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Experimental Study of Hybrid Fibre (Polypropy line Fibre & Coconut Fibre) Reinforced Concrete

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Abstract:- Concrete is most widely used material and has most desirable properties like compressive strength, stiffness and durability. In the case steel fibre used in concrete may increase the strength but at higher cost. Fibre Reinforced Concrete (FRC) is one of the fastest growing segments in the concrete industry as more and more engineers, architects, owners and contractors are turning to the use of fibres to supply their reinforcing needs in their concrete applications. The fibres are used to reduce shrinkage cracks. The test will be conducted by adding 0.4% of hybrid fibres (Polypropylene fibre & 0.3% of Coconut fibre,0.2% of Polypropylene fibre & 0.2% of Coconut fibre and 0.1% of Polypropylene fibre & 0.3% of Coconut fibre. The strength parameters of concrete such as compressive strength test of cubes, split tensile test of cylinders, Flexural strength test of beam by comparing conventional M30 grade concrete with a Hybrid FRC of same grade concrete.

Keywords:- *Polypropylene fibre, Coconut fibre, improvement in strength, Fibre Reinforced Concrete.*

I. INTRODUCTION

Concrete is very durable material that requires less maintenance in a structure and it is employed to resist the compressive stresses. Generally the concrete possess many disadvantages as it has low tensile strength and low resistance to cracking. These cracks propagate with the load, leading to brittle failure. But for all need a material which impact tensile resistance in concrete. Therefore the development of new type of concrete is necessary, to improve the quality of concrete that lead to research to investigate and develop material which perform better in areas where conventional concrete has several limitations. Nowadays fibre offers varying benefits to concrete in both plastic and hardened state.

II. FIBRE REINFORCED CONCRETE

Fibre Reinforced Concrete containing fibrous material which increases its structural integrity and strength of concrete. It contains short discrete fibres that are uniformly distributed and randomly oriented in the material.Fibres are used in concrete to control cracking due to plastic shrinkage and drying shrinkage. They reduce the permeability of concrete and bleeding of water. Some types of fibres produce greater impact, abrasion, shatter resistance in concrete. Besides all of the well known steel fibres nowadays plastic fibres and hybrid fibres (a mix of different fibres) can be used for additional applications. Recent investigations have shown that the combination of different types of fibres (HYFRC) Hybrid Fibre Reinforced concrete provide a higher toughness.

A. Coconut Fibre

Coconut fibres are classified as brown fibres that are extracted from matured coconuts and white fibres that are extracted from immature coconuts. Brown fibres are thick, strong, and have high abrasion resistive property. In engineering brown fibres are mostly used.

➢ *Physical and mechanical properties*

The density of coconut fibre as 0.87 g/cm^3.Coconut fibre is the most ductile fibre amongst all natural fibres. Coconut fibres are having the capacity of taking strain 4-6 times more than that of other fibres.

Diameter (mm)	Tensile strength (MPa)	Young's modulus(GPa)	Toughness (MPa)	Density (kg/m3)
0.12	158	4.2	23	870

Table 1.Properties of coconut fibre

The young's modulus of coconut fibre has the value of 4.2GPa. It has a minimum diameter of 0.12mm.

B. Polypropylene

It is a thermo plastic polymer used in a wide variety of applications including packaging, textiles, stationery, plastic parts, and reusable containers of various types.

➢ Properties of polypropylene fibres

Specific gravity – 0.91gm/cm3. Polypropylene fibres retain more heat for a longer period of time, have excellent insulating property. They have extremely low water absorption, polypropylene fibres resist water-borne stains better than any other fibres.

C. Hybrid Fibre Reinforced Concrete HYFRC

Hybrid fibres are the mix of different fibres. The natural fibre combined with synthetic fibre will improve the quality of concrete, the natural fibre (coconut fibre) possess high tensile strength in the wet condition on other hand the tensile strength of synthetic fibres (polypropylene fibre) are affected in the moist condition. The combination of natural fibre and

synthetic fibre added with the conventional concrete will provide better strength in dry condition as well as in the moist condition.

III. MATERIALS USED IN THE CONCRETE

- Cement(chettinadu OPC 53 grade)
- Fine aggregate
- Coarse aggregate (20mm and 12mm)
- Coconut fibre
- Polypropylene fibre
- Water

A.Mix Design

Specific gravity of cement: 3.2
Specific gravity of fine aggregate: 2.67
Specific gravity of 20mm coarse aggregate: 2.76
Specific gravity of 12mm coarse aggregate: 2.77
Water cement ratio = 0.45
Cement content = 355
Mix design was calculated for the grade of M30

Mix proportion	Per kg/m3	Mix ratio
Cement	355	1.00
Fine aggregate	708	1.87
Coarse aggregate(20mm)	753	2.00
Coarse aggregate (12mm)	472	1.30
Water	160	0.45

Table 2. Table of mix proportion

The mix ratio for M30 grade is calculated using the code book of IS.10262:2009.
The arrived ratio is 1:187:2

IV. TEST ON SPECIMEN

A. Compressive Strength Test

➢ *Compressive strength of specimen for 7 days*

The size of the cube taken for the test is 150 x 150 x 150mm.

Proportion 1 = 0.1% of polypropylene & 0.3% of coconut fibre
Proportion 2 = 0.2% of polypropylene & 0.2% of coconut fibre
Proportion 3 = 0.3% of polypropylene & 0.1% of coconut fibre

S.N	Conventional(N/mm^2)	Proportion 1	Proportion 2	Proportion 3
1.	30.96	32.26	31.83	31.83
2.	30.96	30.96	32.26	31.83
3.	31.39	30.52	31.39	31.39

Table 4. 7 Days Compressive strength

From the above table we inferred that in proportion 2 we have attained the maximum compressive strength compared to the others.

S.N	Conventional(N/mm^2)	Proportion 1	Proportion 2	Proportion 3
1.	38.81	40.11	40.11	40.55
2.	38.37	40.55	40.55	40.55
3.	39.24	40.11	40.98	40.11

Table 5. 28 Days compressive strength

The cubes were casted for various proportions of fibre and compressive strength of that specimen at 7 days and 28 days are calculated. From the above table we inferred that in proportion 2 the cube had attained the maximum compressive strength compared to the others.

B. Split Tensile Strength

S.N	Conventional(N/mm^2)	Proportion 1	Proportion 2	Proportion 3
1.	1.53	2.22	2.36	2.36
2.	1.67	2.22	2.36	2.22
3.	1.39	2.5	2.50	2.50

Table 6. 7 days split tensile strength

For split tensile strength the cylinders of size 150 mm diameters were casted and tested. For 7 days strength test compared to the other proportion the proportion 2 had the higher value.

S.N	Conventional(N/mm^2)	Proportion 1	Proportion 2	Proportion 3
1.	2.36	2.78	3.05	3.05
2.	2.65	3.34	3.34	3.34
3.	2.5	3.34	3.34	3.19

Table 7. 28 days split tensile strength

For 28 days strength the proportion 2 had the higher value when compared to other two.

C. Flexural Strength of Beam

To check the Flexural strength of the beam, the beams were casted at the size of 500 x 100 x 100mm. In this average of two has been taken for the results.

S.N	Conventional (N/mm^2)	Proportion 1	Proportion 2	Proportion 3
1.	3.72	5.39	5.57	5.51
2.	4.19	5.63	5.63	5.63

Table 8. 7 Days flexural strength

Flexural strength of the casted beam was calculated and from the above results the proportion 2 that is 0.2% of polypropylene and 0.2% of coconut fibre has more strength compared to the other two proportions.

S.N	Conventional(N/mm^2)	Proportion 1	Proportion 2	Proportion 3
1.	5.99	6.83	7.37	7.13
2.	6.625	7.19	7.19	6.83

Table 9. 28 Days flexural strength

Flexural strength of the casted beam was calculated and from the above results the proportion 2 that is 0.2% of polypropylene and 0.2% of coconut fibre has more strength compared to the other two proportions.

V. RESULTS AND DISCUSSION

A. Compressive Strength Test

NC = Conventional concrete
HYFC1 = Hybridfiber (0.1% of polypropylene & 0.3% of coconut fibre) reinforced concrete
HYFC2 = Hybridfiber (0.2% of polypropylene & 0.2% of coconut fibre) reinforced concrete
HYFC3 = Hybridfiber (0.3% of polypropylene & 0.1% of coconut fibre) reinforced concrete

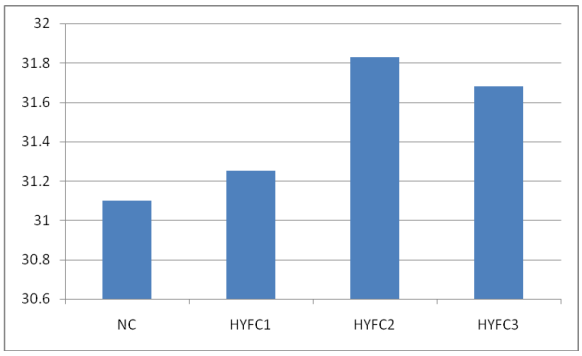

Fig 1:- compressive strength at 7 days

The graph was plotted between the Compressive strength of the cube VS Various proportions of the fibres added to the mix.

From this graph we inferred that the maximum compressive strength of the cubes attined at proportion 2.

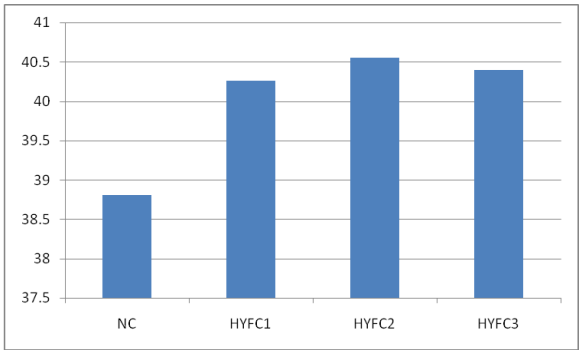

Fig 2:- 28 Days compressive strength

From this graph it was observed that the maximum compressive strength attained at hybrid fibre of proportion (0.2% of polypropylene & 0.2% of coconut fibre) reinforced concrete.

B. Split Tensile Test

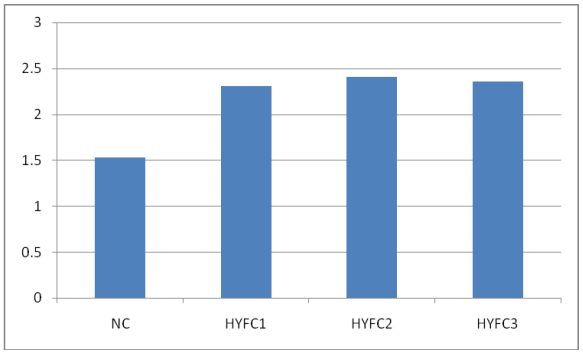

Fig 3:- 7 days split tensile test

From this graph it was observed that the maximum compressive strength attained at hybridfibre of proportion (0.2% of polypropylene & 0.2% of coconut fibre) reinforced concrete

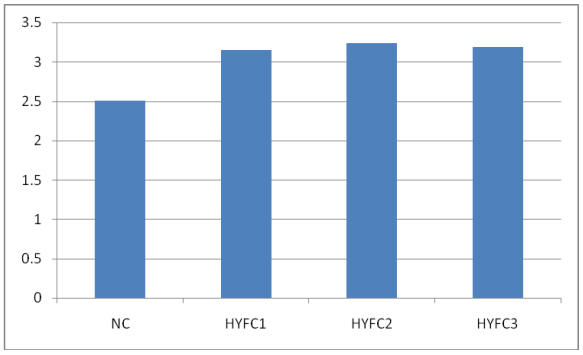

Fig 4:- 28 days split tensile test

From the results it was observed that the maximum split tensile strength attained at hybrid fibre of proportion (0.2% of polypropylene & 0.2% of coconut fibre) reinforced concrete.

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C. Flexural Strength Test

To find the exact proportion at which the concrete has higher flexural strength is calculated by ploting the grpah between flexural strength of concrete VS various proportions of fibres.

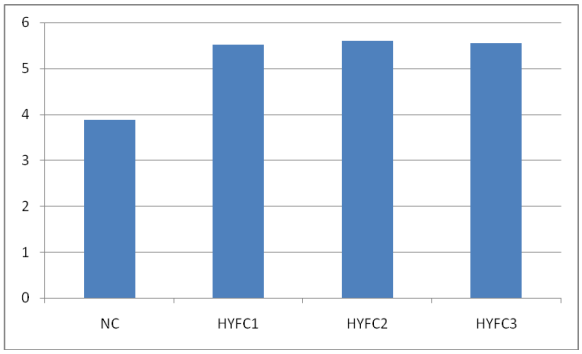

Fig 5:- 7 Days flexural strength

From the results it was observed that the maximum split tensile strength attained at hybrid fibre of proportion (0.2% of polypropylene & 0.2% of coconut fibre) reinforced concrete.

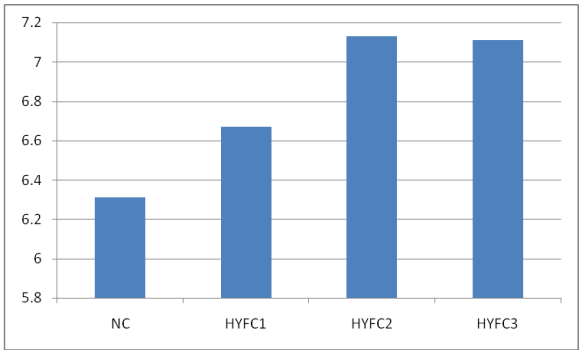

Fig 6:- 28 Days flexural strength

From the results it was observed that the maximum flexural strength attained at hybrid fibre (0.2% of polypropyle fibre & 0.2% of coconut fibre) reinforced concrete.

VI. CONCLUSION

Based on the observation, the following conclusion were made on the Hybrid fibre reinforced concrete with respect to the different % of polypropylene fibre and coconut fibre adding by volume of concrete.

- Maximum " compressive strength " attained at Hybrid reinforced concrete of 0.2% of polypropylene fibre & 0.2%of coconut fibre.
- Maximum "split tensile strength" attained at Hybrid fibre reinforced concrete of 0.2% of polypropylene fibre & 0.2% of coconut fibre.
- Maximum "Flexural strength" attained at Hybrid fibre reinforced concrete of 0.2% of polypropylene & 0.2% of coconut fibre.

From the results, we concluded that Hybrid fibre reinforced concrete of 0.2% of polypropylene & 0.2% of coconut fibre can be used for making concrete to impart inheriting capacity of compressive, split tensile as well as flexural strength of concrete.

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