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Impact of Coconut Fibre and Polypropylene Fibre (RECRON 3S) On Concrete Mix Including Admixture

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Abstract: This paper describes the enhancement in the strength of the conventional concrete by the addition of fibres. Coconut fibres and polypropylene fibres (recron 3S) are used to increase the strength of the conventional concrete. The coconut fibres of various proportions from 1%, 1.5%, 2%, 2.5% and polypropylene fibres of proportions from 0.1%, 0.2%, 0.3% and 0.4% by volume of concrete were used in the M40 grade concrete mix. Slump test was carried on fresh concrete while compressive strength, split tensile strength and flexural strength were carried on hardened concrete. These tests are carried out to determine the mechanical properties of concrete upto 7, 28, and 56 days for compressive strength, 28 days for split tensile strength and flexural strength. A notable increase in the flexural and tensile strength was found..
Keywords: Coconut Fibres (CF), Polypropylene Fibres (PF), Compressive Strength, Split Tensile Strength, Flexural Strength.

I. INTRODUCTION

As we know that concrete which is usually made by mixing cement, water, fine and coarse aggregate and sometimes admixture in their right proportion is major construction material. As everyone known that we live in concrete age, then branch of Civil Engineering "Concrete Technology" becomes the backbone for development of infrastructure of every country. But due to increasing in rate of cement it becomes an obstacle for infrastructural development in the developing countries. And also during product stage of cement greenhouse effect which pollute the air and contribute to environmental as well as human hazardous. But to overcome this, many researches has been made on coconut fibre also which reduces the use of convectional cement and reduces the cost of concrete as well. The overall goal for this research is to make more and more awareness about the advantages and uses of coconut fibre and introducing it as a cheap and easily available natural fibre which did not affect the environment. Among this natural fibre which can be used for construction purpose is coconut fibre which can also be known with other names as Coir, Cocas nucifera, Arecaceae (Palm). Coconut fibre is extracted from the outer shell of a coconut. There are two types of coconut fibres, brown fibre extracted from matured coconuts and white fibres extracted from immature coconuts. Brown fibres are thick, strong and have high abrasion resistance. White fibres are smoother and finer, but also weaker. Coconut fibres are commercial 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.

According to the official website of International Year For Natural Fibre 2009 the cultivation of coconut tree are around 12 million worldwide which produces 5,00,000 tones of coconut fibre annually. This coconut fibre can be used in the concrete which is very important part of any construction. Normally, in convectional reinforced concrete we use steel bars which increase the weight as well as the cost of the concrete which cannot be easily affordable to all rulers as well as urban civilians.

The polypropylene fibre has been one of the most successful commercial applications. The common forms of this fibre are smooth-monofilament and have triangular shape. Polypropylene fibres have some unique properties that make them suitable for reinforcement in concrete. The fibres have allow density, are chemically inert and non corrosive.

II. LITERATURE REVIEW

Roohollah et. al [2012] were investigating that Fibre addition was seen to enhance the physical and mechanical properties of lightweight concrete(LWC). Compared to unreinforced LWC, polypropylene (PP) reinforced LWC with fibre proportioning 0.35% and12 mm fibre length, caused 30.1% increase in the flexural strength and 27% increase in the splitting tensile strength. Increased fibre availability in the LWC matrix, in addition to the ability of longer Polypropylene fibres to bridge on the micro cracks, are suggested as the reasons for the enhancement in mechanical properties.

Praveen et. al [2013] were suggested that the effect of variation of polypropylene fibres ranging from 0.1% to 0.4% along with 0.8% steel fibres on the behaviour of fibrous concrete. The mechanical properties of the concrete such as compressive and tensile strength have been investigated. The result shows that addition of polypropylene fibre has a little effect on the Compressive strength, but there was significant increase in the tensile strength with increase in fibre volume fraction. The present investigation shows an increase of 47% of split tensile strength and 50% of flexural strength. The result shows that ultimate load mainly depended on percentage volume fraction of fiber.

Okere [2013] investigated that this work presents the results of laboratory tests carried out using Coconut Fibre Ash (CFA) as a partial re-placement for cement in concrete production. Concrete cubes were cast and tested at curing ages of 7, 14, 21, 28 and 60 days using 0, 10, 15, 20, and 25 percent replacement le-veils. The slump test result shows that the workability of the concrete decreased as the CFA content increased. Results showed that the compressive strength of CFA concrete in-creased with curing age but decreased with increasing per-cent age of coconut fibre ash. The percentage strength gained at 28 days for 5% and 10% to the control of 0% are 95.5% and 95.1% respectively. The optimum compressive strength of 31.88N/mm^2 was obtained at 10% replacement at 60 days of age. The percentage strength at this optimum point to the control is 99.%.

Parbhane et. al [2014] were investigated that the workability and tensile strength of concrete increased to some extent as the coir increased. Concrete produced by 1%, 2%, 3%, 4% & 5% addition attained 28 days tensile strength of 2.68, 2.90, 3.11, 3.25, 2.33 respectively. These results showed that Coir Fibre Concrete can be used in reinforced concrete construction. Its utilization is eco-friendly.

Shubha [2014] investigated that the compressive strength of concrete cubes for M-20 and M-40 grade concrete mix design by doing an experimental study by using Coconut Fibre and Polypropylene Woven Fibre (PPWF) including Admixture in the form of Super-plasticizer as CONPLAST (G-8) 410. Results show that compressive strength of concrete cube increases with admixture. Another study with Coconut fibre and PPWF including admixture also proves that compressive strength of concrete cubes increases much more as compared to with and without admixture-concrete cubes (5).

Abhijeet et. al [2014] were investigated that coconut fibre which is natural fibre makes number of effect on environment and also increases the strength of concrete compare to use of convectional fibre. Concrete cylinders of dimension 150mm×300mm were cast to take the compressive as well as tensile strength test and it shows that the compressive strength of concrete increases with curing age but decrease with increase in quantity of coconut fibre whereas its tensile strength increases. The optimum tensile strength that we get was 3.0 Map. This research is carried out to bring awareness in field of Civil Engineering about the coconut fibre as good and hazardous less construction material. (6)

III. MATERIALS AND METHODS

A. *Materials*

1) *Cement:* Ordinary Portland cement of 43 grade (Ramco) conforming to IS 8112-1989 is used. Table 1 shows the test results of basic properties of cement.

Table 1: Basic Properties of Cement

Properties	Cement
Specific gravity	3.1
Standard consistency	31%
Initial setting time	38min
Final setting time	480min
Fineness	5.3%

B. *Fine Aggregate*

Natural river sand of size below 4.75mm conforming to zone II of IS 383-1970 is used as fine aggregate. Table 2 shows the test results of basic properties of fine aggregates.

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Table 2: Basic Properties of Fine Aggregates

Properties	Fine Aggregate
Specific gravity	2.62
Water absorption	1.45%

C. Coarse Aggregate

Natural crushed stone with 20mm down size is used as coarse aggregate. Table 3 shows the test results of basic properties of coarse aggregates.

Table 3: Basic Properties of Coarse Aggregates

Properties	Coarse Aggregate
Specific gravity	2.65
Water absorption	0.39%

D. Water

Ordinary portable water is used in this investigation both for mixing and curing.

E. Super plasticizer (SP)

Conplast SP430 is used as a super plasticizer. It is a chloride free, super plasticizing admixture. It is supplied as a brown solution which instantly disperses in water.

F. Coconut Fibre

Coconut fibre was used in this study and it was collected from Coir Industries, near Bangalore Karnataka. The diameter of the coconut fibre used ranges between 0.29mm and 0.83mm with length of 6mm to 24mm and having approximate 150 as aspect ratio. Table 4 shows the test results of basic properties of coconut fibre.

Table 4: Basic Properties of Coconut Fibre

Properties	Coconut Fibre
Specific gravity	0.87

G. Polypropylene Fibre (Recron 3s)

Polypropylene fibre was used in this study and it was collected from Reliance Industries Limited, Mangalore, Karnataka. The diameter of the polypropylene fibre used ranges between 34micron with length of 12mm and having approximate 320 as aspect ratio. Table 5 shows the test results of basic properties of polypropylene fibre.

Table 5: Basic Properties of Polypropylene Fibre

Properties	Polypropylene fibre
Specific gravity	0.91

H. Concrete Mix Design

Mix proportion used in this study is 1:1.61:2.65 (M40) with water-cement ratio of 0.4 and super plasticizer of 1.0%.

I. Batching and Mixing of Materials

Weight batching and machine mixing are adopted in this study for concrete production. The percentage of fibers and material weight are shown in Table 6.

Table 6: Mix Proportion Per Cubic Meter

Mixes Name	CF (%)	PP (%)	Cement (Kg)	Fine Aggregate (Kg)	Coarse Aggregate (Kg)	Water (w/c 0.4) (liters)	1.0% SP (liters)
CM	-	-	425	684.25	1126.25	170	3.1875
M1	1.0	0.0	425	684.25	1126.25	170	3.1875
M2	1.5	0.0	425	684.25	1126.25	170	3.1875
M3	2.0	0.0	425	684.25	1126.25	170	3.1875
M4	2.5	0.0	425	684.25	1126.25	170	3.1875
M5	0.0	0.1	425	684.25	1126.25	170	3.1875
M6	0.0	0.2	425	684.25	1126.25	170	3.1875
M7	0.0	0.3	425	684.25	1126.25	170	3.1875
M8	0.0	0.4	425	684.25	1126.25	170	3.1875
M9	1.0	0.1	425	684.25	1126.25	170	3.1875
M10	1.5	0.2	425	684.25	1126.2	170	3.1875
M11	2.0	0.3	425	684.25	1126.25	170	3.1875
M12	2.5	0.4	425	684.25	1126.25	170	3.1875

J. *Casting of Specimens*

Mixing is done by using concrete mixer. For each proportion 12 cubes of size 100*100*100mm, 3 cylinder of 100mm diameter and 200mm in height and 3 beams of 100*100*500mm are casted. Mixing is done by adding aggregate to mixing drum first, followed by 25% of total water and super plasticizer to prevent cement sticking to blades or at the bottom of the drum. Super plasticizer will be added to water measured and stirred well. Then fibers and sand is added with 25% of water and super plasticizer again. After thoroughly mixing of aggregates, cement with admixtures if any is added and remaining 50% of water and super plasticizer is introduced. For each mix slump test is conducted to measure workability. Totally 288 cubes, 69 cylinder and 69 beams are casted. After casting concrete is filled into moulds and compacted on vibration table. Demoulding was done after 24 hours of casting. specimens are cured in curing tank. Water immersion method of curing is adopted. Cubes are cured for 7, 28, days and remaining specimens are cured for 28 days. Figure 1 shows the concrete placed in moulds.

Fig 1: Concrete placed in moulds

K. *Testing of Specimen*

Compressive strength test were carried on cubes, split tensile strength test on cylinders and flexural strength test on beams. The compressive strength and split tensile strength tests are done in the compressive testing machine and the flexural strength test was carried out in the universal testing machine.

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Fig 2 & 3: Setup for compressive and split tensile strength.

Fig 4: Setup for Flexural Strength Test

IV. RESULTS AND DISCUSSIONS

The following figures represent the test results.

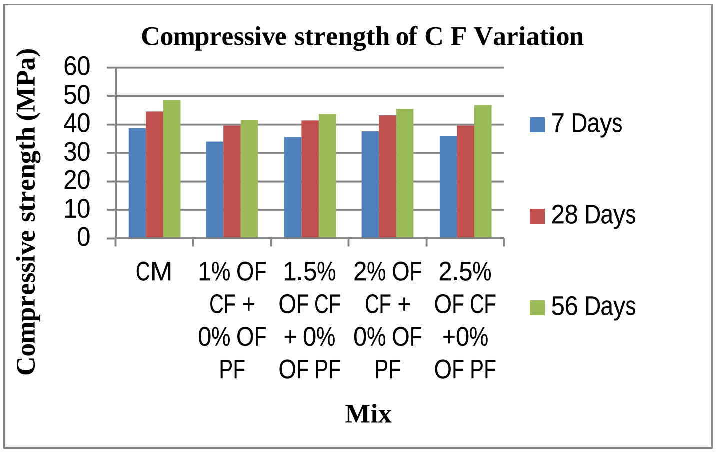

Fig 5: 7, 28 and 56 Days Compressive Strength of CF Variation in concrete mix.

The figure 5 represents the 7,28 and 56 days compressive strength of concrete. It shows that when CF is added to the concrete, the compressive strength of concrete has lower strength than that of control mix. With the increase in the percentage of addition of CF in concrete increases the compressive strength of the concrete mix and decreases with further addition beyond 2% CF.

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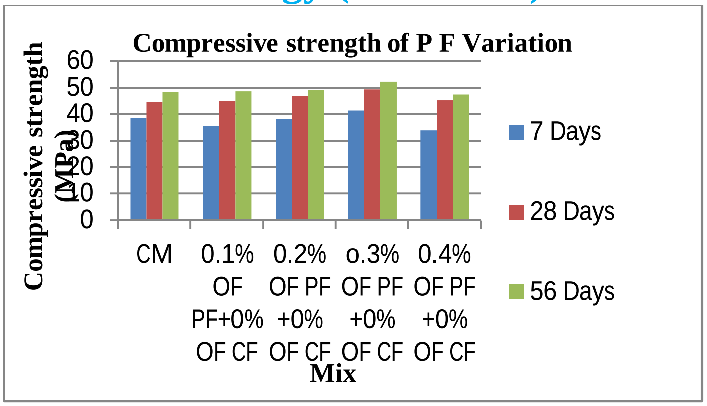

Fig 6: 7, 28 and 56 Days Compressive Strength of PF Variation in concrete mix.

The figure 6 represents the 7,28 and 56 days compressive strength of concrete. It shows that when PF is added to the concrete, the compressive strength of concrete has higher strength than that of control mix. With the increase in the percentage of addition of PF in concrete increases the compressive strength of the concrete mix and decreases with further addition beyond 0.3% PF.

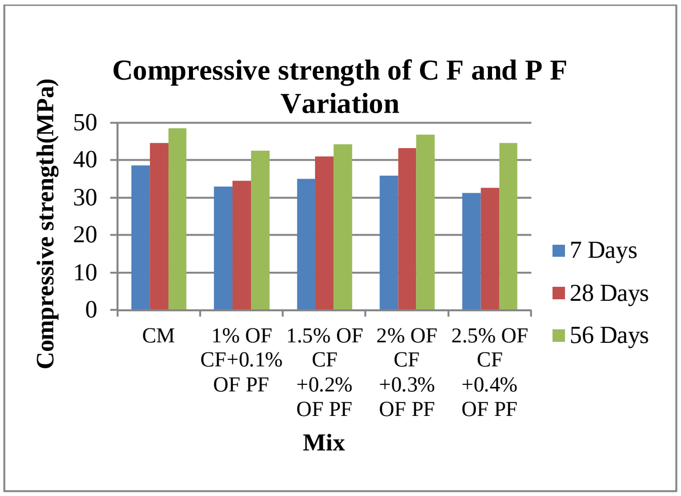

Fig 7: 7, 28 and 56 Days Compressive Strength of CF and PF Variation in concrete mix.

The figure 7 represents the 7,28 and 56 days compressive strength of concrete. With the addition of CF and PF, it shows lower compressive strength than the corresponding control mix. With the addition of CF and PF to the concrete, the compressive strength increases gradually and reaches an optimum value at 0.3% PF and 2% CF combination mix. With further addition of PF and CF to the concrete, the compressive strength starts decreasing.

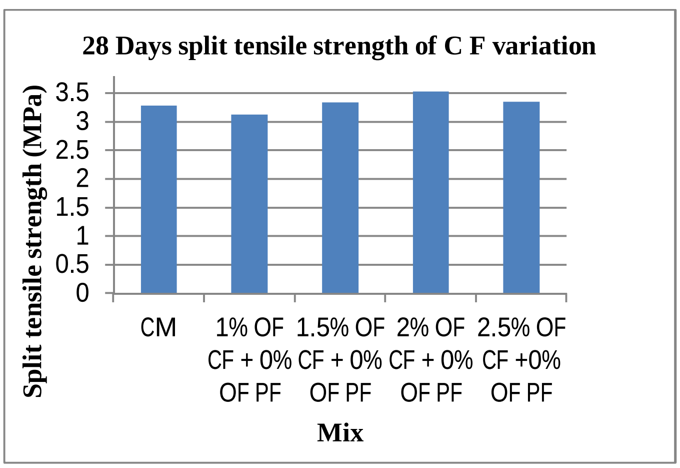

Fig 8: 28 Days Split Tensile Strength of CF Variation in concrete mix.

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The figure 8 represents the 28 days split tensile strength of concrete. With the addition of CF, it shows greater strength than the corresponding control mix at 28 days curing period. It is clearly seen from the graph that the split tensile strength of concrete mix with 2% addition of CF has higher value as that of the control mix. The split tensile strength increases till 2% CF and then goes on decreasing with further CF addition.

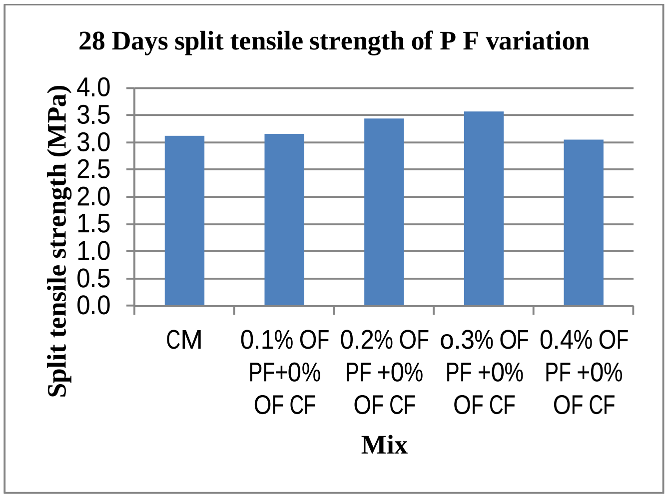

Fig 9: 28 Days Split Tensile Strength of PF Variation in concrete mix.

The figure 9 represents the 28 days split tensile strength of concrete. With the addition of PF, the graph shows greater tensile strength than the corresponding control mix at 28 days curing period. With the addition of 0.3% PF the split tensile strength of the concrete mix is 3.59 MPa. Split tensile strength decreases beyond the addition of 0.3% PF.

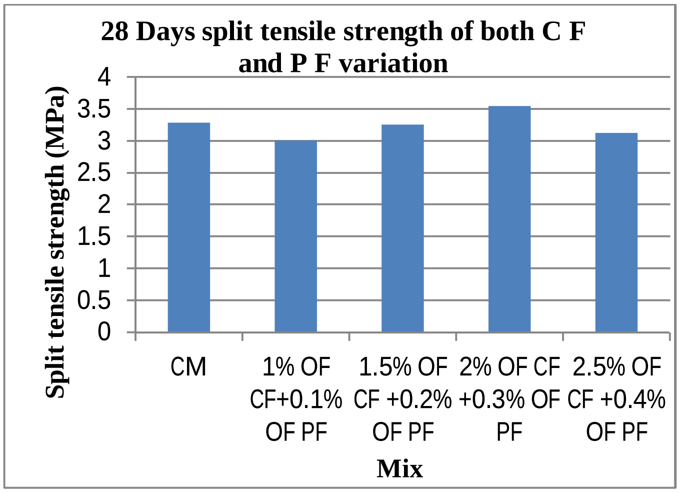

Fig 10: 28 Days Split Tensile Strength of CF+PF Variation in concrete mix.

The figure 10 represents the 28 days split tensile strength of concrete. With the addition of both CF and PF, it shows greater strength than that of the corresponding control mix at 28 days curing period. The Split tensile strength increases till 2% CF and 0.3% PF addition and decreases later on.

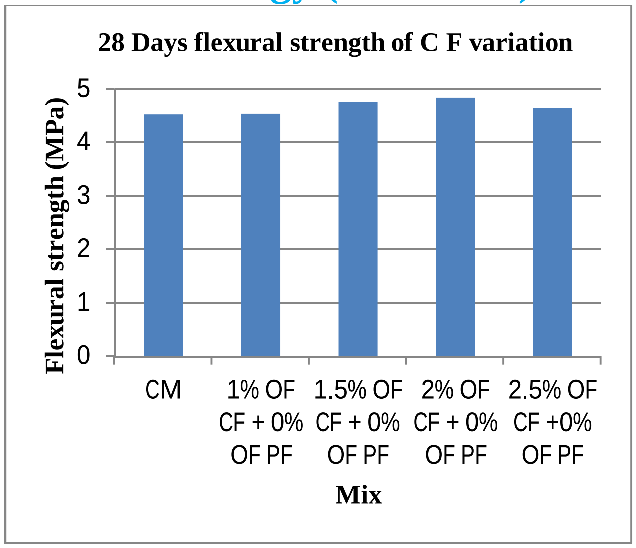

Fig 11: 28 Days Flexural Strength of CF Variation in concrete mix.

From the graph 12, we can clearly observe that the flexural strength of CF shows greater strength than that of the corresponding control mix at 28 days curing period. The flexural strength at 2% CF combination mix is 4.8 MPa. The flexural strength of the concrete mix decreases beyond the addition of 2% CF.

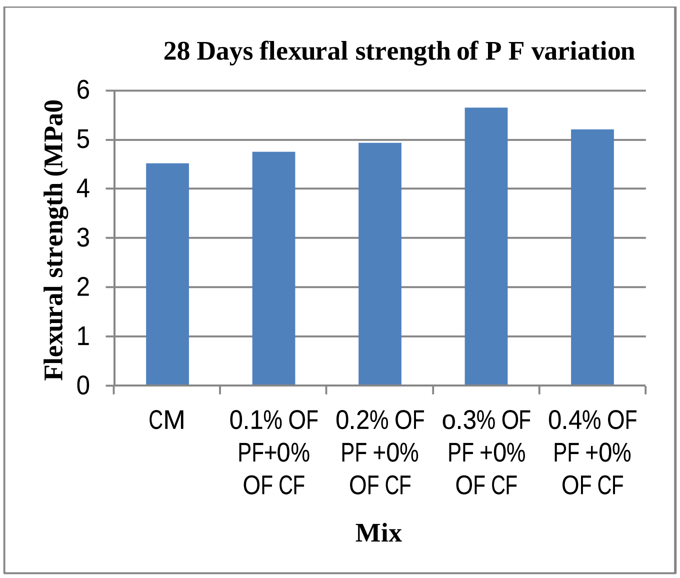

Fig 12: 28 Days Flexural Strength of PF Variation in concrete mix.

The graph 12 represents the flexural strength of the concrete mix. The addition of PF shows greater strength than that of the corresponding control mix at 28 days curing period. Flexural strength is highest at 0.3% PF combination mix. The flexural strength decreases beyond the addition of 0.3% PF.

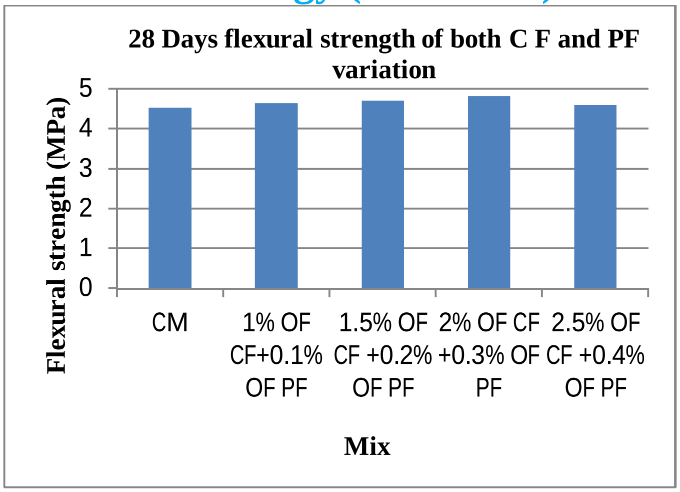

Fig 13: 28 Days Flexural Strength of CF + PF Variation in concrete mix.

From the graph 13 represents the flexural strength results of the concrete addition of both CF and PF. The graph shows that the addition of both CF and PF has greater flexural strength than that of the corresponding control mix at 28 days curing period. Flexural strength increases till 2% CF and 0.3% PF combination mix and decreases with the further addition.

V. CONCLUSION

Based on the experimental investigation the following conclusion are drawn

A. The workability of the fibre concrete (CF and PF) has been found to decrease with increase in coconut fiber and polypropylene fibre in the concrete mix.

B. The compressive strength of the fibre mixed concrete has lower value than that of the control mix.

C. The split tensile strength of the fibre mixed concrete has higher value than that of the control mix.

D. The flexural strength of the fibre mixed concrete is comparatively very high than that of the control mix.

E. With the increase in the addition of fibres to the concrete, the split tensile and the flexural strength increases to some extent and gradually decreases with further increase in the percentage of the fibers.

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