

Experimental Study on Strength Characteristics of M25 Concrete with Partial Replacement of coarse aggregate with coconut shell and cement with Fly Ash

Jyoti Kamal¹, Proff. J.P. Singh²P.G Student , Dept of Civil Engg, B.I.T Sindri, Dhanbad, India¹Associate Professor, Dept of Civil Engg, B.I.T. Sindri, Dhanbad, India²

ABSTRACT :Today, disposal of waste material is a great problem and it becomes difficult to find natural resources due to their excessive exploitation. Use of waste materials as construction materials has numerous benefits such as reduction in cost, saving in energy, and protection of environment. coconut shell is a waste material which can be a substitute for aggregate. So, the main objective of this project is to encourage the use of coconut shell as a construction material and to prepare lightweight concrete by using coconut shell as coarse aggregate. In this project, experimental study has been done on strength characteristics of M25 concrete with replacement of 10%,20% and 30% of coarse aggregate by coconut shell .Also an attempt has been made to examine the suitability of replacing the 20% of fly ash with cement and simultaneously by replacing 10%,20% and 30% of coconut shell as coarse aggregate for concrete of grade M25.The proportion used in this study is 1:1.48:2.99 and water cement ratio is 0.44.Cubes,Cylinders and Beams were casted and their compressive, tensile and flexural strength of concrete and workability was evaluated at 7,14,28 days and also the results were compared for both replacement. The strength of concrete decreased as the percentage of replacement of the conventional material increased.

KEYWORDS: civil engineering; construction materials; compressive strength, coconut shells ,coarse aggregate, concrete, waste, environment; sustainability.

I.INTRODUCTION

Concrete is a manmade composite, consists of ingredients such as aggregate, cement, and water. Today, due to development of infrastructure in both developing and developed countries, the consumption of concrete has been increasing at a higher rate. The cost of construction material is increasing day by day because of high demand and scarcity of raw materials. Increasing demand of concrete causes depletion of aggregate deposits, environmental degradation and ecological imbalance. In view of this challenge, researchers throughout the world have been investigating way of replacing aggregate to make construction sustainable and economical. Various researchers have investigated the use of coconut shell and their derivative in civil engineering construction. Coconut shell is an abundantly available agricultural waste from local coconut industries, so its disposal is a serious problem for local environment. So, these wastes can be used as replacement material in the construction industry. This will reduce cost of construction materials and solve the problem of disposal of wastes. The impact resistance, moisture retaining and water absorbing capacity of coconut shells are more compared to conventional aggregate. Density of coconut shells are within the specified limits for lightweight aggregate, and also the durability properties of coconut shell aggregate are comparable to other conventional lightweight concrete, so lightweight concrete can be prepared by using coconut shell as coarse aggregate. These alternative lightweight materials are adopted for non load bearing walls and non structural floors in building.

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II. LITERATURE REVIEW

Nor Azazi et al. (1999) also studied lightweight concrete using oil palm shell. Even though, the replacement of aggregate by oil palm shell reduced compressive strength of concrete, the strength of 20 N/mm² still can be achievable and meet the provision of BS 8110:1985. From the Reinforced Concrete beam and column tests, it is found that provision of BS 8110:1985 can be safely applied to this lightweight concrete. The creep and shrinkage values of oil palm shell concrete are higher and addition of steel fibre brought the values down considerably.

J.P. RIES (2011) studied that Lightweight aggregate (LWA) plays important role in today's move towards sustainable concrete, Lightweight aggregates contributes to sustainable development by lowering transportation requirements, optimizing structural efficiency that results in a reduction in the amount of overall building material being used, conserving energy, Reducing labor demands and increasing the survive life of structural concrete.

AMARNATH YERRMALLA (2012) et al studied the strength of coconut shells(CS) replacement and different and study the transport properties of concrete with CS as coarse aggregate replacement. They concluded that

- a. Increase in CS percentage decreased densities of the concrete.
- b. With CS percentage increased the 7 days strength gain also increased with corresponding 28 days curing strength.

VISHWAS P. KULKARNI (2013) studied that Aggregates provide volume at low cost, comprising 66 percent to 78 percent of the concrete. Conventional coarse aggregate namely gravel and fine aggregate is sand in concrete will be used as control. While natural material is coconut shell as course aggregate will be investigate to replace the aggregate in concrete.

III. EXPERIMENTAL INVESTIGATIONS

* Materials

The constituent materials used in this project were obtained from local sources and these were Portland pozzolana cement(P.P.C), Fly ash as partial replacement of cement , sand as fine aggregate, crushed granite and coconut shell both as coarse aggregate. Potable water was used for mixing and curing.

Cement: Portland Pozzolana cement with trade name 'LAFARGE DURAGUARD' was used conforming to IS 1489-1991(Part1) and physical property are given below.

S.No.	Physical Property	Test Results
1.	Standard Consistency	34%
2.	Fineness of cement	6%
3.	Initial Setting Time	106 min
4.	Final Setting Time	5 hr 12 min
5.	Specific Gravity	3.055

Fine aggregate: River sand was used as fine aggregate conforming to zone III as per IS 383-1970

S.No.	Physical Property	Test Results
1.	Specific Gravity	2.678
2.	Fineness Modulus	2.289
3.	Bulk Density	1.617gm/cm ³

Coarse Aggregate: Crushed granite was used as coarse aggregate of size 20mm and 10mm both. The results obtained have been mentioned in table.

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S.No.	Physical Property	Test Results
1.	Specific Gravity	2.88
2.	Fineness Modulus	6.9
3.	Bulk Density	1.845gm/cm ³
4.	Water Absorption	0.15%
5.	Impact Value	15.6%

Coconut Shell: coconut shell were collected from temple and its properties were evaluated.

S.No.	Physical Property	Test Results
1.	Specific Gravity	1.56
2.	Water Absorption	23%
3.	Bulk Density	510-600
4.	Aggregate Impact Value	8.55%
5.	Fineness Modulus	6.85

*Mix Proportions

To investigate the properties of CS concrete, first of all control mix that is without CS was made. After that different concrete mixes were prepared by replacing 10%,20% and 30% of coarse aggregate by coconut shells. Furthermore, mix with both coconut shell and fly ash was also employed , in which 10%,20% and 30% of CS were replaced with coarse aggregate and 20% of fly ash was replaced with cement. Constant water cement ratio of 0.44 was maintained for all concretes. The proportion used in this study is 1:1.48:2.99.

*Mixing, compaction, Specimen preparation , and Curing

With the help of electronic weigh balance , batching was done as per the mix proportions. After addition of water, mixing was done for 3-4 minutes in tilting mixer. Cubes are cleaned and oiled and tamping was done after placing the concrete in cubes. The entrapped air in concrete is removed by table vibrator. After 24 hr, demoulding was done and concrete cubes were kept in curing tank for 7,14, and 28 days. Concrete cubes were removed from curing tank to conduct tests on hardened concrete.

IV. RESULTS AND DISCUSSION

The properties of coconut shell aggregate concrete is examined and the use of coconut shell aggregate in construction is tested. In this project, Replacement is done in two ways. One is replacement of 10%,20%,and 30% of coarse aggregate by coconut shells and another is replacement of 20% of fly ash with cement along with 10%,20%.30% of CA by coconut shell. The parameters that will be tested are workability, density, permeability voids, water absorption ,compressive strength, tensile and flexural strength of concrete cubes. A comprehensive summary of properties of normal and CS concretes are presented with the help of Table and Graphs.

4.1. Permeable Voids and Water Absorption of concrete cubes.

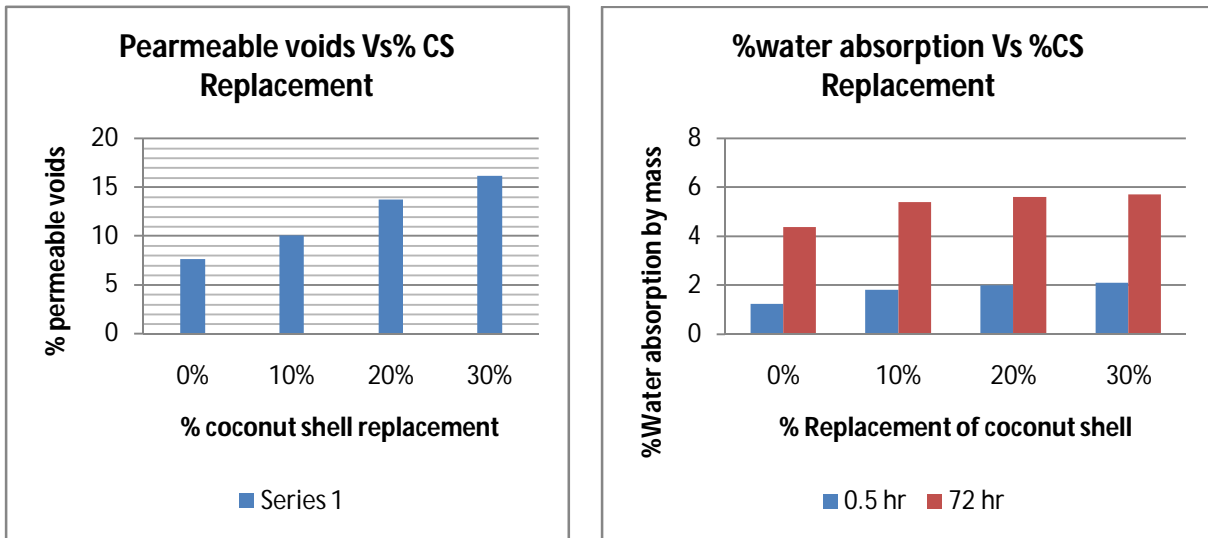
With Increase in CS replacement, permeable voids also increased. With 10% CS replacement the permeable voids were 30 percent higher than control concrete .Similarly, the permeable voids were 88 percent higher than control concrete for20% CS replacement. The absorption characteristics shows that the initial 30 min absorption as well as absorption after 72 hr, increases with increase in percentage Replacement of coconut shell.

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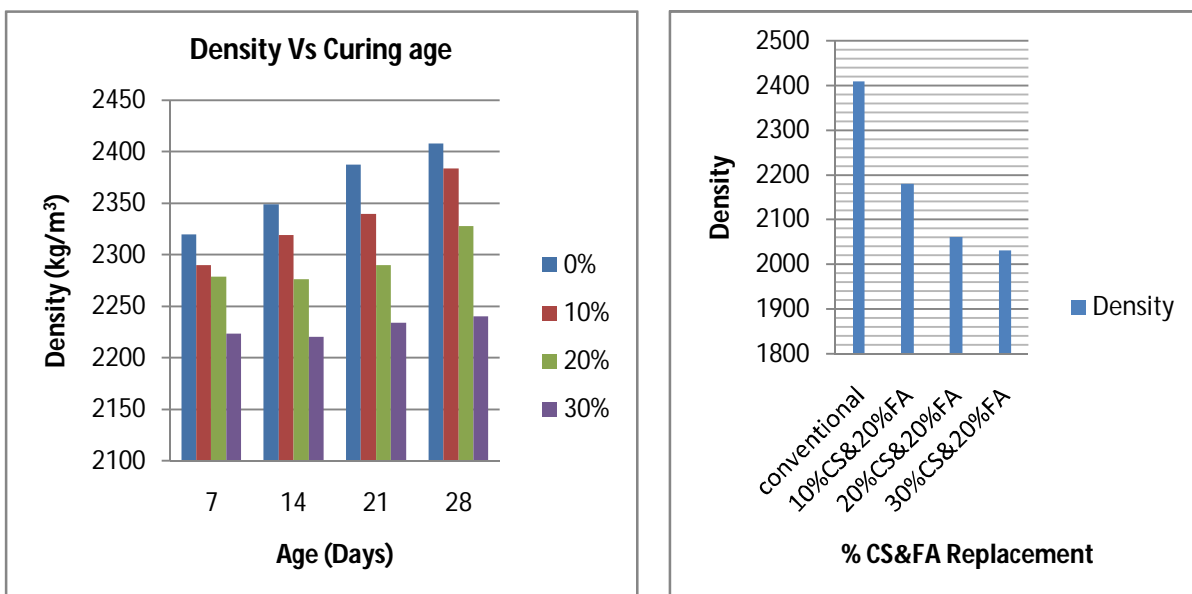
Fig4.1: Variation of Permeable Voids and water absorption with % CS replacement



4.2 . Density of Concrete Cubes

It is seen that the maximum density, 2408 kgm-3 was attained at 0% replacement while the minimum density, 2240 kgm-3 was attained at 30% replacement. It is also seen that the density of concrete reduced as the percentage replacement with coconut shells increased. As the percentage of coconut shells increased, the mass of the mix reduced since coconut shells are lighter than the granite they replaced. So, Lightweight concrete can be prepared by using coconut shell as coarse aggregate.

Fig 4.2: Variation of Density for both replacement (%CS & %CS+20%FA)



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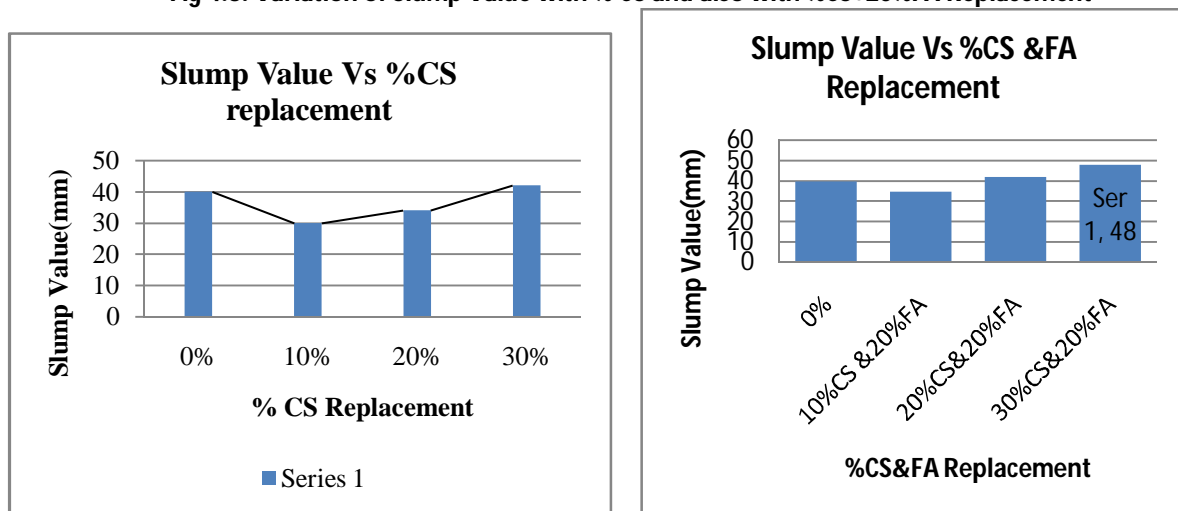
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4.3. Workability of concrete

The slump of the concrete increased when the percentage of coconut shell increases and decrease as comparison with the conventional concrete .The workability was found to be increasing with increase in the replacement percentage of aggregate with coconut shell. coconut shell concrete probably has better workability due to the smooth surface on one side of the shells. Addition of fly ash as cement increases workability in concrete

Fig 4.3: Variation of Slump Value with % CS and also with %CS+20%FA Replacement



4.4.Compressive Strength of concrete cubes

Compressive strength is the major parameter which influences other properties of concrete. Comparison is made between compressive strength of two type of replacement, one is only with CSA and other is with CSA along with 20%FA.



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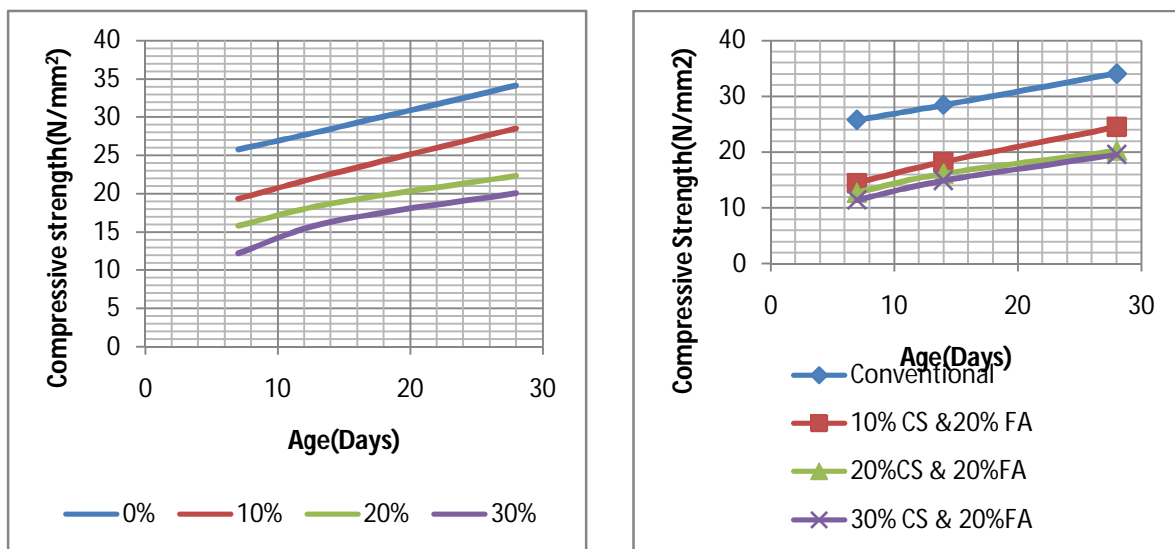
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Table 4.1: compressive strength test Results

Days	CONVENTIONAL	10% CS Replacement	10% CS+20%FA	20% CS Replacement	20%CS+20% FA	30% CS Replacement	30% CS+20%FA
7	25.77	19.29	14.44	15.86	12.72	12.22	11.41
14	28.46	22.55	18.24	18.72	16.12	16.32	14.92
28	34.10	28.53	24.52	22.32	20.24	20.12	19.58

Fig4.4: Variation of compressive strength with age for both %CS & %CS+20%FA replacement.



From the above test results, it is clear that when coarse aggregate is substituted with CSA, the compressive strength is found to be reducing. This may be due to the fact that the failure of NSC (normal strength concrete) is caused by bond failure of bond between CSA and cement mortar. The bond between mortar and CSA is weaker than that of CA. The decrease in strength was found to be high when replacement is done with CSA along with 20%FA.

4.5.Split Tensile Strength of Concrete Cylinders

The split tensile strength was found to be reducing with increase of CSA. The results demonstrated that, irrespective of CS percentage replacement there was good relationship between compressive strength and split tensile strength. Comparison is made between split tensile strength of two type of replacement, one is only with CSA and other is with CSA along with 20%FA.

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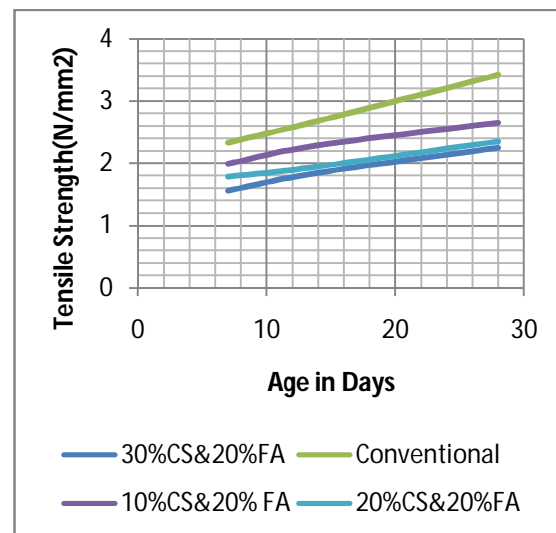
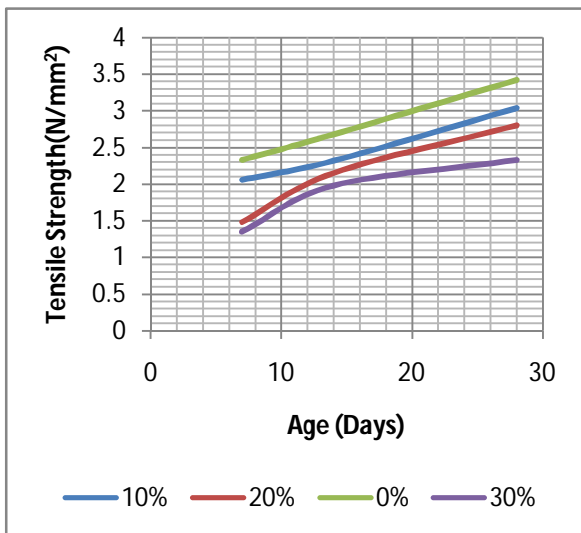
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Table 4.2: Tensile Strength Test Results

Days	conventional	10%CS	10%CS &20%FA	20% CS	20%CS& 20%FA	30% CS	30%CS&20%FA
7	2.33	2.066	1.99	1.48	1.79	1.35	1.56
14	2.68	2.32	2.29	2.15	1.95	1.98	1.85
28	3.42	3.04	2.65	2.80	2.35	2.33	2.25

Fig4.5: Variation of Tensile Strength with Age for both %CS & %CS+20%FA replacement.



4.6. Flexural Strength of Concrete Beams

The determination of Flexural Strength is essential to estimate the load at which the concrete member may crack

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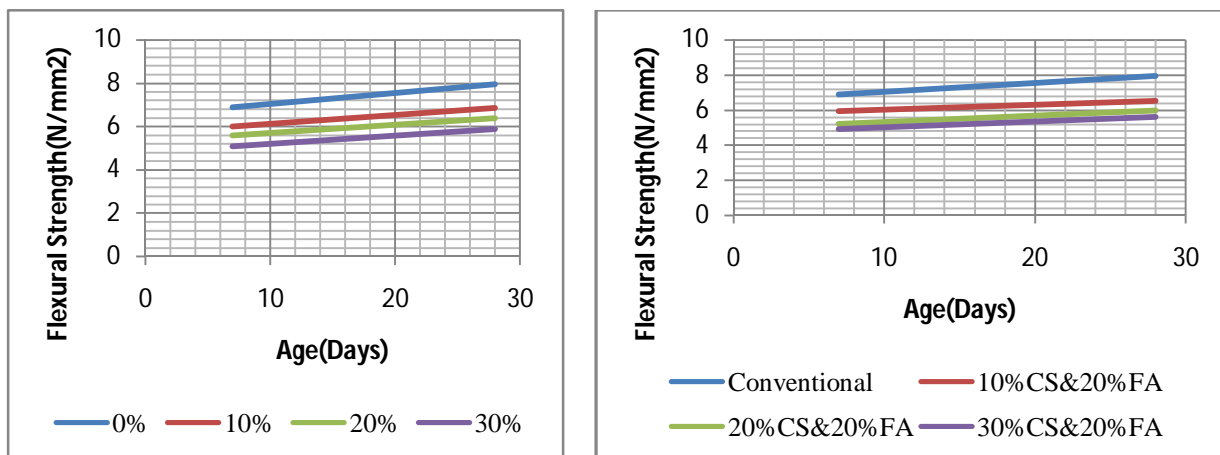


Table 4.3: Flexural Strength Test Results

Days	Conventional	10%CS	10%CS&20%FA	20%CS	20%CS&20%FA	30%CS	30%CS&20%FA
7	6.9	6	5.94	5.6	5.2	5.1	4.92
28	7.92	6.85	6.54	6.4	5.98	5.9	5.62

Flexural strengths of concrete specimens with CA only, with 10% CSA, 20%CSA, and with 30% CSA were found to be 7.95 MPa, 6.85 MPa, 6.4 MPa, and 5.9 MPa respectively. Whereas Flexural strengths of concrete specimens with 10% CSA+20%FA, 20%CSA+20%FA, and with 30% CSA+20%FA were found to be 6.54 MPa, 5.98 MPa, and 5.62 MPa respectively. Flexural strength is equal to $0.7\sqrt{f_{ck}}$ where f_{ck} is the characteristic compressive strength of conventional concrete. So, similar to compressive strength, flexural strength also decreases with increase in CS replacement. Comparison is made between split tensile strength of two type of replacement, one is only with CSA and other is with CSA along with 20%FA, with the help of graph.

Fig 4.6: Variation of Flexural Strength with age for both %CS & %CS+20%FA replacement.



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V. CONCLUSIONS AND RECOMMENDATION

It is concluded that

- a) Increase in percentage Replacement of coconut shell reduces compressive, tensile and Flexural Strength of concrete.
- b) Increase in percentage of coconut shell, decreases densities of concrete.
- c) Increase in percentage replacement by coconut shell increases workability of concrete.
- d) Lightweight concrete can be prepared by using coconut shell as coarse aggregate.
- e) When the various Percentage of coconut shell as 10%,20%,30% is replaced in concrete with coarse aggregate ,the compressive strength, split tensile strength, and flexural strength are more as compared to concrete replaced by coconut shell as 10%,20%,30% along with cement replaced by 20% fly ash.
- f) Permeable voids and water absorption increases with increase in CS replacement.

* The following recommendation are made at the end of the study

- CSAC may be beneficial for use in earthquake prone areas, since it is lightweight and has shown good ductility.
- The effect of temperature on the concrete developed can be studied.
- Durability studies on coconut shell concrete should be carried out to assess its behaviour in aggressive environments
- Effect of different admixtures can be studied on coconut shell concrete

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