STUDY ON MECHANICAL PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF COCONUT SHELL AS COARSE AGGREGATE

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Abstract **- Concrete is an artificial material similar in appearance and properties to some natural lime stone rock. It is a manmade composite, the major constituent being natural aggregate such as gravel or crushed rock, sand and fine particles of cement powder all mixed with water. The use of crushed coconut shell as coarse aggregate in concrete has never been in a usual practice. Coconut is grown in more than 93 countries. India is the third largest, having cultivation on an area of about 2.1 million hectares. The overall production of coconut in 2012 was 60 million tonnes. In this project, M20 grade of concrete and water-cement ratio of 0.5 were used with different proportions such as 0%, 5%, 10%, 15%, 20% of coconut shells. The properties such as specific gravity, water absorption of coconut shell were checked. Hence its compressive strength, flexural strength, split tensile strength were also tested.**

***Key words*:** coconut shell, compressive strength, flexural strength, specific gravity, split ten

I.INTRODUCTION

Concrete is the broadly used structural material in the world today. Normal concrete contains four components namely cement, coarse aggregate, fine aggregate and water. But now-a-days there has been a great demand for all these basic constituents, so that there has been a great hike in the price of housing industry. So we are greatly in need of some alternative material to bring down this hike. Some of the lightweight aggregates that can be as a replacement for cement in concrete productions are sludge, demolished concrete etc. The use of alternative materials has become necessity for the construction industry because of the economic, environmental and technological benefits derived from their use. The use of coconut shell as coarse aggregate in concrete has never been a usual practice among the average citizens, particularly in areas where light weight concrete is required for non-load bearing walls, non-structural floors, and strip footings. The coconut industry in India accounts for more than one-fourth of the world's whole coconut oil production and is set to rise further with the global increase in demand. Coconut shell symbolizes more than 60% of the household waste volume. Coconut Shell, which presents serious disposal problems for local environment, is an abundantly available agricultural waste from local coconut industries. This will have the double advantage of reduction in the cost of construction

material and also as a means of disposal of wastes. Concrete using Coconut Shell aggregates resulted inacceptable strength required for structural concrete. Coconut Shell may present itself as a coarse aggregate and as potential construction material in the field of construction industries. Moisture maintenance and water absorbing capacity of Coconut Shell are compared with conventional aggregate. There is existence of sugar in the Coconut shell as long as it is not in a free form. But it will not affect the setting and strength of concrete. It is found that wood based materials, being hard and of organic origin, will not pollute or leak to produce toxic substances once they are bound in concrete matrix. Coconut shells do not need pretreatment, except for water absorption.

II. LITERATURE REVIEW

Parag S. Kambli, Sandhya R. Mathapati (2014), investigated Application of Coconut Shell as Coarse Aggregate in Concrete. Coconut shell particles were used as reinforcing material for investigation. Shell particles of size between 20 mm– 600 μ were prepared in grinding machine. Coconut shell aggregates were potential candidates for the development of new composites because of their high strength and modulus properties. An estimated value of coconut shell density is 1.60 g/cm3. The target of the experimental program was to determine the contribution of natural material aggregate type to the development of the strength behaviour of the confined concrete. From the experimental resultsit is concluded that, the coconut shell has potential as lightweight aggregate in concrete. So it is recommended to replace coarse aggregate.

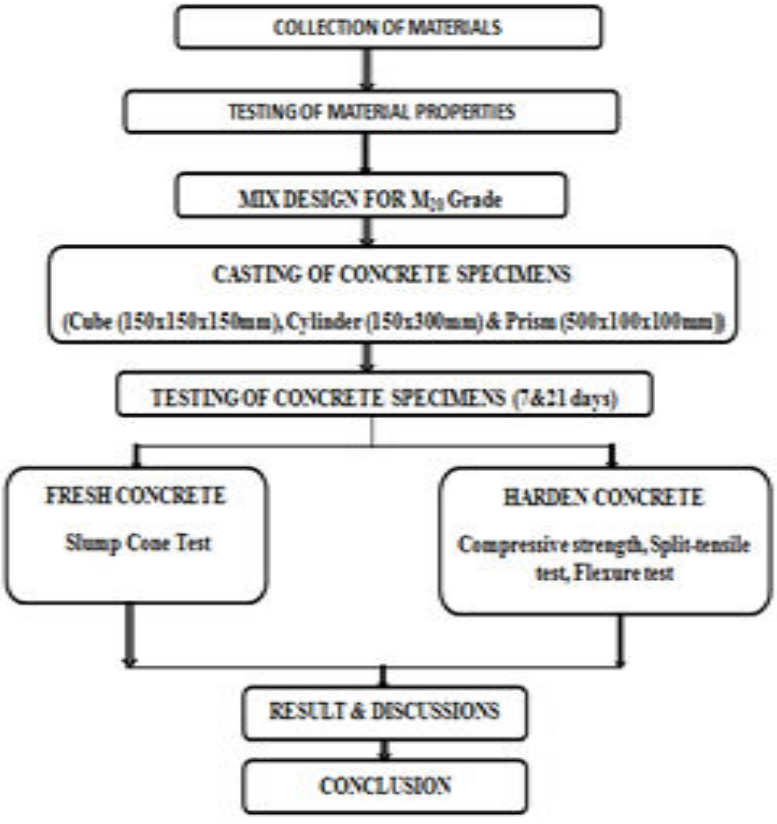
B.Damodhara Reddy,S.ArunaJyothy, FawazShaik (2014) made experimental Analysis of the use of Coconut Shell as coarse aggregate. In this study, coconut shell was used as light weight aggregate in concrete. Moisture content and water absorption after the experiment were 4.20% and 24% respectively and these values were more when compared to conventional aggregate. Coconut shell exhibits more resistance against crushing, impact and abrasion compared to conventional aggregate. Density of coconut shell was in the range of 550-650 kg/m3. Biological decay was not evident as the coconut shell aggregate concrete cubes gained strength even after 365 days. The continual increase in strength indicates that the coconut shell aggregate does not deteriorate once coconut shell aggregates were encapsulated into the concrete matrix. Cubes were casted in different ratio. But in case of 100% replacement of coarse aggregate with coconut shell flexural strength was not obtained as the specimen failed under its self-weight.

ManinderKaur, ManpreetKaur (2012) studied on Utilization of Coconut Shell as Coarse Aggregates in Mass Concrete. The construction industries have identified many artificial and natural lightweight aggregates that have replaced conventional aggregates thereby reducing the size of structural members. This has brought immense change in the development of high rise structures using Light weight concrete. He concluded that, coconut shell concrete can be used in countryside areas and places where coconut is copious and may also be used where the conventional aggregates are costly.KabiruUsmanRogo, SalehAbubakar (2010) made exploratory study of coconut shell as a coarse aggregate in Concrete. A total of 72 concrete cubes size

150x150 x150mm with different mixed ratios 1:2:4, 1:11/2:3 and 1:3:6 were casted and tested to determine the physical and Mechanical properties. Since the concrete strength of coconut shell with mix ratio 1:11/2 :3 Attained 16.5N/mm^2 at 28 days it can be used as plain concrete. Hence cost reduction of 48% was obtained.

SitiAminahBtTukiman and Sabarudin Bin Mohd (2009) investigated the combination of coconut shell and grained Palm kernel to replace aggregate in concrete. In this study, five different concrete mixes were taken. Three sample specimen will be prepared for each concrete mixes. The parameters will be tested are flexural strength, compressive strength, tensile strength, modulus of elasticity, durability and deflection crack behavior. Coconut shells were sun dried for 1 month before being crushed manually. The crushed materials were later transported to the laboratory and allowed to dry under ambient temperature for another 1 month. It was concluded that the Coconut shell were more suitable. Because, low strength- giving lightweight aggregate when used to replace common coarse aggregate in concrete production was found to be economical.

III.METHODOLOGY



COLLECTION OF MATERIALS COCONUT SHELL

Coconut shells were collected from nearby farm. It was cleaned and external fibers were removed. Shells were crushed into small pieces such that it passes into 20mm sieve and retains 4.75mm sieve. Crushed shells

were sun dried and immersed in water for 24 hours before used in concreting.

Similarly all other materials were bought from the shop as per the requirement which was designed in mix design.

TESTING OF MATERIAL PROPERTIES

The properties of materials were examined by water absorption test, specific gravity test and sieve analysis test. The following tables shows the results obtained from the test.

CEMENT

Table 3.1 PROPERTIES OF CEMENT

S.no	**Characteristics experimental value**	**Experimental value**	**As per is :8112-1939**
1	Consistency of cement	33%	-
2	Specific gravity	3.08	3.15
3	Initial setting time	32 min	30 min
4	Final setting time	8 hrs 20 min	Max 10 hrs

Table 3.2 PROPERTIES OF FINE AGGREGATE

S.No	Properties	Observed Values
1	Fineness modulus	8.13
2	Specific gravity	2.65
3	Water absorption	0.55%

COARSEAGGREGATE

Table 3.3PROPERTIES OF COARSEAGGREGATE

S.No	Properties	Observed Values
1	Fineness modulus	8.13
2	Specific gravity	2.65
3	Water absorption	0.55%

COCONUTSHELL

Table 3.4 PROPERTIES OF COCONUT SHELL

S.No	Properties	Observed Values
1	Specific gravity	1.132
2	Water absorption	11.3%

IV.TESTING DETAILS

SLUMP TEST

Slump test is conducted with fresh concrete to ensure workability and consistency of concrete. Concrete mixed with various percentageswere poured initially into slump cone mould. Concrete was poured as three layers and each layer tampered 25 times with tamping rod of 16 mm diameter. After the top layer has been done, the concrete was leveledwith a trowel and tamping rod. The mould was removed immediately by raising it slowly in vertical direction. This allows the concrete to subside. This subsidence is referred as slump value.

S.No	PERCENTAGE REPLACEMENT	SLUMP (mm)
1	0%	80
2	5%	73

3	10%	63
4	15%	51
5	20%	42

COMPRESSIVE STRENGTH TEST

The compressive strength of the concrete was determined by applying axial compression on the cubes of size 150 mm x 150 mm x 150 mm was casted. Three test specimens shall be made from each sample and tested after 7 and 21 days curing. The load was applied to the specimen uniformly. The failure load shows the ultimate compressive load. The compression strength in specimens is,

Compressive Strength= $\frac{P}{A}$ N/mm2 where, P= Ultimate Load (N);

A= Surface Area (mm^2)

SPLIT TENSILE STRENGTH TEST

The split-tensile strength of the concrete was determined by placing cylinder of size 150 mm x 300 mm horizontally in the compression testing machine. The load was applied gradually till the failure of the specimens is recorded. The tensile strength is calculated from the following formula. The split tensile strength of the specimens is,

The split-tensile strength = $\frac{2P}{\pi DL}$ N/mm^2 where P-Ultimate load

D-Diameter of Cylinder

L-Length of Cylinder

FLEXURAL STRENGTH TEST

Beams of size (400 mm X 100 mm X 100 mm) casted and the specimen were subjected to two point loading. The specimen was marked50 mm at both ends and as well as 133.3 mm marking from where 50 mm marking is done. The failure load is noted based on the following formula flexural strength is calculated. The flexure strength of the specimen is,

Flexure strength = $\frac{PL}{bd^2}$ N/mm^2

V. RESULTS AND DISCUSSIONS

A. TEST RESULT FOR FRESH CONCRETE:

The test results are given in Table 5.1, thus there is a reduction in workability of concrete as the percentage of coconut shell replacement is increased.

B. TEST RESULT FOR HARDENED CONCRETE:

Compressive strength test results:

Table 5.2 Compressive strength test results

DAYS	7	21
0%	19.4 N/mm^2	26 N/mm^2
5%	19.5 N/mm^2	26.8 N/mm^2
10%	18.8 N/mm^2	24.8 N/mm^2
15%	17.6 N/mm^2	21.6 N/mm^2
20%	15.7 N/mm^2	19.26 N/mm^2

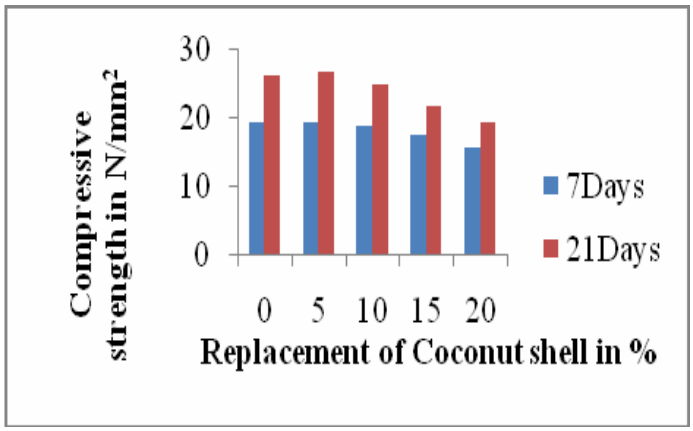


Figure 5.1 Comparison of compressive strength results in 7 and 21 days

C. Flexural strength test results:

Table 5.3 Flexural strength test results

DAYS	7	21
0%	5 N/mm^2	5.9 N/mm^2
5%	3.2 N/mm^2	3.8 N/mm^2
10%	2.8 N/mm^2	3.1 N/mm^2
15%	2.69 N/mm^2	2.9 N/mm^2
20%	2.3 N/mm^2	2.5 N/mm^2

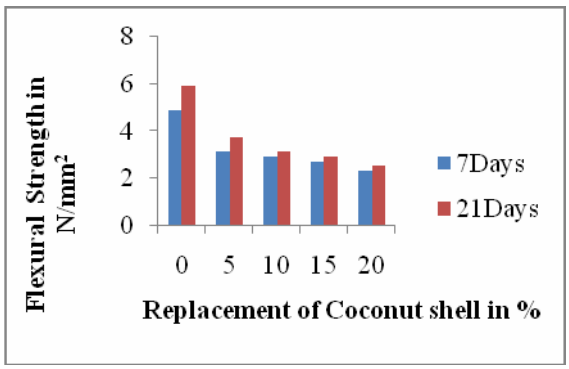


Figure 5.2 Comparison of flexural strength results in 7 and 21 days

D. Split Tensile strength test results:

Table 5.4 Split Tensile strength test results

DAYS	7	21
0%	0.71 N/mm^2	1.11 N/mm^2
5%	0.53 N/mm^2	0.78 N/mm^2
10%	0.42 N/mm^2	0.51 N/mm^2
15%	0.35 N/mm^2	0.42 N/mm^2
20%	0.26 N/mm^2	0.28 N/mm^2

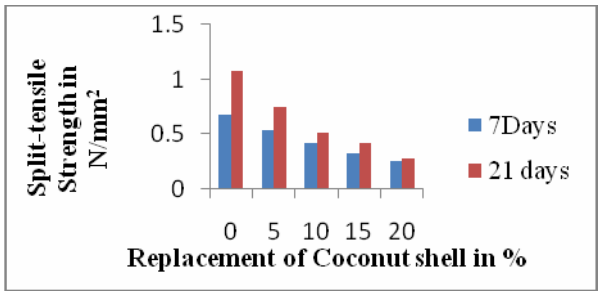


Figure 5.3 Comparison of split tensile strength results in 7 and 21 days

According to the tests conducted, the following results are derived

- The flexural strength and split tensile strength of concrete tends to decrease when there is increase in percentage of coconut shells
- Workability decreases as the percentage of coconut shell is increased.
- With the addition of 5% of coconut shell, it is observed that the compressive strength is similar to the conventional concrete.

- With the addition of 10%, 15%, 20% of coconut shell, it is observed that there is a decrease in the

compressive strength, flexural strength and split tensile strength.

- Hence replacement of coconut shell can be done upto 5%.
- Since the flexural strength decreases rapidly, replacement of coconut shell in concrete can be used for compression members only.

VI. CONCLUSION

From the experimental results and discussion, the coconut shell has been defined as lightweight aggregate in concrete. The usage of the coconut shell as aggregate in concrete can reduce the material cost in construction because of their low cost and their abundant existence as an agricultural waste. However, the entire replacement of coconut shell as coarse aggregate is not recommended. The optimal quantity of replacement will end in better strength and will also be economical.

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