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RESEARCH ARTICLE

STUDY ON BEHAVIOUR OF CONCRETE CUBES WITH COCONUT SHELLS AS A PARTIAL REPLACEMENT OF COARSE AGGREGATE

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ABSTRACT

The high cost of conventional building materials is a major factor affecting housing delivery in the world. This has necessitated research into alternative materials of construction. In this study, coconut shell is used as light weight aggregate in concrete. The properties of coconut shell and coconut shell aggregate concrete is examined and the use of coconut shell aggregate in construction is tested. The project paper aims at analyzing flexural and compressive strength characteristics of with partial replacement using M30 and M20 grades of concrete. The project also aims to show that Coconut shell aggregate is a potential construction material and simultaneously reduces the environment problem of solid. cubes are casted, tested and their physical and mechanical properties are determined. The main objective is to encourage the use of these seemingly waste products as construction materials in low-cost housing.

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INTRODUCTION

Concrete is the premier civil engineering construction material. Concrete manufacturing involve consumption of ingredients, aggregates, water and admixtures. Among all the ingredients, aggregates form the major part. Use of natural aggregate in such a rate leads to a question about the preservation of natural aggregates sources. In light of this, in the contemporary civil engineering construction, using alternative materials in place of natural aggregate in concrete production makes concrete as sustainable and environmentally friendly construction material Different alternative waste materials and industrial byproducts such as fly ash, bottom ash, recycled aggregates, foundry sand, china clay sand, crumb rubber were replaced with natural aggregate and investigated properties of the concretes. Apart from above mentioned waste materials and industrial by products, few studies identified that coconut shells, the agricultural by product can also be used as aggregate in concrete. According to a report, coconut is grown in more than 86 countries worldwide, with a total production of 54 billion nuts per annum. India occupies the premier position in the world with an annual production of 13 billion nuts, followed by Indonesia and the Philippines.

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Limited research has been conducted on mechanical properties of concrete with coconut shells as aggregate replacement. However, further research is needed for better understanding of the behavior of coconut shells as aggregate in concrete. India is the third largest producer of coconut products in the world. Coconut trees are widely cultivated in the southern states of India, especially Kerala. Disposal of these coconut shells is therefore a serious environmental issue. In this structure, the study on use of coconut shell as a substitute or partial replacement of coarse aggregate in concrete is gaining importance in terms of possible reduction of waste product in environment and finding a sustainable alternative for non renewable natural aggregates

MATERIALS AND METHODS

Materials Used

Cement: Portland cements are hydraulic cements, meaning they react and harden chemically with the addition of water. Cement contains limestone, clay , cement rock and iron ore blended and heated to1200 to 1500 C°. The resulting product "clinker" is then ground to the consistency of powder. Gypsum is added to control setting time.

Sand: Normally called sand, this component can be natural sand or crushed stone, and represents particles smaller than 3/8".Generally accounts for 30%-35% of the mixture.

Aggregate: May be either gravel or crushed stone. Makes up 40%-45% of the mixture, comprised of particles greater than 1/4" and size of aggregate is 20 mm.

Coconutshellsas 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 2-8mm, they were crushed to the required sizes in the range 3-12 mm in length using the specially developed crusher. The sieve analysis was conducted and the particle size distribution of CS is presented in Figure.

Tests conducted on concrete

Consistency Test: Prepare a paste of weighed quantity of cement (300gms) with weighed quantity of potable or distilled water, taking care that the time of gauging is not less than 3minutes not more than 5minutes and the gauging is completed before any sign of setting occurs. The gauging is counted from the time of adding water to the dry cement until commencing to fill the mould. Fill the vacant mould with this paste resting upon a non-porous plate. Lower the plunger gently to touch the surface of the test block and quickly release, allowing it sink into the paste. Record the depth of penetration. Prepare trial pastes with varying percentages of water and test as described above until the plunger is 5mm to 7mm from the bottom of the vicat mould.

Concrete Slump: The test is carried out using a mould known as a slump cone or Abram's cone This cone is filled with fresh concrete in three stages, each time it is tamped using a rod of standard dimensions. At the end of the third stage, concrete is struck off flush to the top of the mould. The mould is carefully lifted vertically upwards, so as not to disturb the concrete cone. Concrete subsides. This subsidence is termed as slump, and is measured in to the nearest 5 mm. Only a true slump is of any use in the test. A collapse slump will generally mean that the mix is too wet or that it is a high workability mix, for which slump test is not appropriate. Very dry mixes; having slump 0 – 25 mm are used in road making, low workability mixes; having slump 10 – 40 mm are used for foundations with light reinforcement, medium workability mixes; 50 - 90 for normal reinforced concrete placed with vibration, high workability concrete; > 100 mm

Compacting factor: The sample of concrete to be tested is placed gently in the upper hopper, using the hand scoop. The hopper is filled level with its brim and the trap – door is opened so that the concrete falls into the lower hopper. The cylinder is covered by the trowels When all the concrete has come to rest in the lower hopper, the cylinder is uncovered, the trap door of the lower hopper opened and the concrete is allowed to fall into the cylinder. The weight of the concrete in the cylinder is measured to the nearest 10 g. This is known as 'the weight of partially compacted concrete'.

Compressive Test: 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 This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimens should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen. These specimens are tested by compression testing machine after 7 days curing or 28 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.

Tests conducted on aggregates

Specific gravity & water absorption of aggregate (IS: 2386-Part 3-1963): About 2kg of the aggregate sample is washed thoroughly to remove fines, drained and then placed in the wire basket and immersed in distilled water at a temperature between 22 to 32^0C with a cover of at least 50 mm of water above the top of the basket. Immediately after the immersion the entrapped air is removed from the sample by lifting the basket containing it 25 mm above the base of the tank and allowing it to drop 25 times at the rate of about one drop per second. The basket and the sample are then weighed while suspended in water at a temperature of 22 to 32^0C. The weight is noted while suspended in water (W_1) g. The empty basket is then returned to the tank of water, jolted 25 times and weights in water (W_2) g. Then the aggregate is transferred to the second dry cloth spread in a single layer, covered and allowed to dry for at least 10 minutes until the aggregates are completely surface dry. 10 to 60 minutes drying may be needed. The surface dried aggregate is then weighed W_3 g . The aggregate is placed in a shallow tray and kept in an oven maintained at a temperature of 110^0C for 24 hours. It is then removed from the oven, cooled in air tight container and weighed W_4 g

$$\text{Specific gravity} = \frac{W_4}{W_3 - (W_1 - W_2)}$$

$$\text{Water absoption} = \frac{W1 - W2}{W1} \times 100$$

Aggregate crushing value: The cylindrical steel cup is filled with 3 equal layers of aggregate and each layer is tamped 25 strokes by the rounded end of tamping rod and the surplus aggregate struck off, using the tamping rod as a straight edge. The net weight of aggregate in the cylindrical steel cup is determined to the nearest gram (W_A) and this weight of aggregate is used for the duplicate test on the same material. The cup is fixed firmly in position on the base of the machine and the whole of the test sample is added in thirds, The surface is leveled and the plunger is inserted so that it rests horizontally on the surface. The whole assembly is then placed between the platens of testing machine and loaded at a uniform rate so as to reach a load of 40 tones in 10 minutes. The load is then released and all aggregate is removed from the cup and sieved on 2.36 mm. IS sieve until no further significant amount passes in one minute. The fraction passing the sieve is weighed to an accuracy of 0.1 g (W_B) each third being subjected to 25stokes from tamping rod.

Aggregate crushing Value $=(W_B/W_A) \times 100$

CALCULATION AND RESUTLS

Specific gravity, water abs option, crushing value and impact value

S.no	Coarse Aggregate	Coconut Shellls
Specific gravity	2.9	1.33
Water abosption	16%	8%
Crushing value	21.45%	4.77%
Impact value	40%	11.5%

Specific gravity and water absorption of fine aggregate

S.No	Fine aggregate
Specific Gravity	2.63
Water Absoption	6%

Setting time measurement of ordinary cement

TIME(min)	5	10	20	25	30
PENETRATION(mm)	0	1	3	4	5

Mix Design of Nominal Mix M20 and Workability Values

% of CS replacement	W/C ratio	Mix ratio	Compaction factor	Slump (mm)
0	0.5	1:1.5:3:0.5	0.85	30
5	0.5	1:1.5:3:0.5	0.85	30
10	0.5	1:1.5:3:0.5	0.85	30
15	0.5	1:1.5:3:0.5	0.85	30
20	0.5	1:1.5:3:0.5	0.85	30
25	0.5	1:1.5:3:0.5	0.85	30

Compressive strength of M30 grade of concrete

% of CS replacement	0	5	10	15	20	25
7 days	22.99	22.11	22.22	22.44	22.77	20.77
14 days	26.88	25.44	25.88	26.22	26.77	22.44
28 days	30.33	28.11	28.77	29.11	29.77	24.99

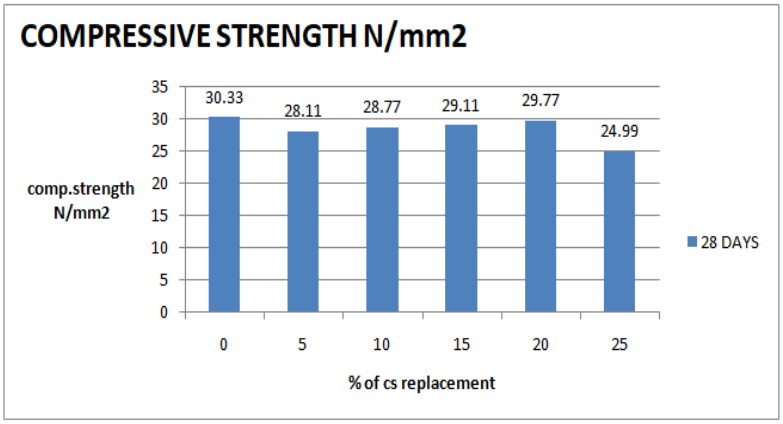
Compressive strength of M 20 grade of concrete

% of CS replacement	0	5	10	15	20	25
7 days	13.11	10.99	12	12.55	12.88	9.38
14 days	14.44	12.99	13.33	13.77	14.22	12
28 days	20.44	19.11	19.33	19.66	20	18

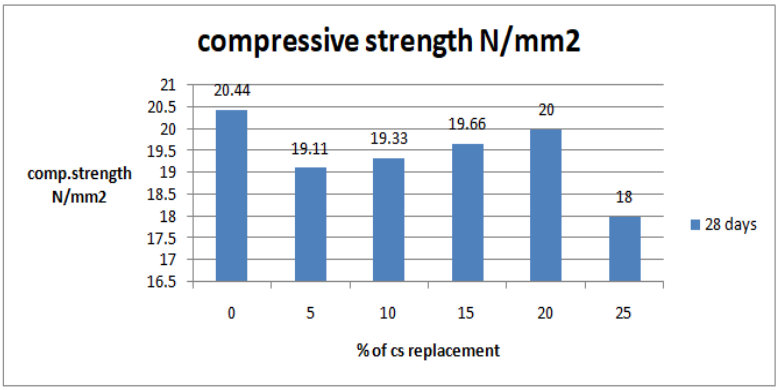
Compressive strength analysis of m30 CS concrete at 28 days

% of CS replacement	W/C ratio	Mix ratio	Compaction factor	Slump (mm)
0	0.4	1:1.04:2.71:0.4	0.8	30
5	0.4	1:1.04:2.71:0.4	0.8	30
10	0.4	1:1.04:2.71:0.4	0.8	30
15	0.4	1:1.04:2.71:0.4	0.8	30
20	0.4	1:1.04:2.71:0.4	0.8	30
25	0.4	1:1.04:2.71:0.4	0.8	30

Compressive strength analysis of m30 CS concrete at 28 days



Compressive strength analysis of m20 CS concrete at 28 days



Aggregate impact value: The net weight of aggregate in the cylindrical steel cup is determined to the nearest gram (W_A) and this weight of aggregate is used for the duplicate test on the same material. The cup is fixed firmly in position on the base of the machine and the whole of the test sample is placed in it and compacted by a single tamping of 25 strokes of tamping rod.

The hammer is raised until its lower face is 380 mm. above the upper surface of the aggregate in the cup, and allowed to fall freely onto the aggregate 15 times, each being delivered at an interval of not less than one second. The crushed aggregate is removed from the cup and sieved on 2.36 mm. IS sieve until no further significant amount passes in one minute. The fraction passing the sieve is weighed to an accuracy of 0.1 g (W_B)

Aggregate impact Value = $(W_B / W_A) \times 100$

Conclusion

From the experimental results and discussion, the coconut shell has potential as lightweight aggregate in concrete. Also, using the coconut shell as aggregate in concrete can reduce the material cost in construction because of the low cost. We can use the coconut shells in aggregate up to 20% replacement in M20 and M30 grade of concrete the strength is not attained so, we can use the CS in concrete as replacement of aggregate up to 20% in M20 grade of concrete Coconut Shell Concrete can be used in rural areas and places where coconut is abundant and may also be used where the conventional aggregates are costly. Coconut shell concrete is also classified as structural lightweight concrete. It is concluded that the Coconut Shells are more suitable for lightweight aggregate when used to replace normal coarse aggregate in concrete production.

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