COMPARATIVE STUDY ON STRENGTH PARAMETERS OF FIBRE REINFORCED CONCRETE WITH AND WITHOUT TREATMENT OF COCONUT FIBRES

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Abstract:
A greater range of construction materials with innovative qualities are needed as modern engineering methods. It involves modifying existing materials qualities and combining them with additional suitable materials. Here one of the natural fibre is used to boost concrete's tensile strength. However, the primary drawback of choosing natural fibre is that it is biodegradable. To combat this, sodium hydroxide (NaOH) treatment is applied with the aim of enhancing fibre strength and reducing water absorption capacity. The ionisation of the hydroxyl group to the alkoxide is hence promoted by the addition of aqueous sodium hydroxide (NaOH) to natural fibre. Thus, the cellulosic fibril, the level of polymerization, and the extraction of lignin and hemi-cellulose components are all directly impacted by alkaline processing. The breaking of hydrogen bonds in the network structure caused by alkaline treatment is a significant alteration that raises surface roughness. When compared to normal cement concrete, this treatment increases the tensile strength of concrete by removing some of the lignin, wax, and oils that are present on the exterior of the fibre cell wall.

Keywords: Coconut Fibre; Chemical Treatment; Alkaline treatment; Sodium Hydroxide.

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Introduction

Concrete is a common composite material used in building. Concrete has many benefits, but one significant drawback is its weak tensile strength [8]. By adding synthetic or natural fibres to concrete, reinforcing has been utilised to increase the tensile strength in order to prevent cracks and failure. There have been efforts undertaken to lessen cracks and improve the tensile strength of concrete members. It has long been understood that adding small, uniformly dispersed fibres that are tightly spaced and act as crack resistance to concrete would greatly enhance both its static and dynamic qualities [7].

There have been more studies on the use of natural fibres in place of synthetic fibre in fiber-reinforced composites. Natural fibres are advantageous since they are inexpensive, low density, and biodegradable [5]. The main drawbacks of natural fibres in composites, however, are their poor compatibility with the matrix and relatively high moisture absorption rates. Therefore, when changing the fibre surface qualities, chemical treatments are taken into account. The chemical modification of fibre may not only change the fibre surface but also boost the fibre strength in an effort to increase adhesion between the fibre surface and the polymer matrix. Composites have less water absorption and better mechanical qualities. Due to the hydrophilic nature of natural fibres and the low interfacial characteristics between fibre and polymer matrix, chemicals may activate hydroxyl groups or introduce novel moieties that can successfully interlock with the matrix. Natural fibres can be treated in a variety of ways, including with alkali, saline, maleate coupling agents, isocyanates, permanganate, etc. Alkaline treatment was used in the current investigation to track changes in fibre strength when employed in concrete. On the other hand, the composites containing fibres treated with alkali displayed the highest values of tensile strength regardless of the time of treatment.

Literature review

Amar et al. (2014), they studied the impact of coconut fibres on concrete physical characteristics. They use 20mm down size aggregate, OPC43 grade cement, coarse aggregate with sand passing through 4.75mm and they used concrete of the M30 grade. For this investigation, they took into consideration fibre aspect ratios of 75 and 125, respectively. The percentages of fibre varied and were 1%, 2%, and 3%. At 3, 7, and 28 days after curing, they tested 21 cubes, cylinders, and beams. They discovered that all compressive, flexural, and split tensile strength tests performed best with 2% of fibre fraction. The findings of the flow table test indicate that for every 1% of fibre quantity, flow decreased by 25% for aspect ratios of 75 and 27% for those of 125.

R.A.C.J. Seneviratne, G. Tharmarajah and P. Archbold, (2017), they discussed the effect of natural fibres on concrete specimens density, compressive strength, and flexural strength High strength concrete was mixed with coconut coir fibre to create 36 test cubes and 36 beam samples. Testing on cube and beam samples reveals that the addition of coir fibres lowers the compressive strength of high strength concrete. Variations in the decrease are observed depending on the fibre length and content. Additionally, a comparison of cubes and beams shows that concrete density can vary. The test results indicate a decrease in flexural strength in the majority of cases, with the exception of 2% coir fibre reinforced concrete, where a modest increase in flexural strength was noted. Compressive strength of high strength concrete was significantly reduced by 20% to 75% with the inclusion of coir fibres. Additionally, it was shown that as fibre length increased, compressive strength decreased. Only a 3% to 6% increase in flexural strength was seen in 2% (25 mm, 40 mm) fibre added mixes when compared to the flexural strength of high strength plain concrete. Flexural strength was decreased in the remaining fibre mix proportions by 2% to 32%.

Salwick and Amit, (2017), conducted research on reinforced concrete with polypropylene and coconut coir. In M25 grade concrete, both synthetic and natural fibres were employed. Fiber percentages in concrete range from 0% to 5% to 1.5% to 2.5% to 3.5% to 4.5%, correspondingly. The prepared samples of the beams and cubes were maintained for up to 28 days of curing. They conducted their study using coconut coir measuring 2-3 cm and polypropylene fibre measuring 1-2 cm. They saw that compressive and flexural strength increased from 0 to 3.5%, but then decreased from there. At 28 days, they discovered that the compressive and flexural strengths were 30.19 N/mm^2 and 5.19 N/mm^2, respectively.

V.SaiUday and B.Ajitha, (2017), they investigated the behaviour study of coconut fibre in concrete structure. Concrete's different engineering qualities are enhanced by the addition of coconut fibre. Before being used in concrete, coconut fibre is processed as a natural fibre. Concrete's compressive strength, flexural strength, and split tensile strength are all

increased by the addition of coconut fibre. The experiment involved adding fibre in five different mix proportions (1%, 2%, 3%, 4%, and 5% by the weight of cement) to high strength concrete. Concrete that has been cured for three, seven, and twenty-eight days was assessed for compressive strength and split tensile strength. The study discovered that 1% of fibre was the ideal level (by the weight of the cement). As the concrete compressive strength and split tensile strength reached their maximum values, they obtained compressive and split tensile strengths at 28 days that were, respectively, 66.52 N/mm^2 and 4.54 N/mm^2. This research demonstrates that coconut fibre can be used in building.

Experimental Program

The concrete mix of M20 grade with mix proportions of 1:1.88:3.09 and water-cement ratio 0.53 was used. Later the coconut fibres with aspect ratio 50 of different percentages 1%, 2%, 3% and 4% was added to concrete without treatment to determine the strength parameters. The fibre percentage was reduced for treated coconut fibre reinforced concrete by trial and error to avoid balling action and achieve good interfacial bond between matrix and fibres. i.efibres percentage decreased to 0.1%, 0.15%, 0.2%, 0.25%, 0.3%, and 0.35% to conduct chemical treatment and observed the improvement in strength parameters of reinforced concrete.

Natural fibres can be treated in a variety of ways, including with alkali, saline, maleate coupling agents, isocyanates, permanganate, etc. In the present study alkaline treatment was carried out to observe the changes in strength of fibres when used in concrete. The fibres are first immersed in a solution with a normality of 1N and a pH of 14 is maintained, which is alkaline in nature, for two hours to allow for absorption. They are then removed from the solution and left at room temperature for 24 hours. After drying, the colour has changed before and after treatment, as shown in Figures 1 and 2. They are employed in casting of cubes, cylinders, and beams to test the compressive strength, split tensile strength, and flexural strength, respectively, after treatment there was a slight increase in the weight was observed.

Figure 1. Immersed Coconut Fibres

(a) (b)

Figure 2. Before (a) and After (b) Treatment of Coconut Fibres

Results and Discussion

Table 1 shows the compressive strength, split tensile strength and flexural strength of untreated coconut fibre reinforced concrete. It is observed that as fiber quantity increases the strength of concrete also increased. The addition of 2% coconut fiber shows ultimate compressive strength of 28.30MPa, split tensile strength of 3.42MPa and flexural strength of 3.72MPa at 28 days of curing period which is about 15% to 40%

more compare to conventional concrete.

Table 1. Strength parameters of Untreated Coconut fibre reinforced concrete**.**

Sl no.	Percentage of fibre added (%)	Untreated Coconut fibre reinforced concrete		
		Compressive strength (MPa) at 28days	Split Tensile strength (MPa) at 28days	Flexural strength (MPa) at 28days
1	0	22.73	2.72	3.33
2	1	24.25	2.92	3.45
3	2	28.30	3.42	3.72
4	3	27.21	3.26	3.58
5	4	26.24	3.14	3.42

Table 2 shows the compressive strength, split tensile strength and flexural strength of treated coconut fibre reinforced concrete. The addition of 0.3% fiber shows ultimate compressive strength of 39.42MPa, split tensile strength of 4.98MPa, flexural strength of 4.40MPa at 28days of curing period. When compare to untreated coconut fibre reinforced concrete, the quantity of fibres required is less after treatment to use in concrete.

Table 2. Strength parameters of Treated Coconut fibre reinforced concrete

Sl no.	Treated Coconut fibre reinforced concrete			
	Percentage of fibre added (%)	Compressive strength (MPa) at 28days	Split Tensile strength (MPa) at 28days	Flexural strength (MPa) at 28days
1	0	22.73	2.72	3.33
2	0.1	28.80	3.45	3.75
3	0.15	29.73	3.56	3.81
4	0.20	32.86	3.94	4.01
5	0.25	39.42	4.23	4.40
6	0.30	37.51	4.19	4.28
7	0.35	36.68	4.10	4.23

Comparison of test rests between Treated and Untreated Coconut fibre reinforced concrete

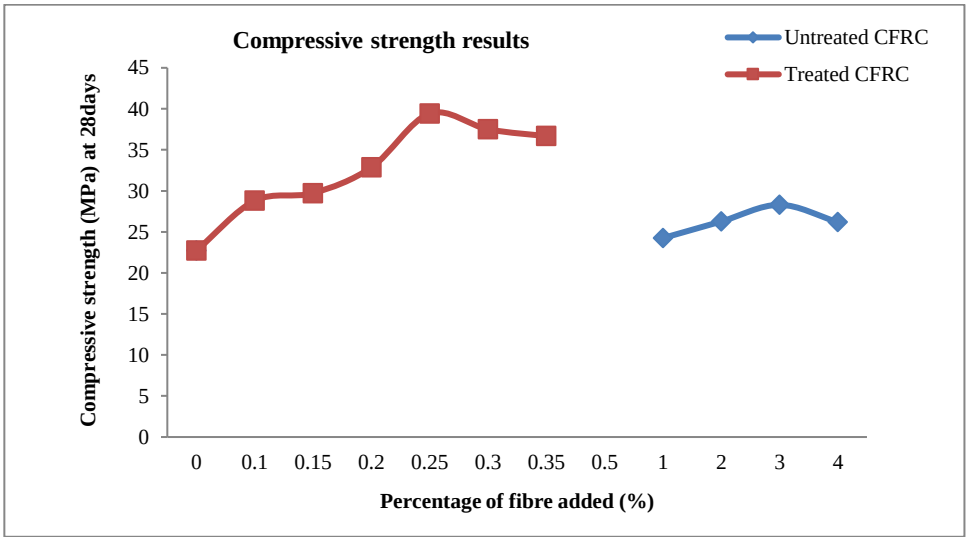

Figure 3. Comparison of Compressive Strength results between treated and untreated CFRC

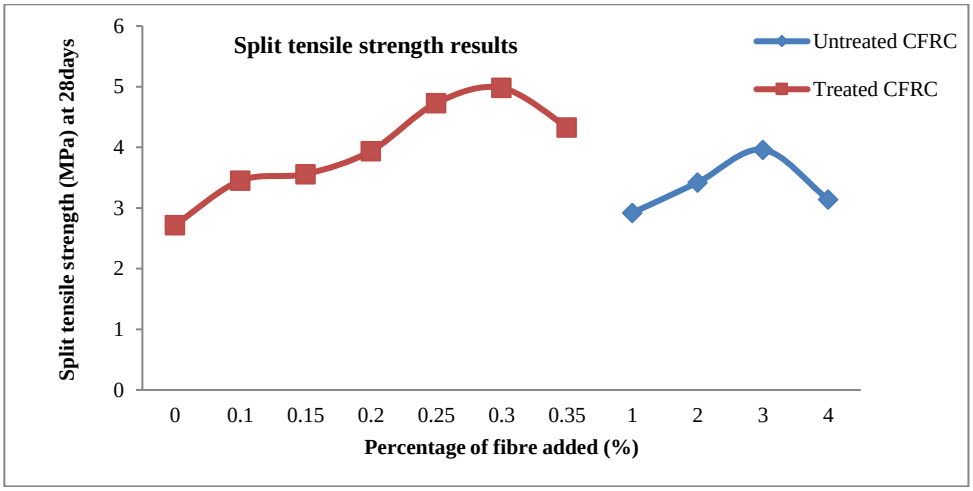

Figure 4. Comparison of Split Tensile Strength results between treated and untreated CFRC

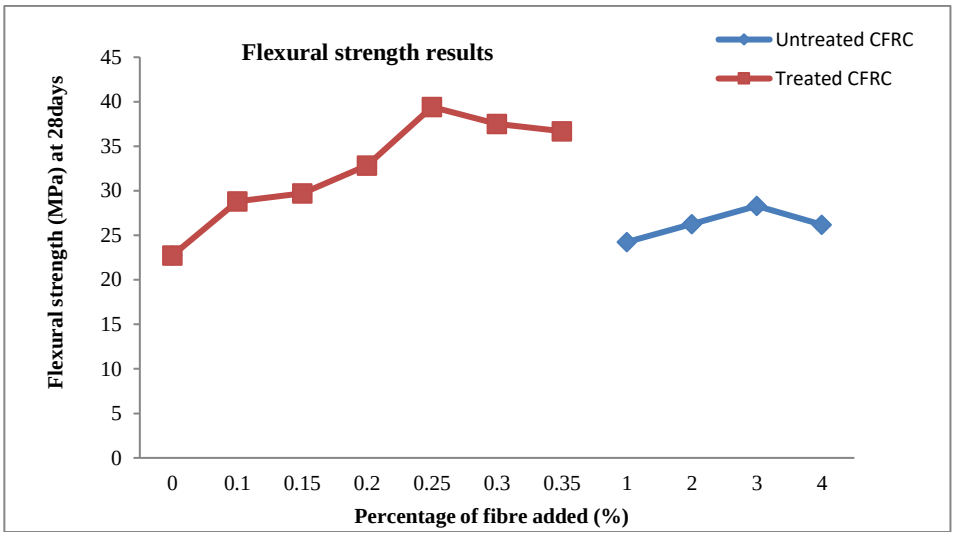

Figure 5. Comparison of Flexural Strength results between treated and untreated CFRC

Figure 3,4 & 5 shows comparison of test results i.ecompressive strength, split tensile strength and flexural strength of treated and untreated coconut fibre reinforced concrete. With the less quantity of fibres the treated CFRC shows increase in strength as compare to untreated coconut fibre reinforced concrete. As coconut fibres are easily available, these can be used in the concrete so that the cost of construction can be minimized. The chemical treatment on fibres reduces the decaying nature of natural fibres in concrete over a period of time.

Conclusion

1. The shrinkage cracks in the concrete can be reduced by the addition of fibres in concrete, also bonding between the matrix and fibres increases by chemical treatment on fibres which in turn reduces the decaying property of natural fibres in concrete.
2. The compressive strength of treated coconut fibre reinforced concrete was increased by 12% to18% as compare to untreated coconut fibre reinforced concrete.
3. The splitstrength of treated coconut fibre reinforced concrete was increased around 25% to 30% as compare tountreated coconut fibre reinforced concrete which will minimise the shrinkage cracks.
4. The flexural strength of treated coconut fibre reinforced concretewas increased by 20% to 25% as compare to untreated coconut fibre reinforced concrete which will improve the bending characteristics of concrete.
5. It was concluded from the results that the strength parameters of concrete is increased by the chemical treatment of fibres with less quantity which in turn decreases the cost of construction.

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