THOMSON REUTERS
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[Pavani* *et al.*, 5(11): November, 2016]
IC™ Value: 3.00

ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

IJESRT
INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

TO STUDY THE EFFECT ON PARTIAL REPLACEMENT OF CEMENT BY SILICA FUMES AND COARSE AGGREGATE BY COCONUT SHELLS

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DOI: 10.5281/zenodo.167059

ABSTRACT

The rising value of construction materials in many countries needs to research and implement of different alternative materials in civil engineering construction .The wastes can be used as aggregate in concrete for the production of light weight concrete. Amid this study, coconut shell is utilized as light-weight mix in concrete. The undertaking paper goes for examining split tensile strength, flexural strength and compressive strength characteristics with complete replacement of coarse combination with coconut shell with different proportions (15%, 30%, 45%)to supply light-weight concrete and to exchange cement by exploitation silica fume as admixtures with completely different percentages (0%, 10% &15%) to urge smart strength like standard concrete. Concrete cubes and cylinders are casted with mix proportion (1:1.79:3.17) and their mechanical properties are determined and compared with standard concrete.. The effective use of silica fumes for the improvement of strength of lightweight coconut shell concrete. The Maximum compressive strength at 28 days when 15% silica fumes& 15% coconut shell is added to the mix and the value obtained is 34.04MPa. The maximum split tensile strength at 28 days when coconut shell is 15% and silica fumes is 15% is added to the mix and the value is 2.98MPa.The maximum Flexural strength at 28 days when coconut shell is 15% and silica fumes is 15% is added to the mix and the value is 6.21MPa.

KEYWORDS: Coconut Shell (CS), Light Weight Aggregate (LWA), Coconut Shell Concrete (CSC), Compressive Strength, Split tensile Strength, Flexural Strength, Air-Dry (AD), Oven Dry (OD).

INTRODUCTION

Concrete is a man-made product, essentially consisting of a mixture of cement, aggregates, water and admixture(s). Traditionally aggregates have been readily available at economic prices and of qualities to suit all purposes. The word “sustainable” is becoming very common worldwide. The trend goes beyond the practice of design and construction, since the awareness of the current population is a crucial factor for the success of this tendency. Some examples of research with sustainable materials worldwide are the use of recycled concrete aggregates, coal fly ash, ground clay brick and pervious paver block system. Further, research work with sustainable materials has been conducted on fiber-reinforced concrete which is a concrete primarily made of a mix of hydraulic cement, aggregates, water and reinforcing fibers. In developed countries, the construction industries have identified many artificial and natural lightweight aggregates (LWA) that have replaced conventional aggregates thereby reducing the size of structural members. However, in Asia the construction industry is yet to utilize the advantage of LWC in the construction of high rise structures. Coconut Shell (CS) are not commonly used in the construction industry but are often dumped as agricultural wastes. The aim of this review is to spread awareness of coconut fibers as a construction material.

LITERATURE REVIEW

Vishwas P. Kukarni, Sanjay kumar B. Gaikwad: Comparative Study on Coconut Shell Aggregate with Conventional Concrete has done and the strength properties are founded to be 28 days compressive strength of coconut shell concrete was found to be 24.21, 22.81 and 21.80N/mm^2 for 10%, 20% and 30% replacement by coconut shell aggregate under full water curing and it satisfies the requirement (density) for structural lightweight concrete. [28]

GopalCharanBehera, Ranjan Kumar Behera: Three mixes and replacing CA by 0,5,10% with CS by resulting comp. strength as 40.37, 30.67, 23.51N/sq.mm , Flexure strength as 3.56, 3.47, 3.07N/sq.mm and split tensile strength as 3.05, 2.06, 1.76 N/sq.mm. As strength of the member is reducing with increase in percentage of coconut shell, this can be used for low strength concrete mixes.[29]

MATERIALS AND THEIR PROPERTIES

CEMENT: Ordinary Portland cement (OPC) is the most common type of binder used for concrete production and hence, OPC 43 Grade conforming to Indian Standard IS 12269:1987 was used as a binder. The local brand name of the OPC cement is used. Specific gravity of the cement is found to be 3.15 in the laboratory.

FINE AGGREGRATE: River sand was used throughout the investigation as the fine aggregate conforming to grading zone II as per IS 383:1970. The density of the fine aggregate is found to be 2671 kg/m^3, specific gravity is found to be 2.65 Fine aggregate of the same grading but with a difference of 1% voids content may result in a remarkable difference in water demand. The optimum gradation of fine aggregate for concrete is determined more by its effect on water requirement than on physical packing.. Fine aggregate with a fineness modulus in the range of 2.5 to 3.2 are preferable.

COARSE AGGREGATE: Crushed granite stone aggregate 3-12 mm sizes were used for CC for comparison. The bulk density, specific gravity, water absorption, aggregate impact value (AIV), aggregate crushing value (ACV), aggregate abrasion value, and particle size distribution were determined. A 20-25mm nominal maximum size aggregate is common for producing concrete strengths up to 60MPa and 10-12 mm above 60MPa. In general, the smallest size aggregates produces the highest strength for a given water cement ratio.

COCONUT SHELL AS AGGREGATE: CSAC, which is produced using CS aggregates, was the main concrete studied in this investigation. CS is discarded at coconut industries as half-shell rounds. CS was collected from the local coconut oil mills to analyze the properties of CS in this study. CS have maximum thickness in range of 2-8 mm, they were crushed to the required sizes in the range 6-20 mm in length using the specially developed crusher.

PRESENTUSE OF COCONUT SHELL: Coconut Shell (CS) has good durability characteristics, high toughness and abrasion resistant properties; it is suitable for long standing use. CS is mostly used as an ornament, making fancy items, house hold utensils, and as a source of activated carbon from its charcoal. The powdered shell is also used in the industries of plastics, glues, and abrasive materials and it is widely used for the manufacture of insect repellent in the form of mosquito coils and in agarbathis.

WATER: Water is an essential component of concrete for mixing and curing. It should be free from harmful impurities. The pH value of water shall not be less than 6. If the water is drinkable, it is considered to be suitable for concrete making. Hence, potable tap water was used in this study for mixing and curing.

SILICA FUME: The micro silica of silica fume, a by-product of the electrometallurgical industrial plays a double role: first as a filler and then as a pozzolonic material, which reacts with $Ca(OH)_2$ liberated by C_3S. The pozzolanicity of the silica fume can be characterized by its ability to react with $Ca(OH)_2$. In the mixture of OPC + 30% silica all the $Ca(OH)_2$ liberated by the hydration of clinker silicates has been consumed by this micro silica. The Ca/Si ratio of C-S-H is systematically lower in calcium than that of Portland cement and the higher amount of silica fume the lower the C/S, but inversely, they contain more alkalis respectively 1.3 and 0.5%.

MATERIAL PROPERTIES

CEMENT: In the present study OPC 43 grade local brand was used. The specific gravity of cement is given in Table

Specific gravity of cement

Sl. No.	Observations	Trail 1	Trail 2	Trail 3
1.	Weight of the specific gravity bottle W1, g	35.8	35.8	35.8

2.	Weight of the specific gravity bottle + 1/3rd filled cement W2, g	53.8	53.6	53.8
3.	Weight of the specific gravity bottle + 1/3rd filled cement + kerosene W3, g	89.4	89.3	89.4
4.	Weight of the specific gravity bottle W1 + kerosene W4, g	76.2	76.2	76.2
5.	Specific gravity	3.0	3.02	3.0

Average specific gravity of cement = 3.01

FINE AGGREGATE: Locally available river sand conforming to grading zone-II as per IS: 383 – 1970 was used. The screened at site to remove deleterious materials. Sieve analysis and specific gravity test results of sand were given.

sieve analysis of fine aggregate

Sieve size, mm	Weight retained, gms	Cumulative weight retained, gms	Cumulative % retained (%)	Percentage passing (%)
4.75	0	0	0	100
2.36	11	11	2.2	97.8
1.18	52.7	63.7	12.74	87.26
0.6	138.3	202	40.4	58.6
0.3	249.5	451.5	90.3	9.7
0.15	42.1	493.6	98.72	1.28
<0.15	6.4	500	100	0

Fineness modulus of sand = 2.45

[1] Specific Gravity of Fine Aggregate=2.65

COARSE AGGREGATE: In the present study a locally available coarse aggregate (MSA,20mm) from quarry was used.

Sieve Analysis of Coarse Aggregate

Sieve size (mm)	Weight Retained(g)	Cumulative Weight retained(g)	Cumulative % retained	% Passing
40	0	0	0	100
26.5	0	0	0	100
20	675	13.5	13.5	86.5
12.5	3525	70.5	84	16
10	260	5.2	89.4	10.6
4.75	420	8.4	97.6	2.4
<4.75	120	2.4	100	0

Fineness modulus of coarse aggregate = 3.84

[2] Specific Gravity of Coarse Aggregate=2.72

PHYSICAL AND MECHANICAL PROPERTIES OF COCONUT SHELL:

The crushed CS in different sizes is shown in Figure 3.4. Engineering properties tests on CS which are essentially required such as moisture content, water absorption, specific gravity, density, crushing strength, impact strength, flakiness index etc., to satisfy as an aggregate to be used in the production of concrete were conducted as per the Indian standard procedures.

Crushed coconut shell as coarse aggregate

Fig 1.1 Discarded CS at coconut industries

EXPERIMENTAL INVESTIGATIONS

MIXING: Mixing was carried out in a pan mixer machine. The mixing methodology adopted was as follows: 25 percent of total water, coarse aggregates and admixtures were added to the mixer machine and allowed to mix for 1 minute. Cement and 50 percent water were then added to the mix and mixed for 1 minute. Super plasticizer was blended with the balance 25 percentage water and then added to the mix. Mixing was continued for 5 minutes after adding the blend. Total mixing time was 7 minutes.

CURING: Curing is the one of important part for getting the required strength

Curing of concrete specimens

Freshly casted concrete properties

Workability Test: A concrete mix must be made of the right amount of cement, aggregates and water to make the concrete workable enough for easy compaction and placing and strong enough for good performance in resistin stresses after hardening. If the mix is too dry, then its compaction will be too difficult and if it is too wet, then the concrete is likely to be weak. During mixing, the mix might vary without the change very noticeable at first. For instance, a load of aggregate may be wetter or drier than what is expected or there may be variations in the amount of water added to the mix. These all necessitate a check on the workability and strength of concrete after producing. Slump test is the simplest test for workability and are most widely used on construction sites. In the slump test, the distance that a cone full of concrete slumps down is measured when the cone is lifted from around the concrete. The slump can vary from nil on dry mixes to complete collapse on very wet ones. One drawback with the test is that it is not helpful for very dry mixes. The slump test carried out was done using the apparatus shown in Figure below.

Slump Test

MECHANICAL PROPERTIES

Compressive Strength test: To calculate the compressive strength of concrete cubes the universal testing machine (UTM) having capacity of 300tonnewas used. In this test the strength obtained in tone. The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross sectional area calculated from mean dimensions of the section and shall be expressed

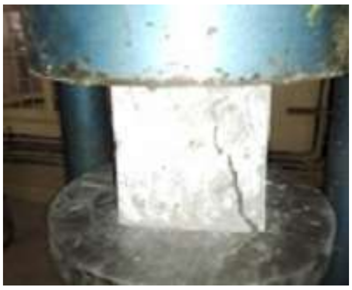
ISSN: 2277-9655
Impact Factor: 4.116
CODEN: IJESS7

to the nearest N/mm2.Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10mm X 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used. These specimens are tested by compression testing machine after 7 days curing, 14 days curing, 28 days curing and 56 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

$$F_c = P/A$$

Where,

F_c - Compressive strength of concrete
P - Maximum Compressive load
A - Cross sectional area




Concrete cube specimens testing for compressive strength

Flexural Strength Test: For this test the beams of dimension100mmX100mmX500mm were casted. Flexural strength, also known as modulus of rupture, bend strength, or fracture strength,[dubious – discuss] a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The transverse bending test is most frequently employed, in which a rod specimen having either a circular or rectangular cross-section is bent until fracture using a three point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of rupture. The beam tests are found to be dependable to measure flexural strength. The value of the modulus of rupture depends on the dimensions of the beam and manner of loading. In this investigation, to find the flexural strength by using third point loading. In symmetrical two points loading the critical crack may appear at any section not strong enough to resist the stress with in the middle third, where the banding moment is maximum. Flexural modulus of rupture is about 10 to 20 percent of compressive strength depending on the type, size and volume of coarse aggregate used. The flexural strength of the specimens was calculated .

Modulus of rupture, $f_b = (P\,L) / (b\,d^2)$,
$= (3P \times a) / (bd^2)$.

where P = Maximum load applied, N
L = Supported length of the specimen, mm
b = Measured width of the specimen, mm
d = Measured depth of the specimen at the point of failure, mm

Concrete specimens testing for flexural strength

Split Tensile Strength Test : As we know that the concrete is weak in tension. Tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However, the determination of tensile strength of concrete is necessary

ISSN: 2277-9655
Impact Factor: 4.116
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to determine the load at which the concrete members may crack. The cracking is a form of tension failure. The usefulness of the splitting cube test for assessing the tensile strength of concrete in the laboratory is widely accepted and the usefulness of the above test for control purposes in the field is under investigation. The standard has been prepared with a view to unifying the testing procedure for this type of test for tensile strength of concrete. The load at which splitting of specimen takes place shall then be recorded. The universal testing machine (UTM) having capacity of 150tonne was used for the splitting tensile strength of the concrete cylinders. The measured splitting tensile strength fsp of the sample was calculated.

$fsp = 2P / (\pi DL)$

where, P = maximum load applied to the specimen, N

D = cross sectional diameter of the specimen, mm and

L = length of the specimen, mm

Concrete specimens testing for split tensile strength

CONCRETE MIX DESIGN FOR M20 GRADE

Material Properties

i) Cement

Type : 43 grade OPC confirming IS: 8112-1989

Specific Gravity : 3.01

ii)Fine Aggregate

Type : Locally available river sand

Specific Gravity : 2.65

iii)Coarse Aggregate

Maximum size : 20 mm

Specific Gravity : 2.72

iv)Water

pH value : 7.00

v)Mineral Admixture

Specific Gravity of Silica Fume : 2.2

Finalized Mix proportion:

Finalized Mix	Cement (Kg/m^3)	Fine Aggregate (Kg/m^3)	Coarse Aggregate (kg/m^3)	Water (l/m^3)
Proportion	1	1.79	3.17	0.55
CCM (M20) (IS:10262-2009)	350	615	1110	192

RESULTS AND DISCUSSIONS

DENSITIES AT DIFFERENT PERCENTAGES OF COCONUT SHELL IN CONCRETE:

- **[3]** At 0% percentage of coconut shell the density is 2421 kg/m^3
- **[4]** At 15% percentage of coconut shell the density is 2315 kg/m^3
- **[5]** At 30% percentage of coconut shell the density is 2231 kg/m^3
- **[6]** At 45% percentage of coconut shell the density is 2136 kg/m^3

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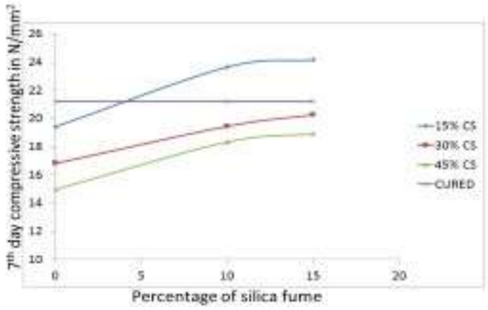
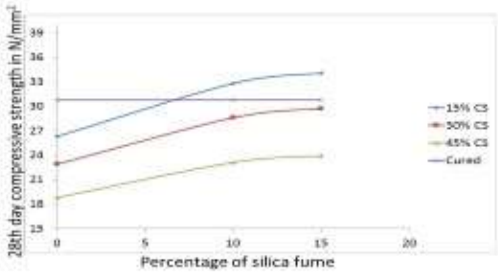
COMPARISON OF COMPRESSIVE STRENGTH AT 7& 28 DAYS:





Mix for 7 days	7 Days Compressive strength (Mpa)	7 Days Change in strength (%)	Mix for 28 days	28 Days Compressive strength (Mpa)	28 days Change in strength (%)
CCM (M20)	21.24	--	CCM (M20)	30.74	--
CS-15,SF-0%	19.41	-8.6	CS-15,SF-0%	26.29	-14.63
CS-15,SF-10%	23.64	+11.3	CS-15,SF-10%	32.78	+6.6
CS-15,SF-15%	24.15	+13.7	CS-15,SF-15%	34.04	+9.7
CS-30,SF-0%	16.81	-20.8	CS-30,SF-0%	22.89	-25.5
CS-30,SF-10%	19.44	-8.5	CS-30,SF-10%	28.57	-7.06
CS-30,SF-15%	20.26	-4.6	CS-30,SF-15%	29.71	-3.36
CS-45,SF-0%	14.97	-29.5	CS-45,SF-0%	18.81	-38.8
CS-45,SF-10%	18.33	-13.7	CS-45,SF-10%	18.33	-22.6
CS-45,SF-15%	18.9	-11.4	CS-45,SF-15%	18.92	-19.2

COMPARISION OF SPLIT TENSILE STRENGTH
SPLIT TENSILE STRENGTH AT 28 DAYS

Mix	Split tensile strength (Mpa)	Change in strength (%)
CCM (M20)	3.09	--
CS-15,SF-0%	2.47	-20.3
CS-15,SF-10%	2.87	-7.15
CS-15,SF-15%	2.98	-4.06
CS-30,SF-0%	2.38	-22.9
CS-30,SF-10%	2.47	-20.06
CS-30,SF-15%	2.64	-14.56
CS-45,SF-0%	2.05	-33.66
CS-45,SF-10%	2.29	-25.9
CS-45,SF-15%	2.41	-22.0

COMPARISION OF FLEXURAL STRENGTH
FLEXURAL STRENGTH AT 28DAYS:

Mix	Flexural strength (MPa)	Change in strength (%)
CCM (M20)	7.11	--
CS-15,SF-0%	4.88	-31.36
CS-15,SF-10%	5.93	-16.59
CS-15,SF-15%	6.21	-12.65
CS-30,SF-0%	4.12	-42.05
CS-30,SF-10%	4.92	-30.8
CS-30,SF-15%	5.58	-21.5
CS-45,SF-0%	3.78	-46.83
CS-45,SF-10%	4.54	-36.11
RC-30,SF-15%	5.01	-29.53

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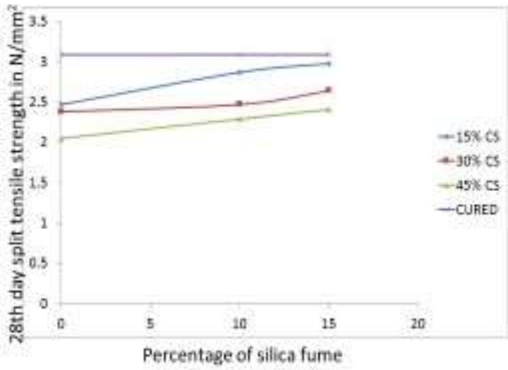

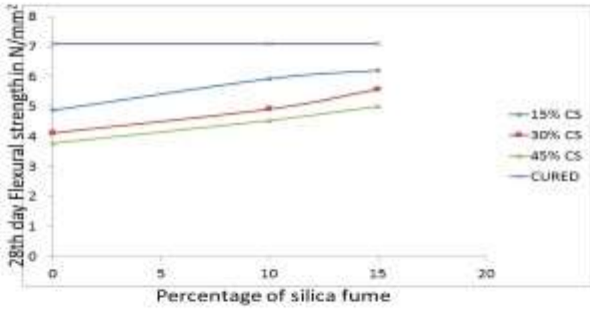

CONCLUSION

The following conclusions are drawn:The test results shows that the addition of coconut shell as aggregate resulted in a significant reduction in concrete compressive strength compared with the conventional concrete. This reduction in compressive strengths increased with increasing percentage of coconut shell aggregate. The silica-fume variations about 0,10 and 15% .so the increase in strength is observed between 0 and 10% but when compared to 10 and 15% there is an increase but small variation. A reduced compressive strength of concrete due to the inclusion of coconut shell aggregate limits its use in some structural applications. Enhancing of the weak properties of concrete by the introduction of different ingredients other than the conventionally used natural aggregates and ultimately leading to the conservation of natural resources. The densities at various proportions are directing low density concrete compared to conventional concrete. Split tensile strength is ranging from 14-17% of comp. strength. The mixes containing silica fume are giving higher strengths by an increase of 10 to 35% of mix which does not contain silica fume. The specific gravity of coconut shell is low as compared to the coarse aggregate and the water absorption is high for coconut shell than coarse aggregate and hence the strength decreased in comparison with the conventional concrete. The reduction in split tensile strength and flexural strength is more compared to compressive strength with replacement of coarse aggregate with coconut shell.

FUTURE SCOPE

The durability tests like corrosive resistance, sulphate attack tests can be taken up. Mortar properties of all the mix can be studied. Study can be made to determine strength parameters of cement with coconut shell ash and mineral admixture like fly ash and GGBS.

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