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COMPARATIVE STUDY OF STRENGTH PROPERTIES OF COCONUT COIR FIBER REINFORCED CONCRETE DUE TO PARTIAL REPLACEMENT OF CEMENT BY POZZOLANIC MATERIALS

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Abstract - *The main objective of the modern day Civil Engineering is to achieve Sustainability and the term is also widely accepted by engineers worldwide. The construction industry is revolutionizing in terms of both equipment, materials. Thus, the basic cost of construction has increased exponentially along with detrimental effects on environment. Thus lot of research work is been carried to reduce the usage of non-renewable resources and to achieve economy. The primary objective of the current project is to investigate the strength properties of coconut coir fiber reinforced concrete due to partial replacement of cement by various pozzolanas.*

Key Words: *Coconut fiber, Compressive strength, Flexural strength, Fly ash, GGBFS, CFRC, Rice husk ash.*

1. INTRODUCTION

Rapid expansion and globalization has led to increase in the use of many non-renewable resources. Thus it's necessary for us to innovate and lessen the usage of the same.Fiber reinforced concrete is primarily made of hydraulic cement, aggregates and discrete reinforcing fibers. An unreinforced concrete is accredited to be a relatively weaker or brittle material, having lesser strain capacity at fracture and tensile strength. Brittle materials have no significant post cracking durability. The short comings are usually rectified by adding reinforcing bars or by fibers or by adding prestressing steel.

Research and advancement of cement replacing materials, fibers and their fabrication in regards with construction industry have seen rapid growth.

Some of the common pozzolonas used are Silica fume, Fly ash, Ground granulated blast furnace slag (GGBFS), Rice husk ash (RHA) etc. The major advantages of using these pozzolanas are highlighted below:

- Increases the compressive strength
- Lesser environmental impact
- Economical
- Moderates the utilization of cement.

The usage of fibers in conventional concrete that too a natural fiber which is a renewable source has reduced dominating factors of construction industry which is "High cost".

The major advantages of using natural fibers are:

- No impact on environmental condition
- Efficiency
- High strength-weight ratio
- It can be moulded into variety sizes and shapes.

The use of coconut fibers which is the most docile in class of other natural fibers and has the competence to be cast-off as reinforcing material in concrete. It is decomposable and hence has the lesser influence on environmental condition and this can be one of the many ways to dispose off fibers derived from coir manufacturing units.

The main of this study is to identify the variations in strength characteristics with the supplement of coconut fiber due to partial replacement of cement with Fly Ash, GGBFS & Rice Husk Ash. Plain conventional concrete is being used as reference to study flexure and compressive strength properties.

2. LITERATURE REVIEW

Sai uday, B Ajitha (2017)[3] , studied the behaviour and engineering properties of coconut fiber in the concrete structure. They conducted series of tests on CFRC's by varying the proportions of fibers at 1%, 2%, 3%, 4%, and 5% by the weight of cement respectively. The study found that the resulting values at 1% additive of coconut fibers showed gradual surge in the strength of concrete with respect to other percentages.

Bhushan et.al (2017) [1], summarized the various properties of cement replacement with RHA such as availability, affordability, quality, strength parameters and its cost feasibility. They replaced RHA by weight at 0%, 5%,

10%, 15%, 20%, 25% and the compressive and split tensile tests results were recorded for the same. They concluded that RHA can be replaced up to 10% by weight of cement deprived of any reduction in properties of concrete and also resulted in cost reduction of concrete.

Mohod et.al [3], studied the various properties pertaining to fly ash replacement in concrete pavements. The pozzlanic material Fly ash was replaced in an array of 0% to 20% by its weight .They conducted various tests on them such as compression, flexure and split tensile strength test. Hence they established that cement replacement between 0 to 15% showed good results when compared to other percentages and was also economically feasible.

Patil et.al (2013) [4], investigated partial replacement of GGBFS with cement and found some very encouraging results. This study deals with experimental study on compression and flexural strength of ordinary Portland cement concrete, with GGBFS partially replacing OPC from 0 to 40%. It was summarized that the up to 20% of cement can be replaced with GGBFS which would give greater strength results and economy.

3. OBJECTIVES

With the knowledge of stated literature review, following objectives are made:

- To investigate the influence of cement replacing materials along with fibers on strength of concrete.
- To find out variations in flexural and compressive strength, using processed strands of fibers at constant fiber content and varying the contents of various pozzolanas.

4. MATERIALS USED AND THEIR PROPERTIES

In this present study, materials used are: cement, fine aggregate, course aggregate, coconut fiber, Fly ash, GGBFS, Rice husk ash.

CEMENT

Penna cement of OPC 43 grade was used in the study.

Table 1: Test results of cement

Sl. No.	Property	Results
1	Normal Consistency	34%
2	Fineness	5.73%
3	Specific gravity	3.11

AGGREGATES

Fine aggregates: In this work locally available river sand which falls under zone-II of IS 383 – 1970 is taken for experimental work.

Table 2: Test results of fine aggregates

Sl. No.	Property	Results	Remarks
1	Specific gravity	2.50	IS 2386 & IS 383
2	Sieve analysis	Zone II	

Coarse Aggregates: 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 aggregates

Sl. No.	Property	Results	Remarks
1	Specific gravity	2.70	IS 2386 & IS 383
2	Water absorption	0.61%	

FLY ASH

Defined as "finely divided residue resulting from the incineration of pulverized coal". Specific gravity of Fly Ash is 2.71 and is determined in accordance with IS specifications.

GROUND GRANULATED BLAST FURNACE SLAG (GGBFS)

It is obtained by snuffing out the iron slag from a blast furnace in steam to give rise to a glassy, granular material that is then dried and ground into a finer powder. GGBFS is procured from "JSW–Vijaynagar works", Bellary. The specific gravity of GGBFS is 3.0 and it is carried out in accordance with IS specification.

RICE HUSK ASH (RHA)

Rice husk ash is by product from the burning of rice husk. It has been found beneficial to burn this rice husk in kilns to make various things and it is locally available from the rice mills. The specific gravity of RHA is 2.67 and is carried out in accordance with IS specifications.

COCONUT FIBER

In the current work coconut fiber are obtained from the local shop which are in the form of bundles, they are then cut in

the form of small threads of length of 40mm. CNF are used as natural fiber in my work.

5. MIX DESIGN

Mix design results for per meter cube of concrete.

Table 4: Mix design results

Sl. No.	Properties	Values
1	Grade of concrete	M 30
2	Type of cement	OPC 43 grade
3	Water-cement ratio	0.45
4	Workability	75 mm slump
5	Exposure condition	Moderate
6	Min. cement content	300 kg/m3
7	Specific gravity of cement	3.11
8	Specific gravity of fine aggregates	2.50
9	Specific gravity of coarse aggregate	2.70
10	Quantity of cement	425.73 Kg/m^3
11	Quantity of fine aggregates	727.44 Kg/m^3
12	Quantity of coarse aggregates	1029.40 Kg/m^3
13	Quantity of water	191.58 Kg/m^3
14	Dosage of fiber	Dosage by volume of mould
15	Coconut fiber	1%
16	Replacement of pozzolanas	By weight of cement
17	Fly ash	5%, 15%, 25%
18	GGBFS	5%, 15%, 25%
19	Rice husk ash	5%, 15%, 25%

6. TEST RESULTS AND DISCUSIONS

Various tests on fresh and hardened concrete has been carried out and the tables and graphs have been formulated and on the outcomes and the same has been described below.

TESTS RESULTS OF FRESH CONCRETE

SLUMP TEST

Slump test is conducted to measure the workability of concrete as per IS 1199 (1959).

Table 5: Results of slump test

TRIAL	W/C RATIO	SLUMP(mm)	REMARKS
Trial 1	0.4	55 mm	Target slump was not achieved
Trial 2	0.45	75 mm	Target slump was achieved

TEST RESULTS OF HARDENED CONCRETE

COMPRESSIVE STRENGTH TEST

CONVENTIONAL CONCRETE

Here, the test results of composite mixture of conventional concrete along with 1% of fibers yields the results as shown in the table.

Table 6: Test results of conventional concrete cubes

Sl. No.	W/C ratio	7 days strength	28 days strength
Average	0.45	20.29	38.81

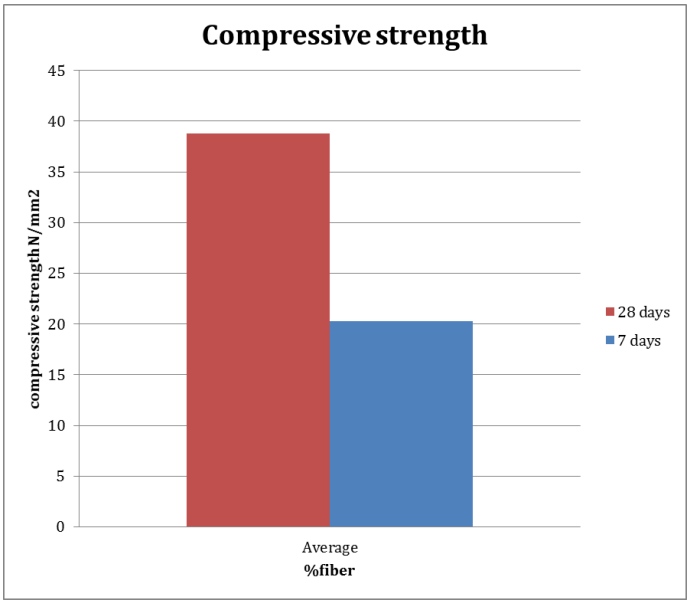

Chart 1: test results of conventional concrete cubes

COMPRESSIVE STRENGTH OF CFRC+FLYASH

In this trial, 5%, 15%, 25% of cement was replaced with Fly ash accordingly and 1% of coconut fiber is introduced

to the mix .The resulting values have been represented in the table below.

Table 7: Test results of CFRC+ Fly ash cubes

Sl. No.	% FLY ASH	7 Days strength	28 Days strength	Percentage increase or decrease
1	5	23.11	39.11	0.77%
2	15	15.11	36.6	-5.6%
3	25	14.22	35.77	-7.83%

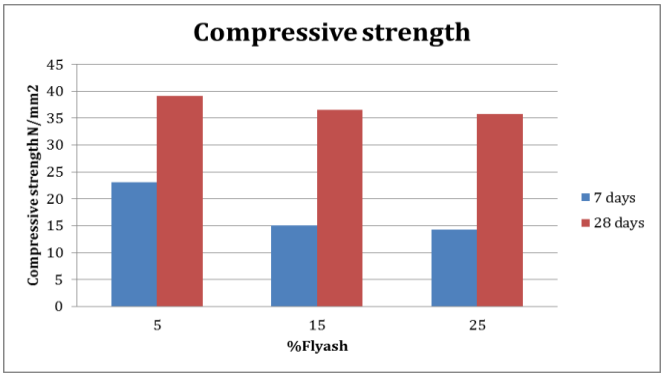

Chart 2: Test results of CFRC +Fly ash cubes

COMPRESSIVE STRENGTH OF CFRC+GGBFS

In this trial 5%, 15%, 25% of cement was replaced with GGBFS accordingly and 1% of coconut fiber is introduced to the mix .The resulting values have been illustrated in the table below.

Table 8: Test results of CFRC+GGBFS

Sl. No.	% GGBFS	7 days strength	28 days strength	Percentage increase or decrease in strength
1	5	27.55	41.77	7.6%
2	15	24.88	37.55	-3.2%
3	25	15.11	35.33	-8.9%

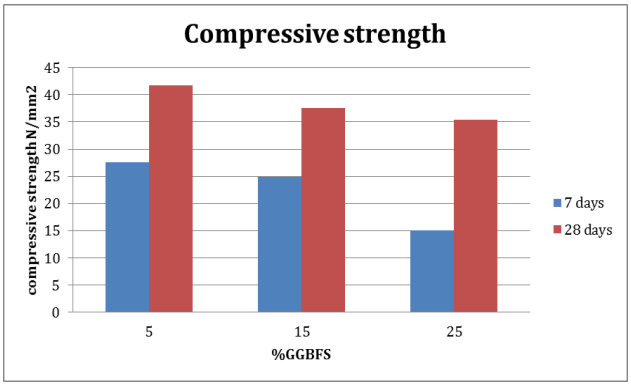

Chart 3: Test results of CFRC+GGBFS cubes

COMPRESSIVE STRENGTH OF CFRC+RHA

In this trial 5%, 15%, 25% of cement was replaced with RHA accordingly and 1% of coconut fiber was introduced to the mix .The resulting values have been represented in the table below.

Table 9: Test results of CFRC+RHA cubes

Sl. No.	% RHA	7 Days strength	28 Days strength	Percentage increase or decrease
1	5	22.2	31.77	-18.1%
2	15	15.11	27.77	-28.4%
3	25	13.33	24.4	-37.1%

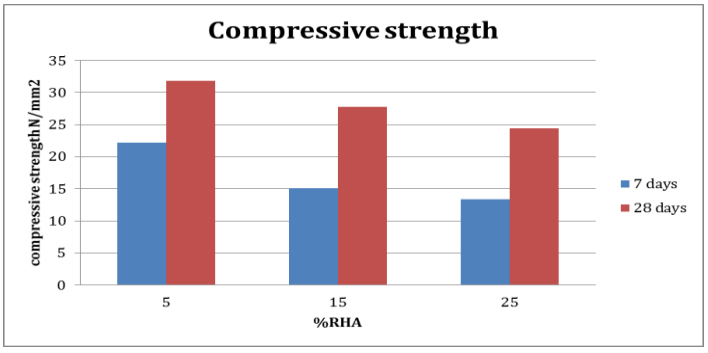

Chart 4: Test results of CFRC+RHA cubes

FLEXURAL STRENGTH TESTS

CONVENTIONAL CONCRETE

Here, the test results of composite mixture of conventional concrete along with 1% of fibers yields the results as shown in the table.

Table 9: Test results of conventional concrete beams

Sl. No.	W/C ratio	28 days strength
1	0.45	5.25
2	0.45	5.4
3	0.45	5.625
Average	0.45	5.4

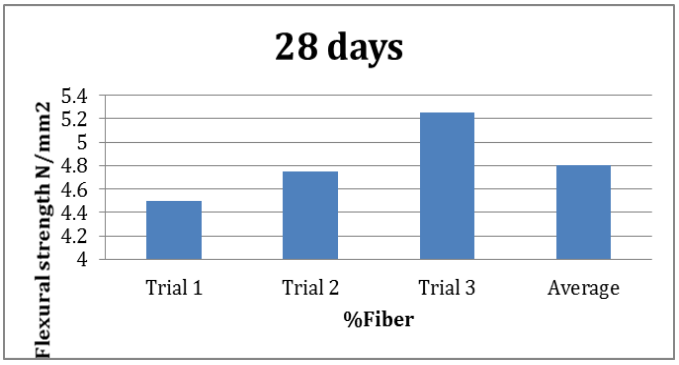

Chart 5: Test results of conventional beams

FLEXURAL STRENGTH OF CFRC+FLYASH

In this trial 5%, 15%, 25% of cement was replaced with Fly ash accordingly and 1% of coconut fiber is put in to the mix .The resulting values have been shown in the table below.

Table 10: Test results of CFRC +Fly ash beams

Sl. No.	% FLY ASH	28 Days strength	Percentage increase or decrease
1	5	6.2	14.81%
2	15	6	11.11%
3	25	6	11.11%

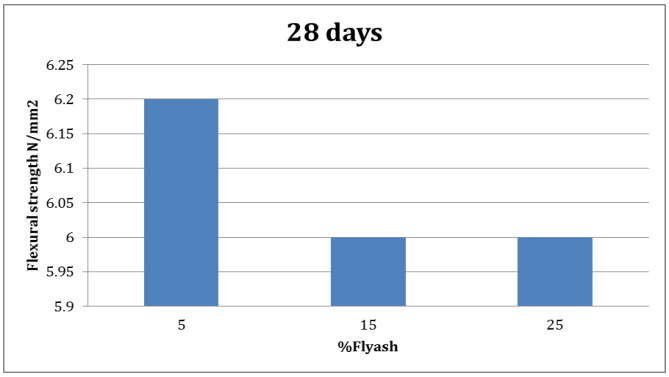

Chart 6: Test results of CFRC +Fly ash beams

FLEXURAL STRENGTH OF CFRC+GGBFS

In this trial 5%, 15%, 25% of cement was replaced with GGBFS accordingly and 1% of coconut fiber is put in to the mix .The resulting values have been portrayed in the table below.

Table 11: Test results of CFRC+GGBFS beams

Sl. No.	% GGBFS	28 Days strength	Percentage increase or decrease
1	5	6.2	14.81%
2	15	6.2	14.81%
3	25	6	11.11%

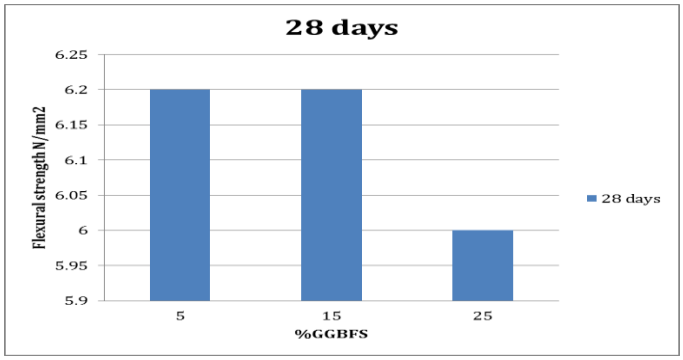

Chart 7: Test results of CFRC+GGBFS beams

FLEXURAL STRENGTH OF CFRC+RHA

In this trial 5%, 15%, 25% of cement was replaced with RHA accordingly and 1% of coconut fiber is put in to the mix .The resulting values have been shown in the table below.

Table 12: Test results of CFRC+RHA beams

Sl. No.	% GGBFS	28 Days strength	Percentage increase or decrease
1	5	6.1	12.96%
2	15	5.7	5.55%
3	25	5.2	-3.7%

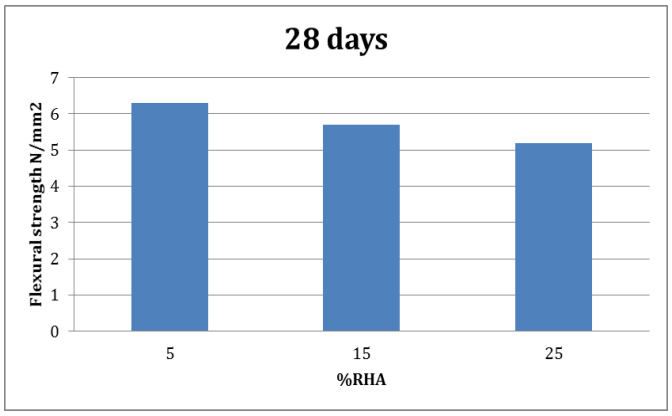

Chart 8: Test results of CFRC+RHA beams

COMPARISIONS OF GRAPHS

COMPRESSIVE STRENGTH COMPARISION

In this article, the 28 days strength comparisons of concrete cubes of proportion 5%, 15%, 25% of all pozzolonas have been made and the same has been shown in the figures below.

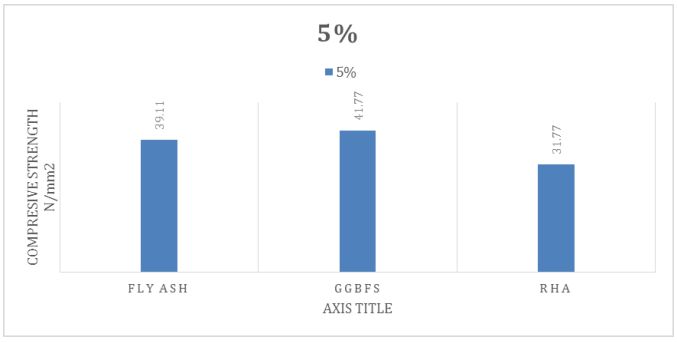

Chart 9: Strength comparison pozzolanas' with 5% replacement

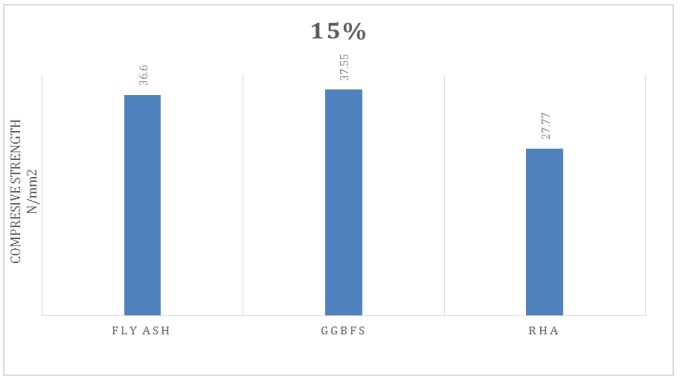

Chart 10: Strength coparison pozzolanas' with 15% replacement

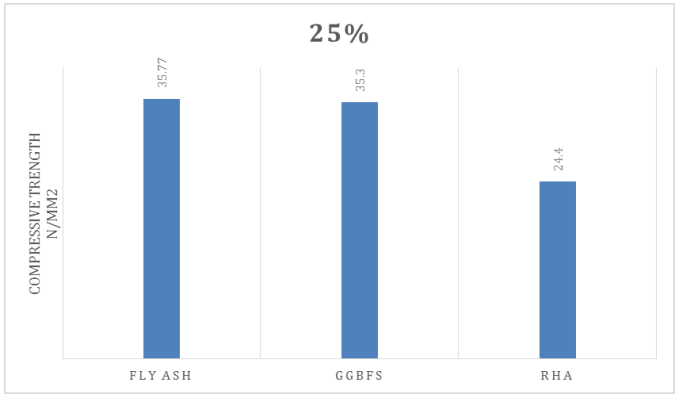

Chart 11: Strength comparison pozzolanas' with 25% replacement

FLEXURAL STRENGTH COMPARISION

In this article, the 28 days strength comparisons of concrete beams of proportion 5%, 15%, 25% of all pozzolonas have been made and the same has been described in the figures below

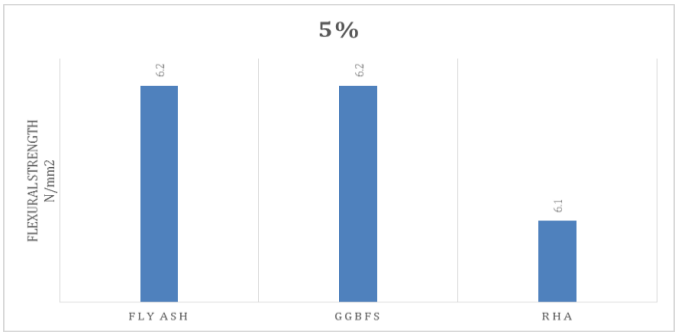

Chart 12: Flexural Strength comparison pozzolanas' with 5% replacement

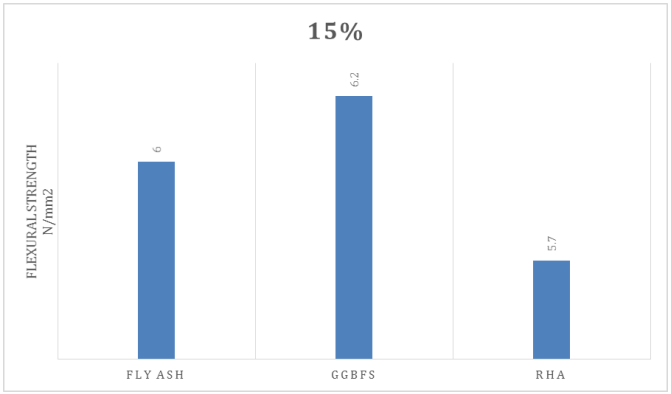

Chart 13: Flexural Strength comparison pozzolanas' with 15% replacement

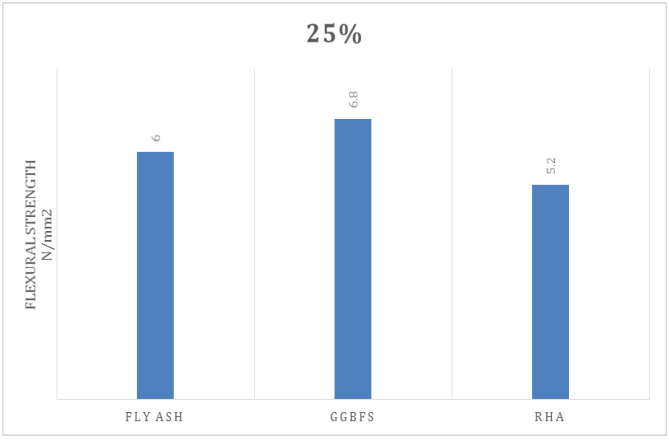

Chart 14: Flexural Strength comparison pozzolanas' with 25% replacement

7. CONCLUSIONS

The experimentation and test results are observed and the following points are the highlighted points

- Adding coconut fiber has not altered workability properties also the addition pozzolona up to 15% did not affect the workability property.
- The compressive strength for CFRC without pozzolona and with different pozzolona has given better values however the strength has decreased remarkably when rice husk ash is used as a pozzolanic material.
- The percentage increase in compressive strength is more for 5% replacement and gradually reduces as the pozzolanic content is increased to 25%
- The percentage increase in compressive strength is 0.77% and 7.6% for 5% replacement of cement by fly ash and GGBFS respectively.'
- Similar increase is observed by an amount of 14.81% for both fly ash and GGBFS.
- With this we can conclude both fly ash, GGBFS has remarkably increased the strength properties.
- However, by seeing the variation of strength in 15% and 25% replacement it can be concluded that GGBFS will give good strength properties. And can be effectively used as a pozzolanic material
- With this work finally, it can be concluded that coir fiber reinforced concrete along with GGBFS, is a good material to attain both compressive and flexural strength.

REFERENCES

[1] A M Neville, "Properties of Concrete", Pearson Education (Singapore) (Pvt). Ltd., Indian branch, New Delhi.

[2] Er.Ravi Bhushan, Sopan Gochhe, Er Harneet singh, Bikram Prasad Bastola, "PARTIAL REPLACEMENT OF CEMENT BY RICE HUSK ASH". International Research Journal of Engineering and Technology, Volume: 4, Issue: 10, Oct-2017, Page no: 251-256.

[3] M.V Mohod, Swapnil Samrit, Piyush Shrikhade, "Use of Fly Ash as Partial Replacement Cement in Concrete Pavements". International Journals of Seventh Sense Research Group, Volume: 10, Dec 2016. Page no: 60-65.

[4] V.Sai Uday, B.Ajitha, "Concrete Reinforced with Concrete Fibers". International Journal of Engineering Science and Computing, Volume: 7, Issue: 4, April-2017, Page no: 10436-10439.

[5] Yogendra O. Patil, Prof. P.N Patil, Dr. Arun Kumar Divedi, "GGBS as Partial Replacement of OPC in Cement Concrete – An Experimental Study". International journal of scientific research, Volume: 2, Issue: 11, November 2013.page no: 189-191.

[6] IS-10262-2009, "RECOMMENDED GUIDELINES FOR CONCRETE MIX DESIGN". Bureau of Indian Standards, New Delhi, India.

[7] IS-383-1970, "SPECIFICATION OF COARSE AGGREGATE AND FINE AGGREGATES FROM NATURAL SOURCE FR CONCRETE". Bureau of Indian Standards, New Delhi, India.

[8] IS-456-2000, "PLAIN AND REINFORCED CODE OF PRACTICE". Bureau of Indian Standards, New Delhi, India.

[9] IS-516-1959, "METHODS OF TESTS FOR STRENGTH OF CONCRETE". Bureau of Indian Standards, New Delhi, India.

[10] IS4031–Part11 (1988), "Methods of Physical Tests for Hydraulic Cement, Part 11: Determination of Density", Bureau of Indian Standards, New Delhi, India.

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