Scientific Journal of Impact Factor (SJIF): 5.71

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 5, Issue 03, March -2018

A STUDY ON STRENGTH OF CONCRETE BY PARTIALLY REPLACEMENT OF CEMENT BY COCONUT ENDOCARP ASH

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Abstract —*Conservation of natural resources and prevention of environment is the essence of any development of the problem arising from continuous technological and industrial development is the disposal of waste materials. If some of the waste materials are found suitable in concrete making, the cost of construction can be cut down, but also safe disposal of waste materials can be achieved. So an attempt has been made to access the suitability of different replacement materials in the concrete making. The project implemented to coconut endocarp. Using Engineering properties of OPC cement and also the design mix (1:1.25:2.93) of concrete is M_{20} grade of concrete. The 7^{th} and 28^{th} day compressive strength, Split tensile strength and flexural strength of conventional concrete and coconut shell ash (CSA) concrete with replacement of 5% to 25%. Finally the results are tabulated and comparisons are plotted using graphs.*

Keywords-*coconut endocarp; opc cement; compressive strength ; split tensile strength; flexural strength; coconut shell ash*

I. INTRODUCTION

Agricultural waste material, in this case, coconut shells, which is an most available, are collected and burnt in the open air to make it as ash(CSA), which in turn was used to partial replacement of cement in concrete structure. Concrete cubes, cylinder and flexural beams were casting, using various replacement levels of 5, 10, 15, 20 & 25% of OPC with CSA. A total of 6 cubes were casting in each percentage. Check and compare their strength on 7 & 28 days respectively.

II. OBJECT OF THE PROJECT

The object of this research is to study the STRUCTURAL BEHAVIOR, analyze the COMPRESSIVE STRENGTH, SPLIT TENSILE STRENGTH & FLEXURAL of coconut endocarp ash added concrete and utilization of waste material (coconut endocarp) in efficient manner.

- To find a non-conventional concrete system and it should easily available, accessible, strength enough and also cheap in cost when compare to the conventional concrete.
- Understand the various advantages and applications involving partial replacement of cement.
- Compare the performance of conventional concrete and cubes, cylinders and beams which are partial replacement of ash 5%, 10%, 15%, 20% and 25%.

III. METHODOLOGY

- Collecting of Coconut Endocarp
- Burning of Coconut Endocarp
- Collecting Initial Stage Ash After Burning
- Sieving of Initial Stage In 90 Micron
- Final Stage Ash To Replace In Concrete
- Mixing of Cement, CSA Ash & Sand
- Mixing of Concrete
- Casting of Cubes, Cylinders & Beams
- Curing of Cubes, Cylinders & Beams
- Testing of Cubes, Cylinders & Beams

IV. MECHANICAL PROPERTIES OF CSA ADDED CONCRETE

4.1. Compressive Strength

Compression test according to IS: 516 (1959) is carried out on the 150 x 150 x 150 mm cubes. For the evaluation of compressive strength, all the cube specimens are subjected to compressive load in a compression testing machine.

The compressive strength of the specimen is calculated using following equation,

$$f_c = P/A$$

Where,

f_c = compressive strength (N/mm^2)
P = maximum load applied to the specimen (N)
A = cross-sectional area of the specimen. (150mm X 150mm)

Figure 1. Testing of cube

4.2. Split Tensile Strength

Split tensile strength is evaluated as per the test procedure given in Indian Standards IS-5816. In order to evaluate the splitting tensile strength of CSA concrete, all the cylinder specimens are subjected to split tensile strength test in a 2000 KN digital compression testing machine. Specimens are placed in the machine in a horizontal manner in between the two parallel steel strips one at top and another at the bottom such that the load shall be applied along the 300 mm length. The load is applied without shock and increased continuously at a nominal rate within the range of 1.2 $N/(mm^2/min)$ to 2.4 $N/(mm^2/min)$ until the specimen failed. The maximum load applied to the specimen is recorded and the split tensile strength of the specimen is calculated using the following equation,

$$f_t = 2P/\pi DL$$

Where,

f_t = split tensile strength (N/mm^2)
P = maximum load applied to the specimen (N)
D = diameter of the specimen (mm)
L = length of the specimen (mm)

Figure 2. Testing of cylinder

4.3. Flexural Strength

Flexural strength is determined using Universal testing machine. The load is applied without shock and increased continuously at a rate of 1800 N/min until the specimen failed. The maximum load applied to the specimen is recorded and the flexural strength of the specimen is calculated using the following equation,

If **a>40cm**, then

Modulus of rupture $f_r = PL/bd^2$

If **a<40cm**, then

Modulus of rupture $f_r = 3Pa/bd^2$

Where,

f_r = Flexural strength (N/mm^2)

P = maximum load applied to the specimen (N)
L = supported length of the specimen (mm)
B = width of the specimen (mm)
D = depth of the specimen (mm)

Figure 3. Testing of beam

V. RESULTS AND DISCUSSIONS

5.1 Compressive strength

Table 1.Conventional concrete 7 & 28 day results

SL No	Description	7 day compressive strength (N/mm^2)	28 day compressive strength (N/mm^2)
1	Specimen – 1	25.77	34.22
2	Specimen – 2	23.11	30.88
3	Specimen – 3	21.33	30.44

Average of Conventional concrete cube 7 days result is 23.40 N/mm^2 and average of Conventional concrete cube 28 days result is 31.84 N/mm^2..

Table 2. 5% CSA added concrete 7& 28 day results

SL No	Description	7 day compressive strength (N/mm^2)	28 day compressive strength (N/mm^2)
1	Specimen – 1	22.26	34.26
2	Specimen – 2	23.42	34.62
3	Specimen – 3	21.73	34.31

Average of 5% CSA added concrete cube 7 days result is 22.47 N/mm^2 and average of 5% CSA added concrete cube 28 days result is 34.39 N/mm^2

Table 3. 10% CSA added concrete 7 & 28 day results

SL No	Description	7 day compressive strength (N/mm^2)	28 day compressive strength (N/mm^2)
1	Specimen – 1	22.20	32.88
2	Specimen – 2	20.20	34.66
3	Specimen – 3	21.11	33.55

Average of 10% CSA added concrete cube 7 days result is 21.17 N/mm^2 and average of 10% CSA added concrete cube 28 days result is 33.69 N/mm^2.

Table 4. 15% CSA added concrete 7& 28 day results

SL No	Description	7 day compressive strength (N/mm^2)	28 day compressive strength (N/mm^2)
1	Specimen – 1	16.00	24.00
2	Specimen – 2	19.77	23.11
3	Specimen – 3	18.22	22.00

Average of 15% CSA added concrete cube 7 days result is17.99 N/mm^2 and average of 15% CSA added concrete cube 28 days result is 23.03 N/mm^2.

Table 5. 20% CSA added concrete 7& 28 day results

SL No	Description	7 day compressive strength (N/mm^2)	28 day compressive strength (N/mm^2)
1	Specimen – 1	16.88	22.00
2	Specimen – 2	15.56	21.80
3	Specimen – 3	16.22	22.20

Average of 20% CSA added concrete cube 7 days result is 16.22 N/mm^2 and average of 20% CSA added concrete cube 28 days result is 22.00 N/mm^2.

Table 6. 25% CSA added concrete 7& 28 day results

SL No	Description	7 day compressive strength (N/mm^2)	28 day compressive strength (N/mm^2)
1	Specimen – 1	13.80	21.30
2	Specimen – 2	14.20	20.40
3	Specimen – 3	14.00	21.10

Average of 25% CSA added concrete cube 7 days result is 14.00 N/mm^2 and average of 25% CSA added concrete cube 28 days result is 20.90 N/mm^2.

5.2. Split tensile strength

Table 7. Conventional Concrete 7& 28 day results

SL No	Description	7 day split tensile strength (N/mm^2)	28 day split tensile strength (N/mm^2)
1	Specimen – 1	3.96	4.57
2	Specimen – 2	3.75	4.33
3	Specimen – 3	3.59	4.30

Average of Conventional concrete 7 days result is 3.77 N/mm^2 and average of Conventional concrete 28 days result is 4.40 N/mm^2.

Table 8. 5% CSA added Concrete 7& 28 day results

SL No	Description	7 day split tensile strength (N/mm^2)	28 day split tensile strength (N/mm^2)
1	Specimen – 1	3.68	4.57
2	Specimen – 2	3.78	4.58
3	Specimen – 3	3.64	4.57

Average of 5% CSA added concrete 7 days result is 3.53 N/mm^2 and average of 5% CSA added concrete 28 days result is 4.57 N/mm^2.

Table 9. 10% CSA added Concrete 7& 28 day results

SL No	Description	7 day split tensile strength (N/mm^2)	28 day split tensile strength (N/mm^2)
1	Specimen – 1	3.68	4.47
2	Specimen – 2	3.51	4.58
3	Specimen – 3	3.58	4.53

Average of 10% CSA added concrete 7 days result is 3.59 N/mm^2 and average of 10% CSA added concrete 28 days result is 4.53 N/mm^2

Table 10. 15% CSA added Concrete 7& 28 day results

SL No	Description	7 day split tensile strength (N/mm^2)	28 day split tensile strength (N/mm^2)
1	Specimen – 1	3.13	3.82
2	Specimen – 2	3.47	3.72
3	Specimen – 3	3.34	3.66

Average of 15% CSA added concrete 7 days result is 3.31 N/mm^2 and average of 15% CSA added concrete cylinder 28 days result is 3.74 N/mm^2

Table 11. 20% CSA added Concrete 7& 28 day results

SL No	Description	7 day split tensile strength (N/mm^2)	28 day split tensile strength (N/mm^2)
1	Specimen – 1	3.20	3.66
2	Specimen – 2	3.08	3.64
3	Specimen – 3	3.14	3.68

Average of 20% CSA added concrete 7 days result is 3.14 N/mm^2 and average of 20% CSA added concrete 28 days result is 3.66 N/mm^2.

Table 12. 25% CSA added Concrete 7& 28 day results

SL No	Description	7 day split tensile strength (N/mm^2)	28 day split tensile strength (N/mm^2)
1	Specimen – 1	2.31	3.61
2	Specimen – 2	2.94	3.52
3	Specimen – 3	2.90	3.58

Average of 25% CSA added concrete 7 days result is 2.72 N/mm^2 and average of 25% CSA added concrete 28 days result is 3.57 N/mm^2**.**

5.3. Flexural Strength

Table 13. Conventional Concrete 7& 28 day results

SL No	Description	7 day Flexural strength (N/mm^2)	28 day Flexural strength (N/mm^2)
1	Specimen – 1	4.37	5.03
2	Specimen – 2	4.13	5.08
3	Specimen – 3	3.97	4.74

Average of Conventional concrete 7 days result is 4.16 N/mm^2 and average of Conventional concrete 28 days result is 4.95 N/mm^2.

Table 14. 5% CSA added Concrete 7& 28 day results

SL No	Description	7 day Flexural strength (N/mm^2)	28 day Flexural strength (N/mm^2)
1	Specimen – 1	4.06	5.03
2	Specimen – 2	4.16	5.06
3	Specimen – 3	4.01	5.04

Average of 5% CSA added concrete 7 days result is 4.08 N/mm^2 and average of 5% CSA added concrete 28 days result is 5.04 N/mm^2

Table 15. 10% CSA added Concrete 7& 28 day results

SL No	Description	7 day Flexural strength (N/mm^2)	28 day Flexural strength (N/mm^2)
1	Specimen – 1	4.05	4.93
2	Specimen – 2	3.87	5.06
3	Specimen – 3	3.95	4.98

Average of 10% CSA added concrete 7 days result is 3.96 N/mm^2 and average of 10% CSA added concrete 28 days result is 4.99 N/mm^2.

Table 16. 15% CSA added Concrete 7& 28 day results

SL No	Description	7 day Flexural strength (N/mm^2)	28 day Flexural strength (N/mm^2)
1	Specimen – 1	3.44	4.21
2	Specimen – 2	3.82	4.13
3	Specimen – 3	3.67	4.03

Average of 15% CSA added concrete 7 days result is 3.64 N/mm^2 and average of 15% CSA added concrete 28 days result is 4.12 N/mm^2.

Table 17. 20% CSA added Concrete 7& 28 day results

SL No	Description	7 day Flexural strength (N/mm^2)	28 day Flexural strength (N/mm^2)
1	Specimen – 1	3.53	4.03
2	Specimen – 2	3.39	4.02
3	Specimen – 3	3.46	4.05

Average of 20% CSA added concrete 7 days result is 3.46 N/mm^2 and average of 20% CSA added concrete 28 days result is 4.03 N/mm^2.

Table 18. 25% CSA added Concrete 7& 28 day results

SL No	Description	7 day Flexural strength (N/mm^2)	28 day Flexural strength (N/mm^2)
1	Specimen – 1	3.19	3.97
2	Specimen – 2	3.24	3.88
3	Specimen – 3	3.22	3.95

Average of 25% CSA added concrete 7 days result is 3.22 N/mm^2 and average of 25% CSA added concrete 28 days result is 3.93 N/mm^2.

VI. GRAPHICAL COMPARISION BETWEEN CONVENTIONAL AND CSA CONCRETE

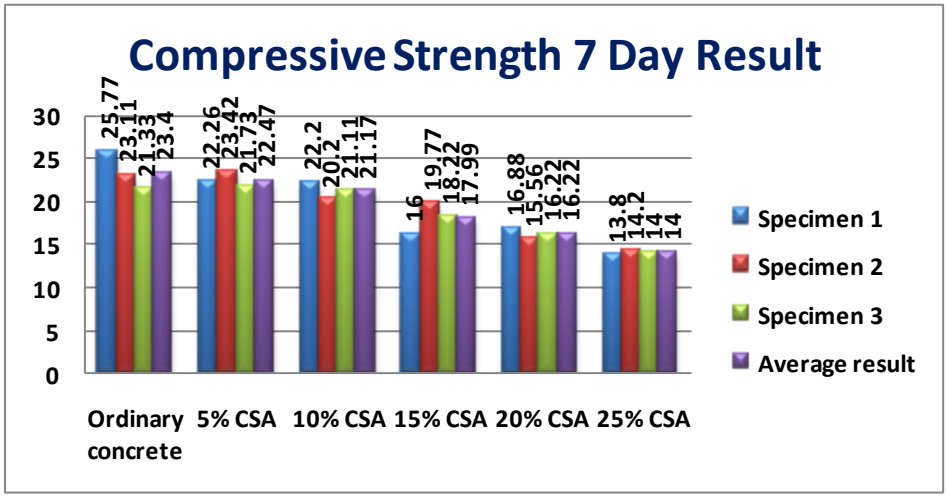

Figure 4. Compressive strength 7 day result

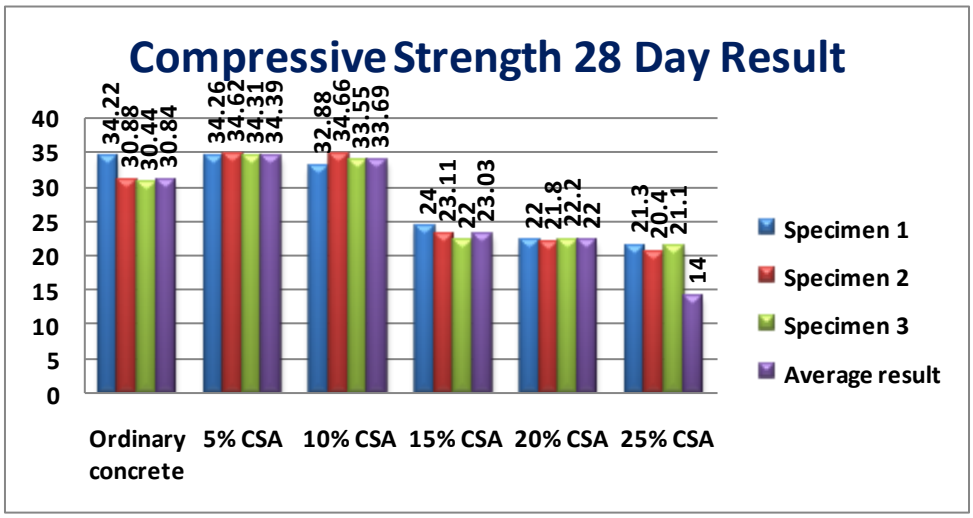

Figure 5. Compressive strength 28 day result

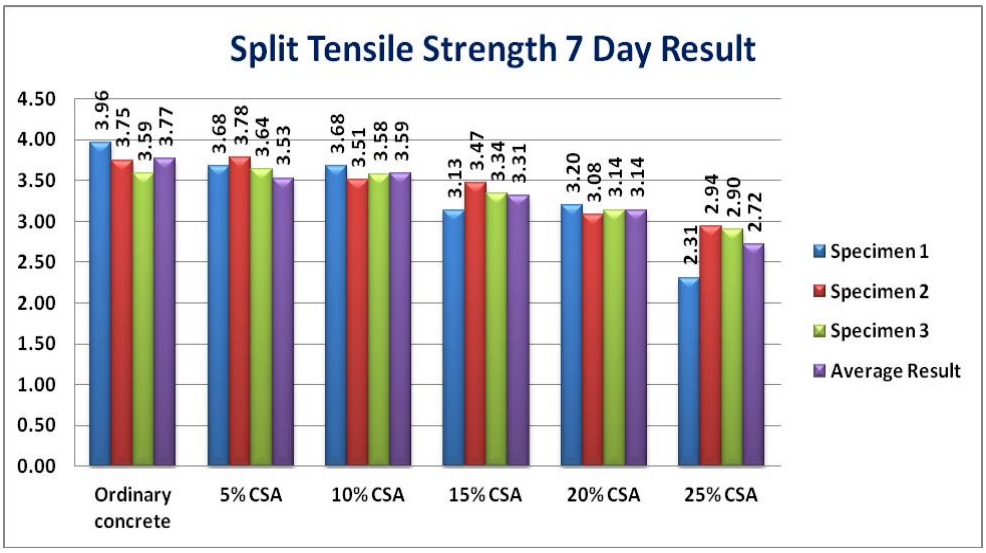

Figure 6. Split tensile strength 7 day result

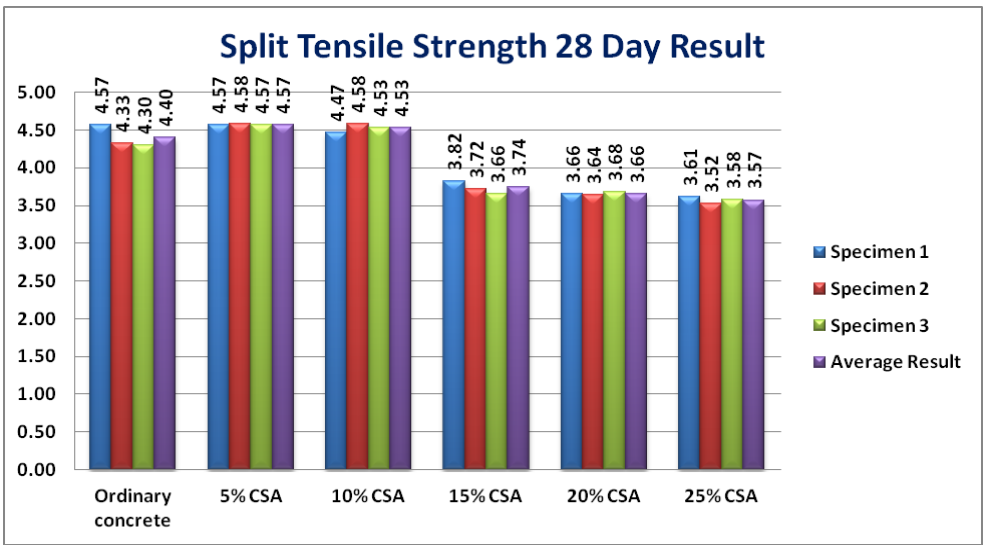

Figure 7. Split tensile strength 28 day result

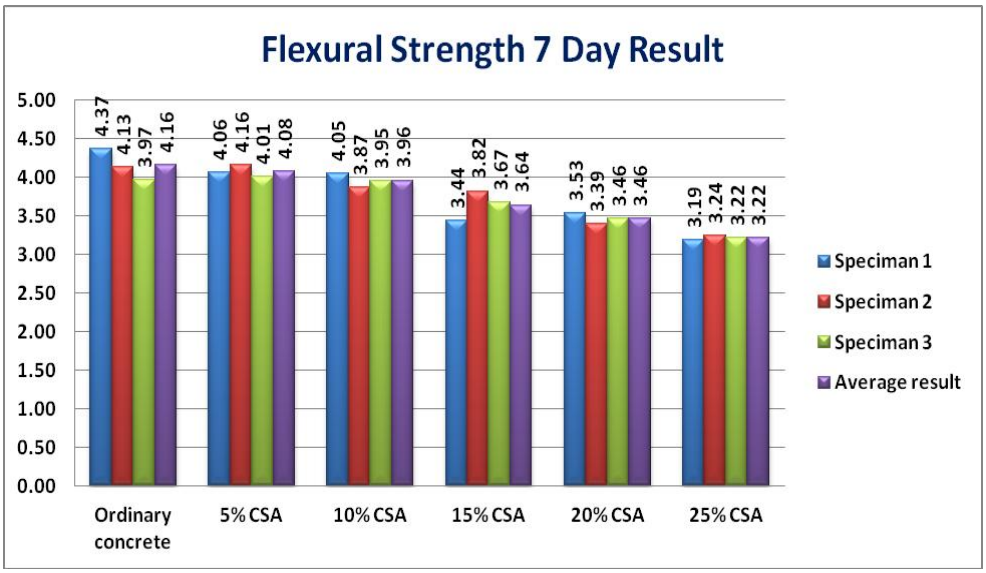

Figure 8. Flexural strength 7 day result

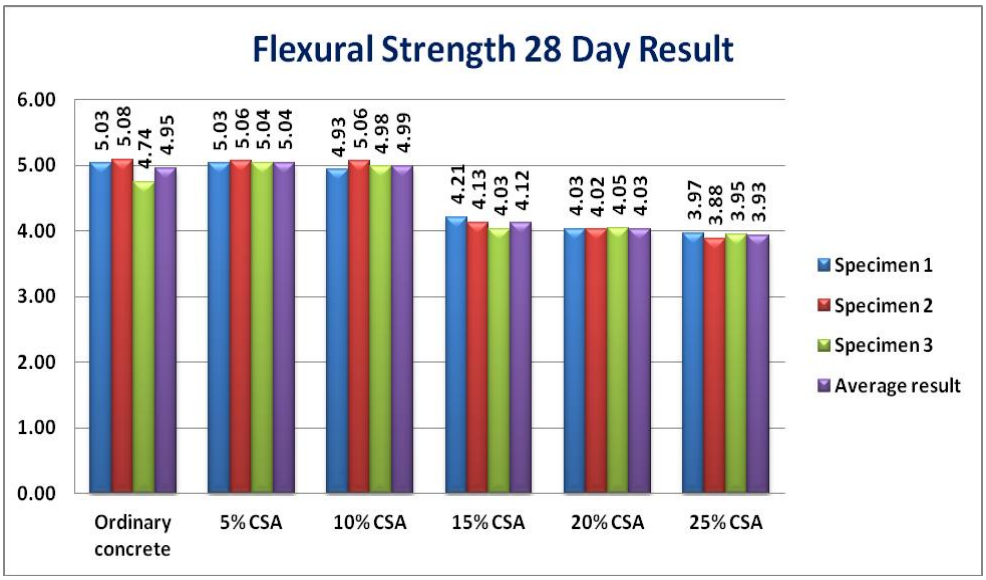

Figure 9. Flexural strength 28 day result

VII. CONCLUSION

From the above results, CSA/OPC mix concrete met some promise for use in reinforce concrete as well as mass concrete structures in building construction. The compressive strength of the cubes at 28 days curing indicates that 10% and 15% replacement levels meet the requirement of IS 456: 2000, Clause 6.1, 9.2.2, 15.1.1, 36.1 and Table 2 for heavy weight concreting and light weight concreting. The Split tensile strength of the cylinders at 28-day curing indicates that 10% and 15% replacement levels meet the requirement of IS 5816: 1999. The Flexural strength of the beams at 28-day curing indicates that 10% and 15% replacement levels meet the requirement of IS 516:1959. In conclusion, the study reveals that 10 to 15% partial replacement of OPC with CSA using W/C ratio of 0.5 are suitable for the production of both heavy weight and light weight concrete. Further areas of research are recommended.

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