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AN EXPERIMENTAL STUDY USING COCONUT AND JUTE FIBERS TO EXAMINE THE STRENGTH OF CONCRETE

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ABSTRACT

The primary goal of the common use of concrete in construction nowadays is to lower construction costs. Waste materials are frequently utilized to maximize the cost of concrete, and a variety of resources are substituted with concrete ingredients to reduce the cost of concrete. Organic Coconut fiber is derived from the unripe coconut and the coconut husk. Coconut fiber is a waste product that remains after coconuts are made. Currently, there is a push to invent new materials using waste elements to enhance products. The construction business should use natural fibers and materials because they are less expensive and enhance the material's qualities. The mechanical properties of jute and coconut fiber reinforced concrete (JCFRC) are investigated experimentally and studied through research studies. To create JCFRC, naturally occurring jute and coconut fibers were chopped to the appropriate length (30 mm) and combined with concrete. In five distinct concrete mixes (M30), the chopped jute fibers were added in three different percentages: 0%, 1.0%, & 1.5%, 2%; and coconut, i.e., 0%, 1.5%, 1%, 1.5%, 0% (by weight of cement).

This study aims to examine how the strength qualities of concrete are affected by the reinforcement of jute fibers. Experimental measurements are made to determine the fiber-reinforced concrete's workability, flexural, split tensile, and compression properties. The workability results indicate that when the proportion of jute and coconut fibers in the concrete sample rose, the slump value (workability) decreased. Concrete's strength is measured after seven, fourteen, and twenty-eight days of curing. Furthermore, each concrete mix's compressive and tensile strengths were enhanced by the addition of jute and coconut fiber. According to this research study, concrete's strength and durability can be increased by adding natural fibers like coconut and jute fibers.

Key words: Waste material, Natural Coconut fiber, husk, jute fiber, Workability, Flexural, split tensile, compression strength.

1. INTRODUCTION

A little bit of reinforcing material with certain properties is called fiber. They could be round or flat. "Aspect ratio" is a valuable metric that is commonly used to define the Fiber. The aspect ratio is the length to diameter ratio of a fiber. Aspect ratios often range from 30 to 150. Their physical and mechanical properties are primarily depend on their sections, like fiber arrangement, moisture content, cellulose content and fiber fibrils. The factors that influence the execution of composite materials incorporate chemical treatment, matrix choice, generation strategies, bonding force between matrix and fiber, fiber introduction, fiber substance and viewpoint proportion **[1]**. Analysts explored mechanical properties of composite materials made from glass, flax, hemp, jute and other natural fibers [**2**]. NFC is broadly utilized in building structural components, aerospace, automobiles, sports, ceilings, ships and machinery [**3**].

Concrete has utilized a wide range of fibers. It is necessary to identify the fiber type that will best fulfill each application's specific requirements. Steel and synthetic fibers are two of the many types of fibers used to strengthen concrete. Polypropylene, Nylon, Polythene, Polyester, and Glass Fibers are among the several synthetic fiber kinds employed. Synthetic fibers may be utilised in architectural and aesthetic concrete products as well as to avoid cracking at an early age. Steel fibers are employed in situations when it is necessary to alter the qualities of hardened concrete, namely its post-crack flexural strength, abrasion resistance, impact resistance, and shatter resistance.

1.1 Characteristics of Jute and Coconut Fiber

1.1.1 Jute Fiber

In India, Bangladesh, China, and Thailand, jute is mostly farmed. It is only farmed for its fiber, which has historically used to make ropes and bags for the transportation of grains and other goods like cement and sugar. Jute fiber, which is strong under stress, may also be employed in a cement matrix. Jute fibers may be produced in a fairly straightforward manner.

The jute fabric-reinforced composites are reasonably priced while meeting the requirements of commercial materials in terms of structural properties [4]. According to a study [5], jute fibers have a tensile strength of 250–300 MPa, which is adequate for the majority of applications, and they are around seven times lighter than steel fibers. Additionally, a researcher investigates the impact and failure characteristics of cementitious composites that are influenced by both long continuous jute fibers and short discrete jute fibers [6]. They claim that adding jute fibers to concrete improves the mixture's strength, resistance to impact, and ability to crack [6]. Jute fibers may be a suitable substitute for conventional fibers in concrete materials, according to a number of research [7] [8]. The physical and mechanical properties of natural fibers **(Table 1)**.

Table 1: Physical and mechanical properties of different types of fibre.

Fibre	ρ g cm^{-3}	L (mm)	D (µm)	SB (%)	TS (MPa)	YM (GPa)	SS (MPa)	SM (GPa)	MC (%)
Cotton	1.21	15-56	12-35	2-10	287-597	6-10	194-452	4-6.5	33-34
Jute	1.23	0.8-6	5-25	1.5-3.1	187-773	20-55	140-320	14-39	12
Flax	1.38	10-65	5-38	1.2-3	343-1035	50-70	345-620	34-48	7
Sisal	1.20	0.8-8	7-47	1.9-3	507-855	9-22	55-580	6-15	11
Ramie	1.44	40-250	18-80	2-4	400-938	61.4-128	590	29	12-17
Hemp	1.35	5-55	10-51	1.6-4.5	580-1110	30-60	210-510	20-41	8
Coir	1.2	0.3-3.0	7-30	15-25	175	6	92-152	5.2	10
Kenaf	1.2	1.4-11	12-36	2.7-6.9	295-930	22-60	246-993	18-50	6.2-12
Banana	1.35	0.9-0.4	12-30	5-6	529-914	27-32	392-677	20-24	10-11
Pineapple	1.5	3-8	8-41	1-3	170-1627	60-82	287-1130	42-57	10-13
Abaca	1.5	4.6-5.2	10-30	2.9	430-813	31.1-33.6	N.S.	N.S.	14
Bamboo	0.6-1.1	1.5-4	88-25	1.3-8	140-441	11-36	383	18	N.S.
Nettle	1.51	5.5	20-80	1.7	650	38	N.S.	N.S.	11-17
Hardwood	0.3-0.88	3.3	16	N.S.	51-120.7	5.2-15.6	N.S.	N.S.	N.S.
Softwood	0.30.59	1.0	30	4.4	45.5-11.7	3.6-14.3	N.S.	N.S.	N.S.
E-glass	2.5	N.S.	15-25	2.5	2000-3500	70-73	800-1400	29	N.S.
S-glass	2.5	N.S.	N.S.	2.8	3-3.5	63-67	1.8	34.4	N.S.

(*Source* – [9] [10] [11] [12] [13] [14] [15] [16]**).**

1.1.2 Coconut Fibers

The strongest natural fiber is coconut fiber, which has a strength of 21.51 MPa. It has a strain tolerance of four to six times that of other fibers [17]. has been investigated for a variety of reasons by numerous scientists.Several properties exhibit crucial changes. For instance, the diameter of coconut fibers is nearly same, but the levels of tensile strength vary somewhat.

2.MATERIALS

According to the applicable norms of practice, the qualities of the ingredients used to create concrete mix are assessed in a laboratory. In the current investigation, several materials including cement, coarse aggregates, fine aggregates, jute and coconut fibers, and super-plasticizer were employed. The goal of a research of various

material characteristics is to enable an engineer to build a concrete mix for certain strength and to verify that the appearance complies with statutory standards.

Table 2 below shows the blend proportions of the constituent ingredients as well as the mix kinds with % relative proportions.

Table 2: Mix types with percentage relative proportions

Mixes	Jute %	Coconut %	Jute (Kg/M^3)	W/C Ratio	Water (L/M^3)	Cement (Kg/M^3)	Coarse Aggregate (Kg/M^3)	Fine Aggregate (Kg/M^3)
Mix 1	0	0	0	0.42	197.16	469.42	997	570.5
Mix 2	0.5	1.5	1	0.42	197.16	448.42	997	570.5
Mix 3	1	1	5	0.42	197.16	427.42	997	570.5
Mix 4	1.5	0.5	7	0.42	197.16	406.42	997	570.5
Mix 5	2	0	9	0.42	197.16	385.42	997	570.5

3. TESTS ON MATERIALS

3.1. Tests on Cement

To identify the qualities of cement, many tests are conducted on it (Table 3).

Table 3: Cement properties.

S.NO	Characteristics	Values obtained experimentally	Values specified by IS 8112:1989
1	Specific gravity	3.15	-
2	Standard consistency percent	31.5	-
3	Initial setting time, minutes	92.25	Not less than 30
4	Final setting time, minutes	244.5	Not more than 600
5	Compressive strength		
	3days	26.4 N/mm2	$23N/mm^2$
	7days	35.1 N/mm2	$33N/mm^2$
	28days	47.9 N/mm2	$43N/mm^2$

3.2. Aggregate Tests

Following tests performed on aggregates for determination different properties.

1. Specific gravity test on coarse and fine aggregates.

2. Sieve analysis on coarse coarse and fine aggregates

Standard I.S sieves are used for sieve analysis process of fine aggregates.

Table 4: Properties of Coarse aggregates

Characteristics	Coarse aggregates	Fine aggregates
Maximum size (mm)	10	9.5
Specific gravity	2.85	2.75
Water absorption (%)	0.20 - 0.35	0.4-0.6

4. RESULT ANALYSIS

4.1. Slump Test on Concrete

The results of the study, which are displayed in Table 5, indicate that the slump of concrete reduced as the amount of jute and coconut fiber rose. The concrete will droop less the smaller the diameter of the coconut and jute fibers. According to the research analysis, coconut and jute fibers absorb water better when their diameters are smaller.

When mixed into the concrete, jute and coconut can absorb moisture from the mixture and help to lower the quantity of free water present.

Table 5 Slump cone test values

	Jute and Coconut fiber concrete slump				
Amount of admixture (%)	Mix 1	Mix 2	Mix 3	Mix 4	Mix 5
Slump(mm)	70	55	40	40	30

4.2 Compressive Strength Test of Concrete

After 7 days, 14 days, and 28 days, the compressive strength findings of the cube specimens (150x150x150 mm) with varying percentages of fibers added for concrete grade M30 reveal that the table 6. The results fig1. showed that after 7 days, 14 days, and 28 days, the highest compressive strength was 28.88 N/mm2, 31.55 N/mm2, and 33.33 N/mm2.

Table 6: Compressive strength results

S. No	Mix ID	7 days compressive strength in N/mm^2	14 days compressive strength in N/mm^2	28 days compressive strength in N/mm^2
1	Mix 1	26.66	28.88	30.22
2	Mix 2	23.82	29.77	31.11
3	Mix 3	28.88	31.55	33.33
4	Mix 4	23.55	28.44	30.66
5	Mix 5	24.88	30.66	32.44

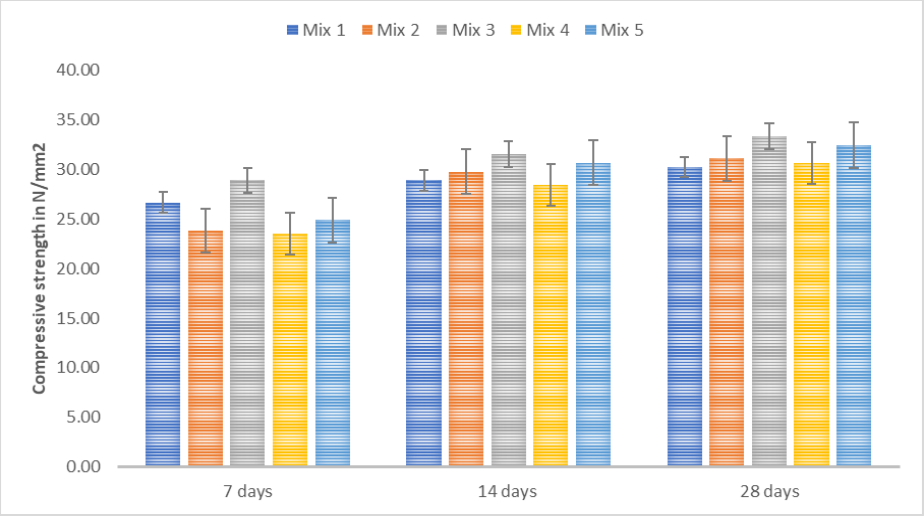

Fig 1: Compressive strength test of concrete in different days

4.3 Split Tensile Strength of Concrete

The Split tensile results of the cylindrical specimens (150 x 300 mm) with the addition of different percentage of fibers for concrete grade M30 after 7 days, 14 days & 28 days show that the table 7. The results fig2. showed that after 7 days, 14 days, and 28 days, the highest split strength was 2.62 N/mm2, 2.97 N/mm2, and 3.40 N/mm2.

Table 7: Split tensile strength results

SN	Mix ID	7 days compressive strength in N/mm2	14 days compressive strength in N/mm2	28 days compressive strength in N/mm2
1	Mix 1	2.58	2.76	3.11
2	Mix 2	2.55	2.84	3.18

3	Mix 3	2.62	2.97	3.40
4	Mix 4	2.58	2.80	3.28
5	Mix 5	2.59	2.77	3.18

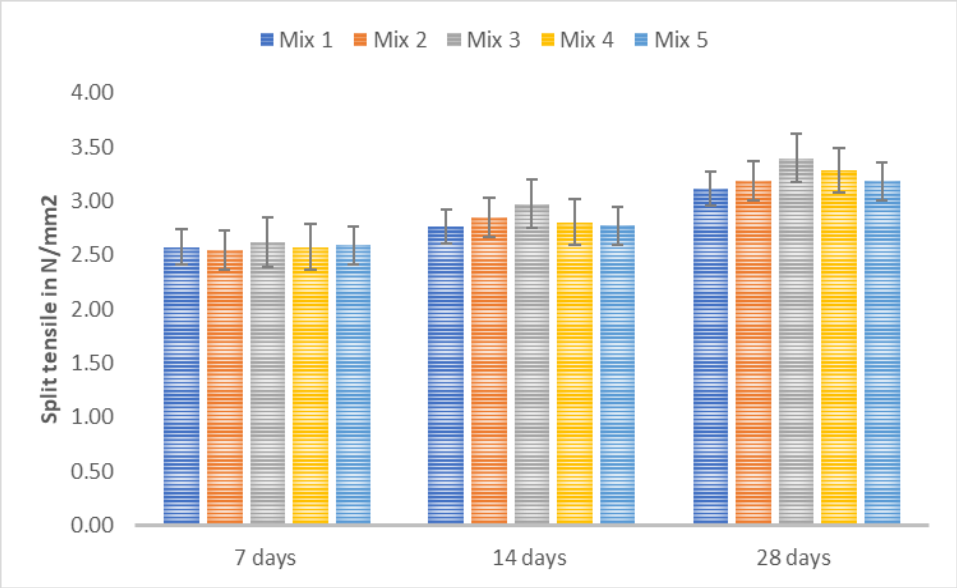

Fig 2: Split tensile strength of concrete in different days

4.4 Flexural Strength Test of Concrete

For bending strength testing, conventional beam dimensions are 150 x 150 x 70 mm. Jute and coconut fibers were mixed in different amounts and added to concrete samples: 0%, 1.5%, 1%, 1.5%, and 0% for the coconut fibers, and 0.5%, 0.5%, 1%, and 0% for the jute fibers. In every instance, the strength values in 7 days, 14 days & 28 days show that the table 8. The results fig3. showed that after 7 days, 14 days, and 28 days, the highest flexural strength was 5.19 N/mm2, 5.60N/mm2, and 5.76 N/mm2.

Table 8: Flexural strength results

S. No	Mix ID	7 days Flexural strength in N/mm2	14 days Flexural strength in N/mm2	28 days Flexural strength in N/mm2
1	Mix 1	4.57	5.24	5.35
2	Mix 2	4.98	5.08	5.55
3	Mix 3	5.19	5.60	5.76
4	Mix 4	5.03	5.16	5.30
5	Mix 5	5.07	5.30	5.67

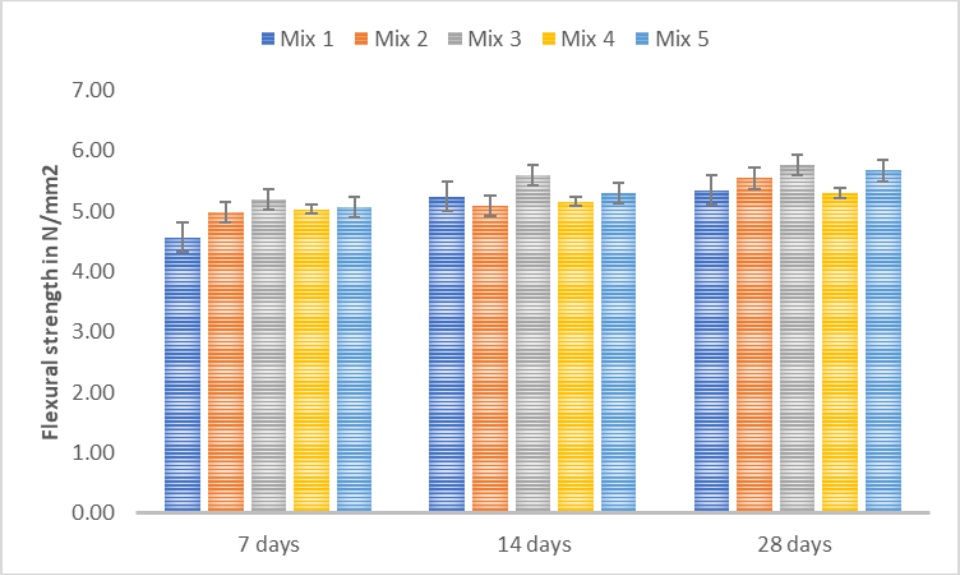

Fig 3: Flexural strength test of concrete in different days

5. CONCLUSION

The mixed jute and coconut fibers' durability properties in the OPC cement medium are highlighted in the article. The mixed fiber length and mixing amount of jute fibers affected the mechanical behaviors of cement-based materials obviously. Either too long or too much fiber would be difficult to distribute evenly thus to degrade the performance. This study investigates the effect of length, volume fraction and mixed fibre length on the tensile, flexural, and Compressive strength test on reinforced cement. It is concluded from the findings and discussion that the addition of mixed fibers and mixtures improves the concrete's tensile strength and durability. The compressive and flexural strength of the fiber reinforced concrete were significantly enhanced by addition of mixed fibers.

REFERENCES

1. Dashtizadeh, Z, Abdan, K, Jawaid, M, Khan, MA, Behmanesh, M, Dashtizadeh, M & Ishak, M (2017), "Mechanical and thermal properties of natural fibre based hybrid composites: a review", Journal of Science and Technology, vol. 25, no. 4, pp. 1103-1122.
2. Kistaiah, N, Udaya Kiran, Ramachandra Reddy, G & Sreenivasa Rao M (2014), "Mechanical Characterization of Hybrid Composites: A Review", Journal of Reinforced Plastics and Composites, vol. 33, no. 14, pp. 1364-1372.
3. Mohammed, L, Ansari, MN, Pua, G, Jawaid, M & Islam, MS (2015), "A review on natural fiber reinforced polymer composite and its applications", International Journal of Polymer Science, vol. 2015, pp. 1-15.
4. Huda MS, Drzal LT, Mohanty AK, Misra M. (2008), "Effect of chemical modifications of the pineapple leaf fiber surfaces on the interfacial and mechanical properties of laminated bio composites", Compos Interface; 15:169–91.
5. Kundu SP, Chakraborty S, Roy A, (2012), "Chemically modified jute fibre reinforced Non-Pressure (NP) concrete pipes with improved mechanical properties", Constr Build Mater; 37: 841–850.
6. Zhou X, Ghaffar SH, Dong W, (2013), "Fracture and impact properties of short discrete jute fibre-reinforced cementitious composites", Mater Des; 49: 35–47.

7. Naik N, Shivamurthy B, Thimappa BH (2019), "Enhancing the mechanical properties of jute fiber reinforced green composites varying cashew nut shell liquid composition and using mercerizing process", Mater Today Proc 2019; 19: 434–439.
8. Sivakandhan C, Murali G, Tamiloli N (2020), "Studies on mechanical properties of sisal and jute fiber hybrid sandwich composite" Mater Today Proc 2020; 21: 404–407.
9. Satyanarayana KG, Arizaga GGC, Wypych F. Biodegradable composites based on lignocellulosic fibers–an overview. Prog Polym Sci 2009;34:982–1021.
10. Dicker MPM, Duckworth PF, Baker AB, Francois G, Hazzard MK, Weaver PM. (2014), "Green composites: A review of material attributes and complementary applications", Compos Part A: Appl Sci Manuf;56:280–9
11. Zini E, Scandola M. (2011), "Green composites: an overview", Polym Compos; 32:1905–15.
12. Huda MS, Drzal LT, Mohanty AK, Misra M. (2008), "Effect of chemical modifications of the pineapple leaf fiber surfaces on the interfacial and mechanical properties of laminated bio composites", Compos Interface; 15:169–91.
13. Faruk O, Bledzki AK, Fink HP, Sain M. (2000–2010), "Biocomposites reinforced with natural fibers", Prog Polym Sci 2012;37:1552–96.
14. Bledzki AK, Gassan J. (1999), "Composites reinforced with cellulose based fibers", Prog Polym Sci; 24:221–74.
15. Fuqua MA, Huo S, Ulven CA. (2012), "Natural fiber reinforced composites", Polym Rev 2012;52:259– 320.
16. Koronis G, Silva A, Fontul M. (2012), "Green composites: A review of adequate materials for automotive applications", Compos Part B Eng;44:120–7.
17. Marie-Therese Wisniowski, (2014), "Cellulosic fibers (natural) cotton art resource", in: Cellulosic Fibers Natural Cotton, pp.1–9.