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COMPARATIVE STUDY ON STRENGTH PROPERTY OF FIBRE REINFORCED CONCRETE USING GI, COCONUT AND GLASS AS FIBRE

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Abstract - *Recent researches have proved that addition of fibres to plain concrete will improve tensile strength. The primary objective of the current project is to analyse the strength behaviour of fibre reinforced concrete with the incorporation of GI, Glass and Coconut coir as mono and hybrid fibre and comparing the results with plain concrete. Preliminary tests are performed to the substances used in current work and mix design for M25 grade is made. Strength characteristics of concrete were studied. Fibres were used at the rate of 1% by volume. The test results were tabulated and compared and conclusion was drawn.*

***Key Words*: Coconut fibre, Glass fibre, GI fibre, Compressive strength, Split – tensile strength, and Flexural strength.**

1.INTRODUCTION

Concrete is most normally and broadly used construction material in civil engineering. Concrete is a composite material consist of binder, natural sand, coarse aggregate, & water. The chemical response between water and cement outcomes in a stone like structure.

As plain concrete is a brittle material, cracks having length of micro will occur even prior to loading, specifically because of drying-shrinkage & alternate in volume of concrete. Additionally compressive strength of plain concrete is excessive, because of lower strain capacity in tension and lower toughness properties, cracks will expand in concrete while subjected to load. This leads to tensile stresses in excess of tensile strength of concrete.

The micro - crack formation is the principle source for concrete failure. Size and magnitude of these cracks will increase as time goes on and consequences in failure of concrete. There has been a constant urge for increasing the tensile behaviour of concrete. Many research works have been made to enhance the tensile strength of the conventional concrete.

Various sorts of fibres such as metal, polymer, glass, nano and natural fibres are integrated into the conventional concrete blend. Conventional concrete with these mentioned fibres, commonly termed as F.R.C (Fibre Reinforced Concrete). Because of the improved ductility and better performance towards flexure by the presence of fibres, FRC become the most promising material in construction.

Addition of fibres in concrete matrix is a way to increase the energy absorption capability and crack resistance in traditional concrete. Fibres present within the concrete bridges the cracks and consequently a post – cracking ductility is furnished, consequently toughness of the concrete increases. Toughness and fracture energy consideration is important, as it determines ductility and crack resistance of the structure assuring the safety and integrity of the structural element before its complete failure.
paper.

1.1 FIBRE REINFORCED CONCRETE

Including fibres which are small discrete, without continuous, closely spaced in closer manner & dispersed in a uniform way into traditional concrete blend will behave like a crack arrestor and will substantially improve its dynamic & static characteristics. This concrete is designated as fibre reinforced concrete (FRC). The quantity of fibres adding into the blend of concrete is measured as the percentage of the composite (fibres & concrete) expressed as (Vf). Aspect ratio (l/d) is the ratio of length of fibres to its diameter. The main intention of including fibres into concrete matrix is to enhance the response of the post cracking of the concrete, to increase the capacity of energy absorption, apparent ductility and act like a crack arrestor. Fibres are used to keep away from the propagation of structural cracks (micro cracks), underneath loading:

2. LITERATURE REVIEW:

Shreeshail.B.H, Jaydeep Chougale, Dhanraj Pimple, Amar Kulkarni (2014)[1] have studied on "Effect of coconut fibres on the properties of concrete". They come to know that by the presence of 2% of coir in M30 mix have shown increment in compressive, split- tensile strength and modulus of rupture. Md.shariful islam (2014) [2] studied on "behaviour of GI fibre reinforced concrete made with natural and recycled aggregates". He observed that workability decreases with increase in fibre content for both fresh & recycled aggregate, but more with recycled aggregate. Both for fresh and recycled brick aggregate compressive, split-tensile, &

rapture strain limit was increases with incorporation of 0.5% of G.I. fiber. **D.M. Parbhane, S.B. Shinde (2014)[3]** have studied on"Strength properties of coir fibre concrete." They come to know that slump and compaction factor value increases but workability of CF is less when compared to conventional mix. Max. split-tensile strength was obtained at 4% of coir addition **Md.Abid Alam, Imran Ahmad, Fazlur Rehman (2015)[4]** have studied on "Experimental study on properties of glass fibre reinforced concrete." They found that the presence of 0.06% fibre has shown substantial improvement in compressive(cube) & tensile(cylinder) strength.**Palkannan. S, Thirumurugan. A, Ramesh. K (2015)[5]** have studied on "A comparative study of hybrid fiber reinforced concrete with plain cement concrete". They come to know that hybrid of (0.8%steel+0.2%coconut.) given the max. compressive, split & flexural strength.**Tejas R Patil, ajay N. Burile (2016)[6]** have studied on "Comparative study of steel and glass fibre reinforced concrete composites". They found that by the incorporation of 0.5% of HSF of length 50mm, max. compressive, split – tensile strength for M20 mix was obtained. Ratio of cylinder to cube for compressive strength obtained was 3:4. Dosage of varying % of HSF of length 35mm lowers the workability. Crack size in split & deflections in flexural test reduces by the usage of GF than HSF. **Rajeev banerjee, S Arshad razanaqvi, Swati srivastava (2016)** [7] have studied on "Use of glass and coconut fibres in enhancing properties of concrete". They observed for 2% of mono Coconut and 0.08% mono glass fibre max. compressive strength was obtained. Hybrid (0.08% glass + 1% coconut) gives max. compressive & tensile strength. **K. Dharunsankar, S. Saravanan (2016)[8] studied on** "An experimental study on concrete with hybrid fibers." They come to know that high flexure, split & compressive strength was obtained at the incorporation of 1% of coir & steel fiber. Further addition of fibers beyond 1% is not recommended

3.OBJECTIVES:

With the above literature review following observations are made

- Presence of coir, glass fibre shows increment in strength properties
- Workability decreases with increase in fibre content for both fresh & recycled brick aggregate, but more with recycled aggregate. Both for fresh and recycled brick aggregate with GI fibre shows improved strength properties.
- Hybrid fibres shows decreased workability and improved strength properties.
- It is observed that majority of study is made on different types of fibres both metallic and non-metallic. With the increase in demand of the fibres and growth in the usage of FRC in various works, the availability is decreasing and cost of fibres is increasing. More over there is a possibility of attack of chemicals present in water and atmosphere on metallic fibres which may result in the failure of FRC.
- Keeping this in mind it is decided to study behaviour of FRC by using coconut coir as fibre.
- A comparative study is made by choosing GI and glass fibre.
- Also the strength of hybrid fibres such as {CNF + GF}, { GF + GIF}, {GIF + CNF}are studied.

4. MATERIALS USED AND THEIR PROPERTIES

In this present investigation materials used are Cement, Fine Aggregate, Coarse Aggregate, GI Fibre, Coconut Fibre And Glass Fibre.

4.1. CEMENT: Coromandel cement of OPC 43 grade was used.

Table -1: Initial test results of cement

Sol no	Preliminary Test	Result
1	Specific gravity	3.036
2	Normal consistency	31%
3	Initial setting time	75 minutes
4	Final setting time	368 minutes
5	Fineness of cement	6.25%

4.2. Aggregate:

Fine aggregate: In this work locally available river sand comes under zone-I of IS 383 – 1970 is taken for experimental work.

Table – 2: Test results of Fine Aggregate

Sl nor	Tests	Result	Remarks
1	Specific gravity	2.65	IS 2386
2	Water absorption	0.857%	
3	Bulk density in Kg/m3	16.26%	

Coarse aggregate: In this work locally crushed aggregate which passes on 20mm size sieve which meets the requirements of IS 383-1970 were utilized. Outcome of the test conducted on CA are shown below.

Table – 3: Test results of Coarse Aggregate

Sl no.	Tests	Result	Remarks
1	Specific gravity	2.65	IS 2386
2	Water absorption	0.48%	
3	Bulk density in Kg/m3	13.42%	

4.3 GI Fiber:

I

n this work GIF is used as a metallic fibre to improve tha ductility behaviour of the concrete. Raw GIF obtained form the local hard ware shop is in the form of spiral (coil). Then the GIF coil cut in the form of filament of length 40mm with 1mm thick.

Table – 4: Properties of GI fibre.

Sl. no.	property	remark
1	Nature of GIF	zinc coated steel metal
2	Adopted length in work	40mm
3	Thickness of GIF	1mm
4	Density of GIF	7800kg/m3

4.4. Coconut fibre:

In the current work coconut fibre (CNF) are obtained from the local shop which are in the form of bundles, then they are cut in the form of small threads of length of 40mm. CNF are used as natural fibre in my work.

4.5. Glass Fibre:

In this work glass fibres (GF) are obtained from the local shop. GF is utilized as a non metallic fiber.

Table – 5: Properties of Glass fibre.

Sl. no.	Property	Remark
1	Modulus of elasticity	72 GPA
2	Diameter of glass filament	14μ
3	Specific gravity	2.68
4	Available length	12mm
5	Aspect ratio	857:1

MIX design

Table – 6: Mix design as per IS 10262 was done.

Concrete grade	M25
Cement brand	OPC 43 grade(coramandel)
Cement unique(specific)gravity	3.036
C A unique gravity	2.65
F A unique gravity	2.65
Max. nominal aggregate size	20.0mm
Zone of fine aggregate	Zone I
strength target	31.6N/mm^2
W/binder ratio	0.45
Calculated water quantity	197litre
Calculated cement quantity	438 Kg/m^3

Table – 7: Outcome of Mix Design

Quantity of cement	438.0Kg/m^3
Quantity of fine aggregate	681.076Kg/m^3
Quantity of coarse aggregate	1065.27Kg/m^3
Quantity of water	197Kg/m^3
W/binder ratio	0.450
Calculated proportions	1:1.55:2.44
Fibre	Dosage of fibre (by volume of mould)
Glass	1%
Galvanized iron	1%
Coconut	1%
Glass+galvanized iron	0.5%+0.5%
Glass+coconut	0.5%+0.5%
Coconut+galvanized	0.5%+0.5%

Results and discussion:

Workability tests such as slump cone test, were conducted for fresh concrete both for mono and hybrid fibers. Also compressive strength, split tensile strength and flexural strength were conducted on both mono and hybrid fibers.

Table – 8: Slump test result of mono fibre

Fibre	% of fibre	Slump(mm)
Plain concrete	0%	100
CNF	1%	80
GF	1%	88
GIF	1%	83

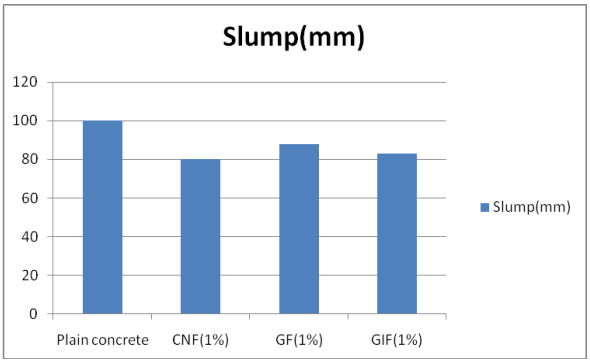


Chart – 1: slump cone test result of mono fibre

Table – 9: 28 days compressive strength test result of mono fibre

Fibres	Compressive strength (N/mm²)	% increase/decrease
Plain concrete	31.70	-------
CNF	32.89	3.75
GF	34.81	9.81
GIF	46.96	48.13

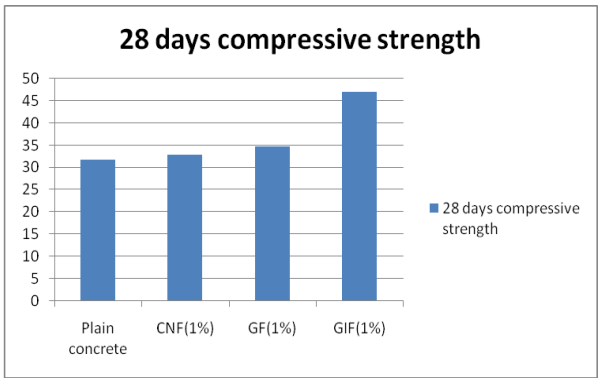


Chart – 2: 28 days compressive strength test result of mono fibre

Table – 10: 28 days Split - tensile strength test result of mono fibre

Fibres	Split-tensile strength(N/mm²)	% increase/decrease
Plain concrete	3.73	-------
CNF	3.86	3.49
GF	4.05	8.57
GIF	4.43	18.76

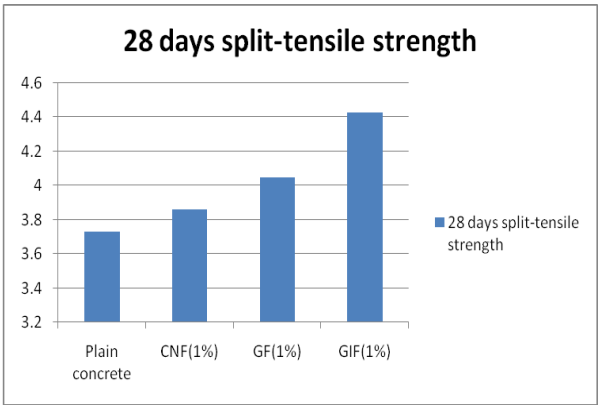


Chart – 3: 28 days Split - tensile strength test result of mono fibre

Table – 1: 28 days Flexural strength test result of mono fibre

Fibres	Flexural strength(N/mm²)	% increase/decrease
Plain concrete	6.33	--------
CNF(1%)	7.66	21.01
GF(1%)	8	26.38
GIF(1%)	13.16	88.89

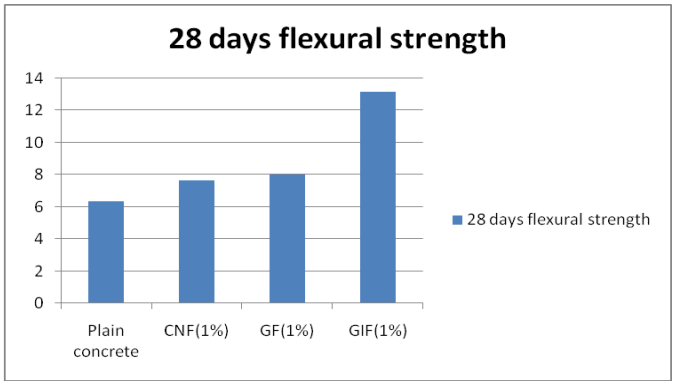


Chart – 4: 28 days Flexural strength test result of mono fibre

Hybrid Fibres

Slump test results

Table – 12 : 28 days Slump test result of hybrid fibre

Fibres	% of fibres added	Slump(mm)
Plain concrete	0%	100
CNF+GF	1%	82
GF+GIF	1%	80
GIF+CNF	1%	79

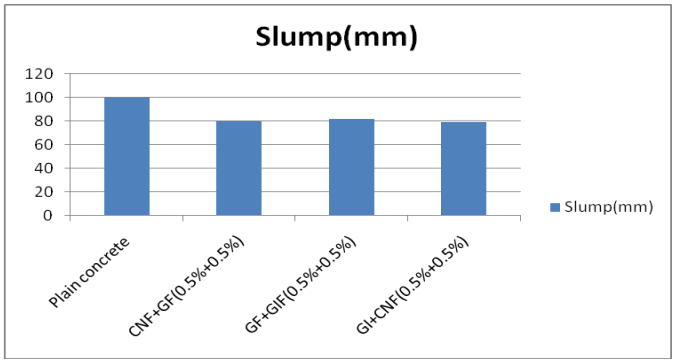
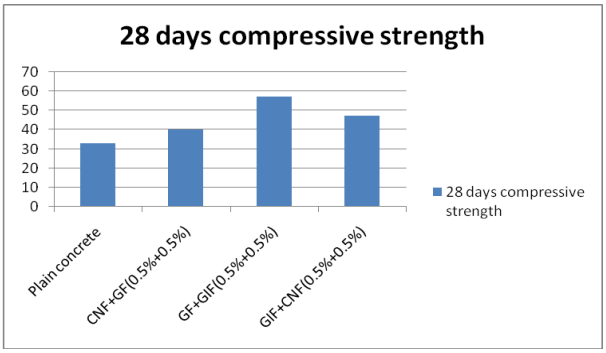


Chart – 5: slump cone test result of hubrid fibre

Table – 13 : 28 days Compressive strength test result of hybrid fibre

Fibres	Compressive Strength(N/mm²)	% increase / decrease
Plain concrete	32.89	-------
CNF+GF(0.5%+0.5 %)	40.15	22.07
GF+GIF(0.5%+0.5 %)	57.33	74.31
GIF+CNF(0.5%+0. 5%)	47.45	44.12



Chart– 6 : 28 days Compressive strength test result of hybrid fibre

Table – 14: 28 days Split - tensile strength test result of hybrid fibre

Fibres	Split – tensile Strength(N/mm²)	%Increase /decrease
Plain concrete	3.73	---------
CNF+GF(0.5%+0. 5%)	4.48	20.10
GF+GIF(0.5%+0.5 %)	4.91	31.63
GIF+CNF(0.5%+0. 5%)	4.62	23.86

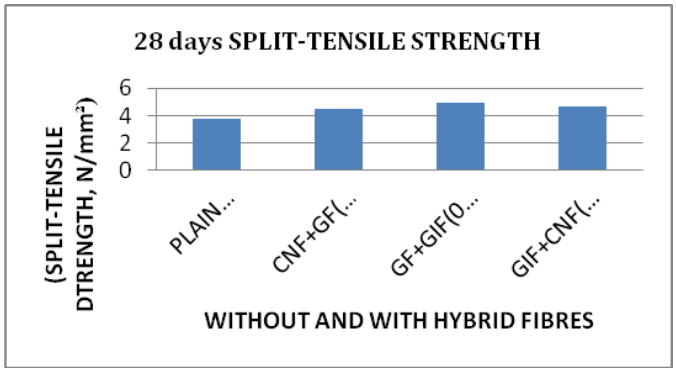


Chart – 7: 28 days Split - tensile strength test result of hybrid fibre

Table - 15: 28 days Flexural strength test result of hybrid fibre

Fibres	Flexural Strength(N/mm²)	% Increase/decrease
Plain concrete	6.33	-----
CNF+GF(0.5%+0.5 %)	8.66	36.8
GF+GIF(0.5%+0.5 %)	9.83	55.29
GIF+CNF(0.5%+0. 5%)	9.16	44.70

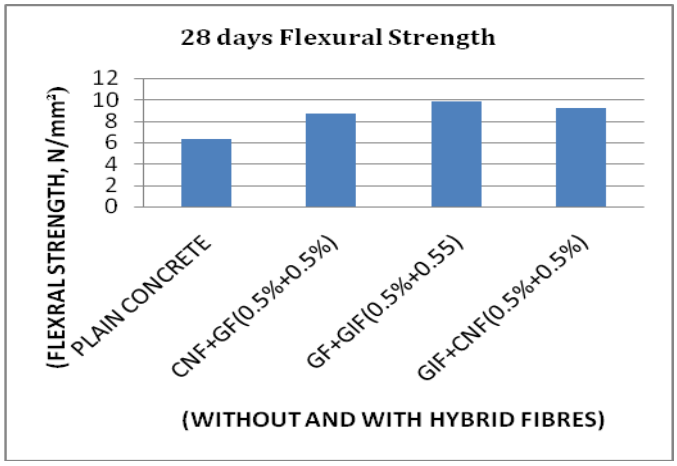


Chart - 8: 28 days Flexural strength test result of hybrid fibre

3. CONCLUSIONS

With the above observations following conclusion is made.

- The strength property of coconut coir FRC is more than that of plain concrete.

- Comparatively the strength is much larger for glass and GI FRC.
- Since the availability of coir fibre is more, it is economical to use coir as fibre in place of glass and GI fibre,

If more strength is required the hybrid fibre either of the combination of GI and Coir or Glass and Coir can be used.

Scope for further study:

Following points can be further studied.

- ✓ The effect of ageing of coir fibre
- ✓ Chemical reaction with cement.
- ✓ Possibility of decaying of the material

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