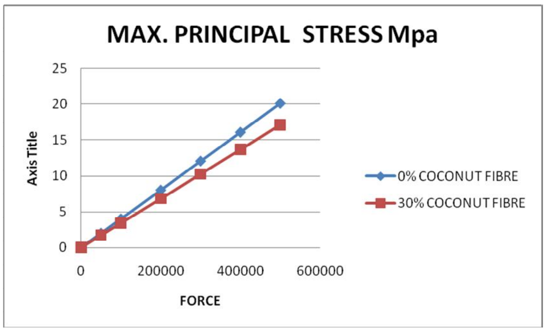
SHEAR STRESS Mpa		
FORCE	0% COCONUT FIBRE	30% COCONUT FIBRE
0	0	0
50000	2.8298	2.40533
1.00E+05	5.6595	4.810575
2.00E+05	11.319	9.62115
3.00E+05	16.979	14.43215
4.00E+05	22.638	19.2423
5.00E+05	28.298	24.0533



Graph 3.3:In this graph the max. shear stress is in coconut fibre.

Table 3.4:MAX. PRINCIPAL STRESS Mpa

MAX. PRINCIPAL STRESS Mpa		
FORCE	0% COCONUT FIBRE	30% COCONUT FIBRE
0	0	0
50000	2.012	1.7102
1.00E+05	4.0239	3.420315
2.00E+05	8.0478	6.84063
3.00E+05	12.072	10.2612
4.00E+05	16.096	13.6816
5.00E+05	20.12	17.102

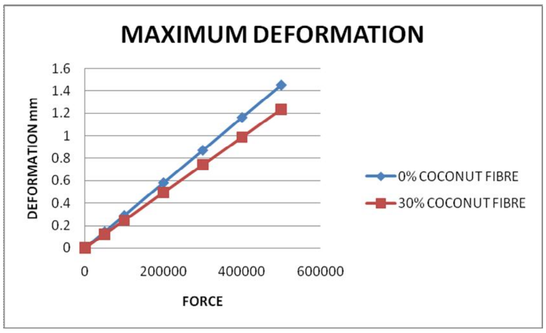


Graph 3.4:In this graph the max. Principal stress is in coconut fibre.

M25 RESULTS

Table 3.5:MAXIMUM DEFORMATION

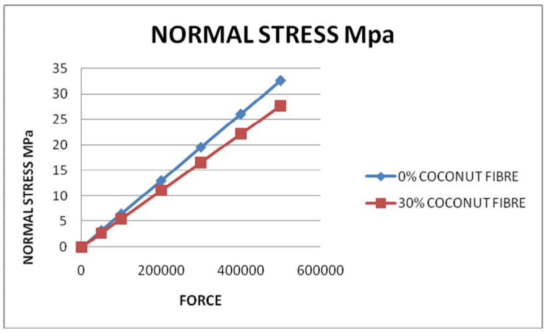
MAXIMUM DEFORMATION		
FORCE	0% COCONUT FIBRE	30% COCONUT FIBRE
0	0	0
50000	0.145275	0.12348375
1.00E+05	0.290537	0.24695645
2.00E+05	0.581087	0.49392395
3.00E+05	0.871624	0.7408804
4.00E+05	1.162161	0.98783685
5.00E+05	1.45275	1.2348375



Graph 3.5:In this graph the max. Deformation is in coconut fibre.

Table 3.6:NORMAL STRESS Mpa

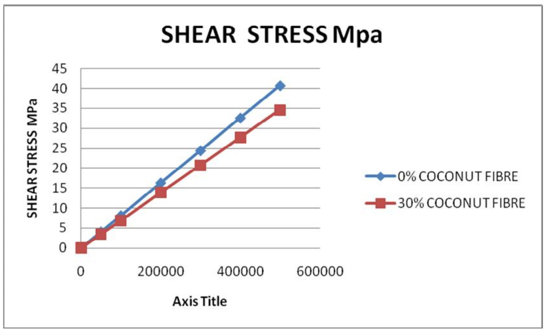
NORMAL STRESS Mpa		
FORCE	0% COCONUT FIBRE	30% COCONUT FIBRE
0	0	0
50000	3.255285	2.76699225
1.00E+05	6.510405	5.53384425
2.00E+05	13.020975	11.06782875
3.00E+05	19.53105	16.6013925
4.00E+05	26.04195	22.1356575
5.00E+05	32.55285	27.6699225



Graph 3.6:In this graph the max. Normal stress is in coconut fibre.

Table 3.7:SHEAR STRESS

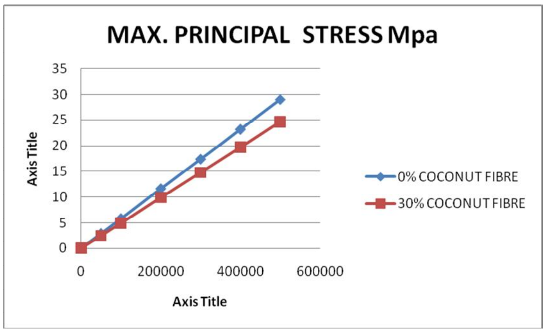
SHEAR STRESS Mpa		
FORCE	0% COCONUT FIBRE	30% COCONUT FIBRE
0	0	0
50000	4.074912	3.4636752
1.00E+05	8.14968	6.927228
2.00E+05	16.29936	13.854456
3.00E+05	24.44976	20.782296
4.00E+05	32.59872	27.708912
5.00E+05	40.74912	34.636752



Graph 3.7:In this graph the max. Shear stress is in coconut fibre.

Table 3.8:MAX. PRINCIPAL STRESS Mpa

MAX. PRINCIPAL STRESS Mpa		
FORCE	0% COCONUT FIBRE	30% COCONUT FIBRE
0	0	0
50000	2.89728	2.462688
1.00E+05	5.794416	4.9252536
2.00E+05	11.588832	9.8505072
3.00E+05	17.38368	14.776128
4.00E+05	23.17824	19.701504
5.00E+05	28.9728	24.62688



Graph 3.8:In this graph the max. Principal stress is in coconut fibre.

IV. CONCLUSION

1) Coconut fibre being low in density reduces the overall weight of the fibre reinforced concrete thus it can be used as a structural light weight concrete.
2) By reinforcing the concrete with coconut fibres which are freely available, we can reduce the environmental waste.
3) Maximum principal stress, shear stress and deformation decreases in case of 30% fibre mix. Thus, economy can be achieved in construction.
4) Also flxural strength is also increased by 15% for M25 and M30 fibre reinfoced concrete

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