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STUDY ON IMPACT AND TENSILE PROPERTIES OF CONCRETE WITH COCONUT SHELL AS COARSE AGGREGATE

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ABSTRACT

The mechanical properties of coconut shell aggregate concrete (CSAC) namely splitting tensile strength, impact strength have been determined and a comparison is made with conventional granite aggregate concrete (CGAC) in the 30 days short-term experimental investigation. From the test results it is observed that coconut shell aggregate concrete has considerably sufficient strength. But the splitting tensile strength of coconut shell aggregate concrete is 50 % less than that of conventional granite aggregate concrete. The coconut shell aggregate concrete results are lies within the limits of structural lightweight concrete. Hence it is considered as structural light weight aggregate concrete. The impact strength result of coconut shell aggregate concrete CSAC is less than the conventional granite aggregate concrete CGAC.

KEYWORDS: Agricultural waste, Coconut shell, Coconut shell aggregate (CSA), Coconut shell aggregate concrete (CSAC), Conventional granite aggregate (CGA), Conventional granite aggregate concrete (CGAC).

INTRODUCTION

The use of agricultural wastes in development of rural areas by construction of low cost housing delivery will make the green and slum cleared country. In India where abundant agricultural wastes are discharged as waste can be used as potential construction material or replacement material in construction industry. The coconut shell is one of the agricultural wastes can be used as coarse aggregate in concrete. Works were carried out using coconut shell as coarse aggregate in concrete making. Annual production of coconut shell as waste materials from coconut industry in India especially in Tamilnadu and Kerala is approximately 2 to 3 million tones. This coconut shell also can be used as coarse aggregate in the production of concrete with lightweight. This coconut shell aggregate concrete has sufficient strengths like structural lightweight concrete. It also has sufficient workability without any admixtures in the matrix part in plastic stage. Using coconut shell as aggregate in concrete making, the gross amount (total cost) of concrete will reduce drastically from the total cost of construction in the estimation. In this experimental investigation the engineering properties of coconut shell aggregate concrete has been studied. The properties of CSAC has compared with control concrete that is CGAC.

MATERIALS AND PROPERTIES

Ordinary Portland cement OPC 53 Grade conforming to Indian Standard IS 12269:1987 was used as a binder. River sand was used as fine aggregate conforming to grading zone III as per IS 383:1970. Crushed granite aggregate (CGA) - 10 mm sizes were used for Conventional Concrete. Coconut Shell Aggregate Concrete (CSAC) is produced using Coconut Shell Aggregate (CSA). It have maximum thickness in range of (2-8) mm, they were crushed using Ball Mill equipment which is available at mechanical engineering, research engine laboratory in Annamalai University. The required crushed sizes are in the range of (4.75 – 10) mm. The sieve analysis was conducted and the Particle size distribution of CS is determined. Potable tap water from Concrete Laboratory of Structural engineering Department at Annamalai University was used in the study for mixing and

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curing. The coconut shells and coconut shell aggregates were shown in the fig 1 and 2. The test results of aggregates are shown in Table 1.

Fig -1: Discarded Coconut shell

Fig -2: Discarded Coconut shell Aggregates

Table -1: Mechanical properties of aggregates.

Sl.No	Mechanical properties		CSA	CGA
1	Maximum size (mm)		10	10
2	Shell thickness (mm)		2 to 8	-
3	Specific gravity		1.7	2.68
4	Impact value (%)		7	12.4
5	Crushing value (%)		2	6.3
6	Abrasion value (%)		0.4	1.85
7	Attrition value (%)		0.67	4.3
8	Bulk density (kg/m^3)	Compacted	640	1650
		Loose	530	1450
9	Fineness modulus		6.3	6.94

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10	Moisture content (%)	4	-
11	Water absorption (%)	22	0.5

MIX DESIGN

Mix design is the process of selecting an optimum proportion of cement, fine and coarse aggregates and water to produce a concrete with specified properties of workability, strength, and durability. The best mix involves a balance between economy and the required properties of concrete. Based on the properties of the available materials, the mix proportions of the CS concrete were approximated using absolute volume method. Hence, the mix design for the CSAC in this study was based on performances of trial mixes and the measure of the selected mix was so adjusted to get the most favorable mix proportion. In this thesis work slump cone method is selected for the workability measurement of conventional granite aggregate concrete and coconut shell aggregate concrete. The measured slump values are 23 mm and 40 mm for mix 1 and 2 respectively. The mix proportion results are shown in Table 2.

Table – 2: Mix proportion results

Mass in (kg/m^3)		**$\frac{w}{c}$**	**Mass in (kg/m^3)**		**Mix ratios**		
C	**W**		**FA**	**CA**	**C**	**FA**	**CA**
450	180	0.40	711.74	1083.62	1	1.6	2.4
400	180	0.45	728.78	1083.62	1	1.8	2.7

MECHANICAL PROPERTIES

4.1. Impact Strength Test

The test specimens used for the impact tests were 150 mm in diameter and 50 mm thick. The method developed by ACI committee 544.1R-82 for the determination of impact resistance of concrete was adopted. During this test, the number of blows was counted till the first crack appeared (initial crack) on each specimen and counting was continued till the specimen was broken into a number of pieces.

The impact resistance generally increased with concrete strength both for initial crack and for failure. However, in conventional concrete there appears to be an optimum value beyond which any increase in strength reduces the impact resistance in both at first crack and at failure. Increase in impact resistance of coconut shell aggregate concrete may be due to the fibrous nature of the coconut shell aggregate and its high impact resistance. Impact Resistant Test Setup shown in Fig. 3 and the test result are in Table 3.

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Fig.3: Impact Resistant Test Setup

Table. 3: Impact Resistant Test Results

Mix.No	Type of Concrete	Number of blows for initial crack		Number of blows for complete fracture	
		blows	Average	blows	Average
1	CSAC	7	8	12	13
		8		13	
		9		14	
	CGAC	12	13.33	17	18
		13		18	
		15		19	
2	CSAC	8	6.67	9	10.33
		6		10	
		6		12	
	CGAC	14	13.67	16	17.67
		15		18	
		12		19	

4.2 Tensile Strength Test

Cube of 100 mm size were used for tensile strength test. The tensile strength was conducted in the machine on which the compressive strength test was performed. The specimens were tested for 28 days and the test results were tabulated with the failure pattern of cube shown in Fig 4 and the test results are in Table 4.

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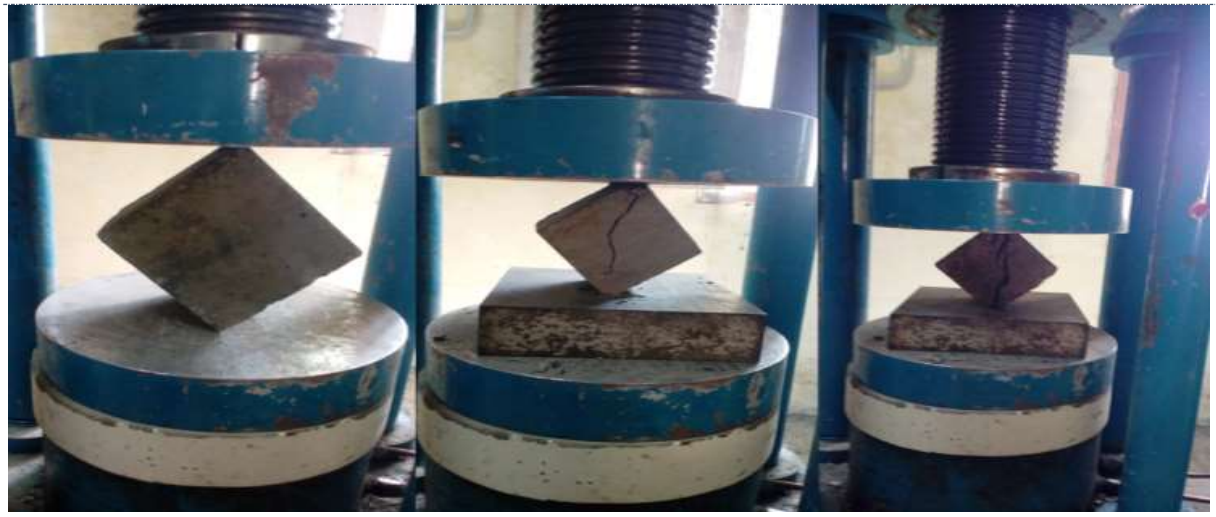

Fig.4: Tensile Strength Test Setup

Table. 4: Tensile Strength Test Results

Mix No	Type of Concrete	Load (kN)	Tensile strength (N/mm^2)	Average Tensile strength (N/mm^2)
1	CSAC	26	2.6	2.86
		28	2.8	
		32	3.2	
	CGAC	30	3	3.96
		42	4.2	
		47	4.7	
2	CSAC	23	2.3	2.56
		26	2.6	
		28	2.8	
	CGAC	33	3.3	3.56
		35	3.5	
		39	3.9	

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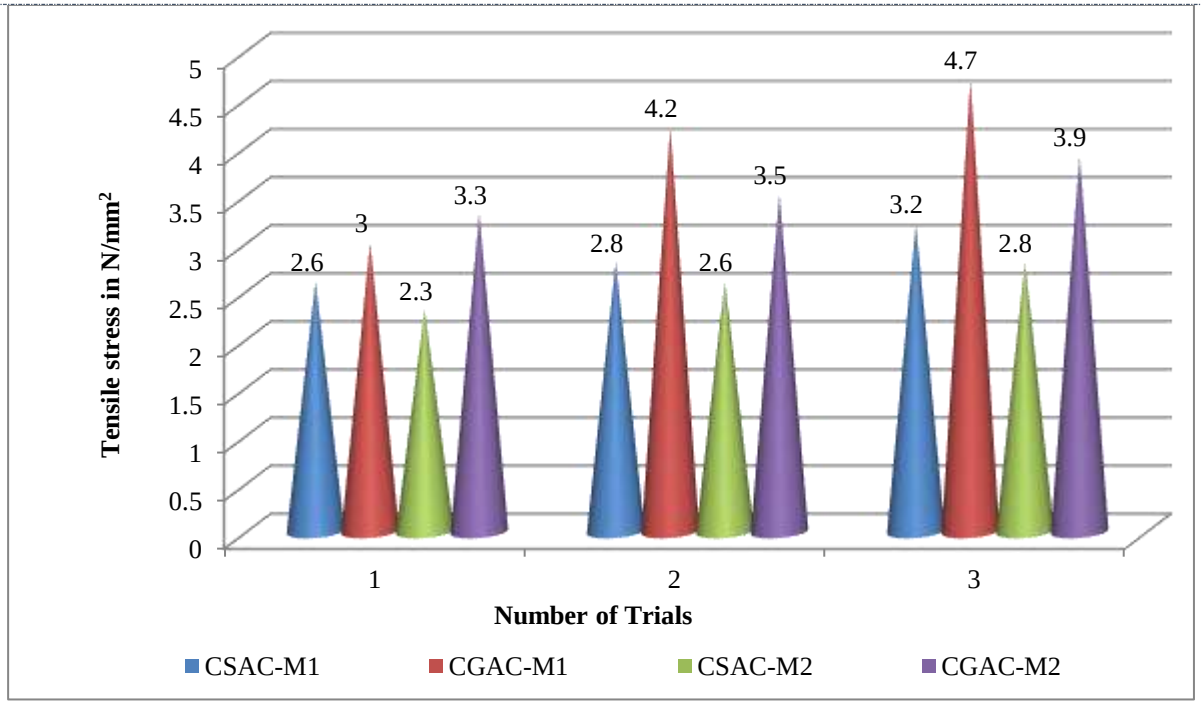

Fig.5: Tensile Stress Relations between CSAC and CGAC

Table. 5: Concrete Cube Density Test Results

Mix No	Type of Concrete	Mass of Cube (kg)	Density (kg/m^3)	Average Density (kg/m^3)
1	CSAC	1.655	1655	1758
		1.787	1787	
		1.832	1832	
	CGAC	2.458	2458	2544
		2.563	2563	
		2.612	2612	
2	CSAC	1.586	1586	1678
		1.779	1779	
		1.670	1670	
	CGAC	2.548	2548	2325
		2.243	2243	
		2.185	2185	

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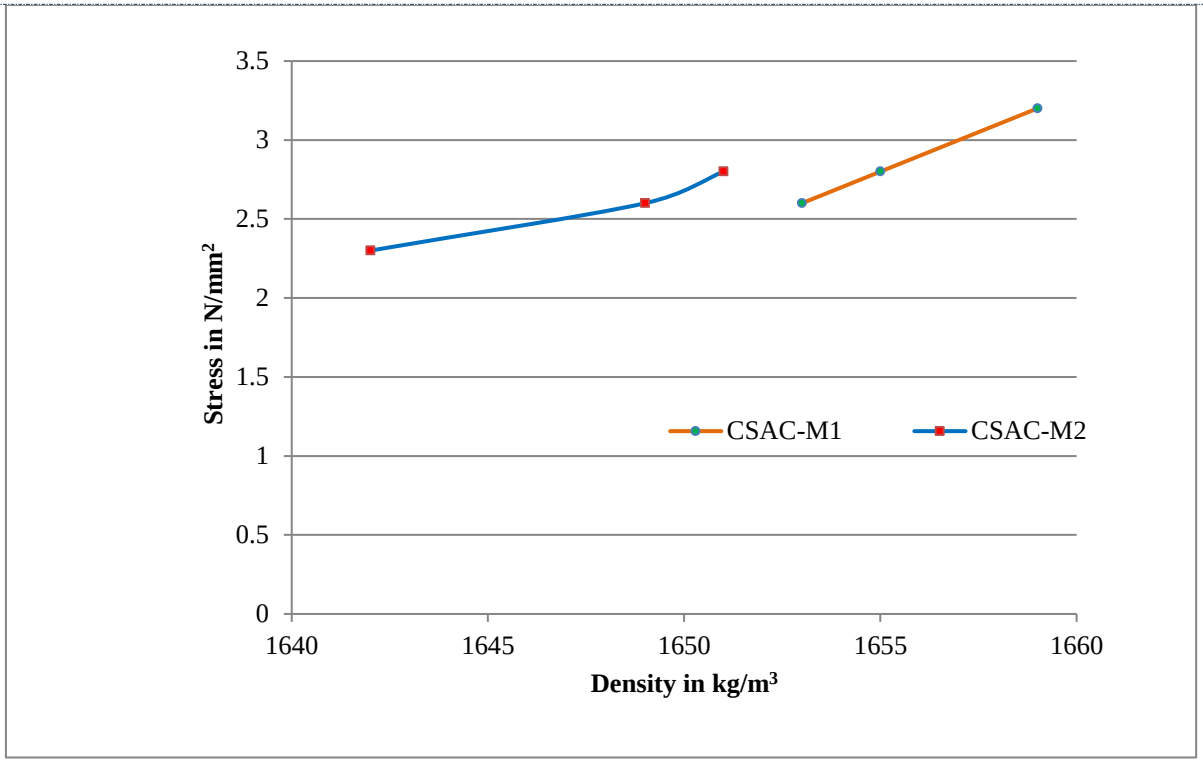

Fig.6: Relation between Tensile stress and Density of CSAC

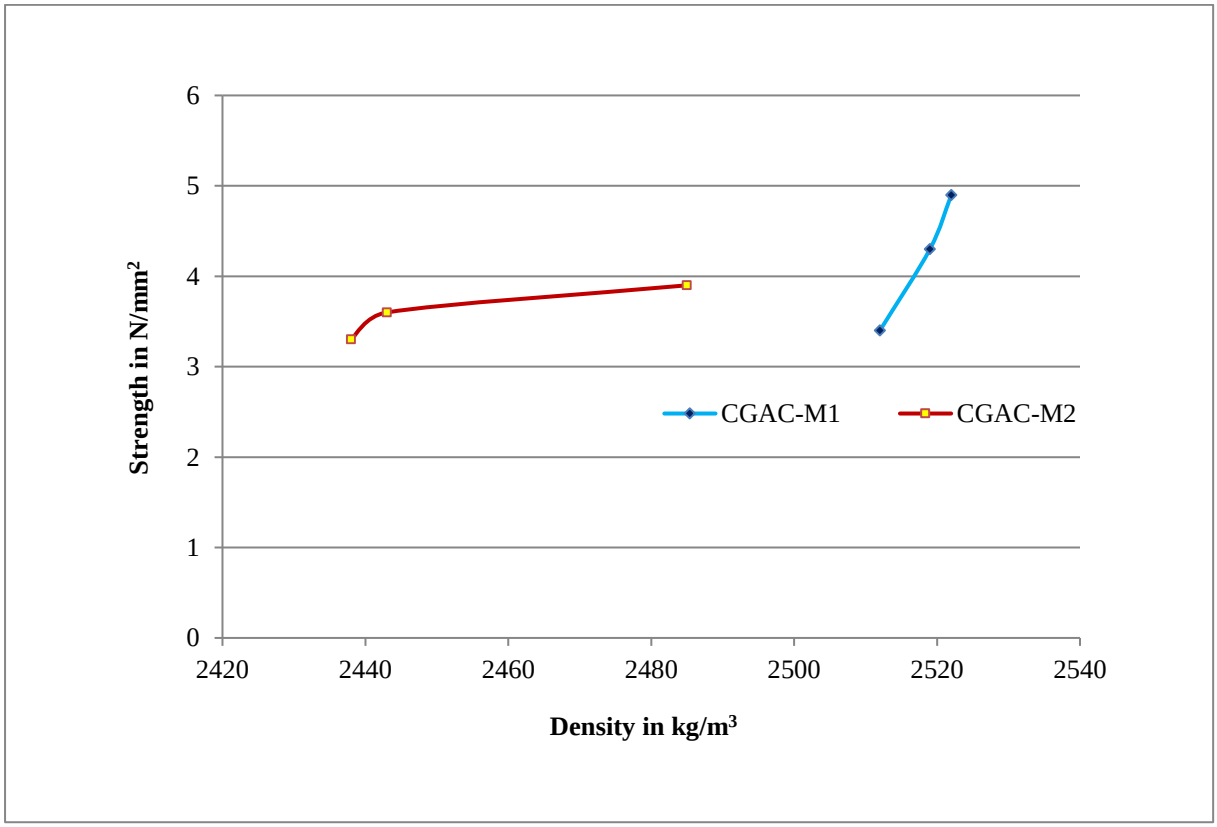

Fig.7: Relation between Tensile stress and Density of CGAC

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CONCLUSIONS

The use of coconut shell as coarse aggregate in concrete provides an alternate for the crushed granite aggregate. This study established that coconut shell can be used as coarse aggregate in the production of concrete with lesser density. The test results obtained from this study also provide significant understanding on basic Material properties and Mechanical properties of coconut shell aggregate concrete. This study gives suggestions for the proper use of coconut shell which will hopefully lead to promotion of sustainable development in the construction industry for the greener environment. Based on the experimental investigation, the following conclusions were arrived.

- To satisfy the criteria of structural concrete by trial mix 1 and 2, coconut shell requires the cement content of (450 and 400) kg/m^3 in the production of concrete using coconut shell as aggregate.
- The 28-day impact resistance of coconut shell aggregate concrete is having (8 blows) when compared with conventional granite aggregate concrete (13 blows) for formation of initial cracks in trial mix - I. and CSAC (6 blows), CGAC (13) for initial cracks in trial mix – II.
- The 28-dayimpact resistance of coconut shell aggregate concrete is having (13 blows) when compared with conventional granite aggregate concrete (18 blows) for fractured pieces in trial mix I. and CSAC (10 blows), CGAC (17) for fractured pieces in trial mix – II.
- The 28-day Tensile strength of coconut shell aggregate concrete (CSAC) were (2.86 and 2.56) N/mm^2 for trial mix 1 and 2 and these are merely less than conventional granite aggregate concrete (CGAC) strength of (3.96 and 3.56) N/mm^2.
- In general, the basic engineering properties namely compressive strength, tensile strength and impact resistance of coconut shell aggregate concrete were compared reasonably and all results lies well and nearly same to the conventional granite aggregate concrete from the tested two trial mix ratios.

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