Study on Properties of Natural Fibre And Concrete Made With Coconut Shell

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Abstract- *Utilization of agricultural waste material in concrete enhances the properties of concrete. To study this phenomenon concrete made of fly ash, stone dust, coconut shell for M20 was done and evaluated. Cement is substituted with fly ash by 5%. Coconut shells are replaced in the place of coarse aggregate. The breadth of coconut shell will vary from 0.25 to 1.0 cm. The present study has illustrated that addition of coconut shells to concrete enhances the properties of concrete as partial replacement.*

In this study, M20 grade of concrete was produced by replacing coarse aggregate by coconut shell. Twelve cubes were casted and their compressive strength is evaluated at 7, 14 and 28 days. The compressive strength of concrete reduced as the percentage replacement increased. Concrete produced by0%,5%,10%,15% replacement attained 28 days compressive strength

Keywords- Natural Resources, Coarse Aggregate, Coconut Shell, Fly Ash, Coconut Shell concrete, Compressive Strength

I. INTRODUCTION

In the world there are many countries in which coconut is cultivated at a big level. Here some data is provided according to production of coconut an area under the coconut cultivation. The coconut industry in India accounts for over a quarter of the world's total coconut oil output and is set to grow further with the global increase in demand. However, it is also the main contributor to the nation's pollution problem as a solid waste in the form of shells, which involves an annual production of approximately 3.18 million tones. Coconut shell represents more than 60% of the domestic waste volume. Coconut Shell, which presents serious disposal problems for local environment, is an abundantly available agricultural waste from local coconut industries.

In developing countries where abundant agricultural and industrial wastes are discharged, these wastes can be used as potential material or replacement material in the construction industry. This will have the double advantage of reduction in the cost of construction material and also as a means of disposal of wastes. The concrete obtained using Coconut Shell aggregates satisfies the minimum requirements of concrete. Concrete using Coconut Shell aggregates resulted in acceptable strength required for structural concrete. Coconut Shell may offer itself as a coarse aggregate as well as a potential construction material in the field of construction industries and this would solve the environmental problem of reducing the generation of solid wastes simultaneously.

The Coconut Shell-cement composite is compatible and no pre-treatment is required. Coconut Shell concrete has better workability because of the smooth surface on one side of the shells. The impact resistance of Coconut Shell concrete is high when compared with conventional concrete. Moisture retaining and water absorbing capacity of Coconut Shell are more compared to conventional aggregate. The amount of cement content may be more when Coconut Shell are used as an aggregate in the production of concrete compared to conventional aggregate concrete. There is presence of sugar in the Coconut shell as long as it is not in a free form; 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 shell needs no pre treatment, except for water absorption. Use of coconut shell aggregate in concrete as structural lightweight concrete is recommended. Coconut shell aggregate is a possible construction material and concurrently reduces the environmental problem of solid waste.

PRESENT STATUS OF COCONUT SHELL

The coconut palm is one of the most useful plants in the world. Coconut is grown in 92 countries in the world. Global production of coconut is 51 billion nuts from an area of 12 million hectares. South East Asia is regarded as the origin of coconut. The four major players India, Indonesia, Philippines and Sri Lanka contribute 78% of the world production. According to FAO statistics (Food and Agriculture Organization) 2007, global production of coconuts was 61.5 MT with Indonesia, Philippines, India, Brazil and Sri Lanka as the major contributors to coconut production. The total world coconut area was estimated at approximately 12 million hectares and around 93 percent is found in the Asian and Pacific region. The average annual production of coconut was estimated to be 10 million metric tons of copra equivalents. Of the world production of coconut, more than 50 percent is processed into copra. While a small portion is converted into desiccated coconut 5 and other edible kernel products, the rest is consumed as fresh nuts.

According to a study done by the Central Plantation Crop Research Institute (CPCRI) at Kasaragod, the country's coconut production was headed for an all-time high of 5 14,370 million nuts in 2006-07. Higher productivity in Tamil Nadu was the main reason for the escalation in the production. In India, the southern states account for 90 per cent of the total production. Kerala tops with 5400 million nuts while Tamil Nadu with 4190 million nuts is the second highest producer. Currently, the crop is grown in 1.91 million hectares with an annual production of nearly 14,000, 15700 & 17500million nuts. As per the recent Government of India statistics 2008-09, 2009- 10 & 2011-12 India has emerged as the largest producer of coconut in the world with a production of 15,840 million nuts. India accounts for 26.9 per cent of the world's production. In India, the four south Indian states namely Kerala, Tamil nadu, Karnataka and Andhra Pradesh account for around 90% of the coconut production in the country.

II. LITERATURE REVIEW

This chapter deals with various research work done on partial replacement of coconut shell as coarse aggregate in concrete. The properties of coconut shell were studied and its advantages were highlighted to justify its selection in this research of work.

Ries (2011): studied that Lightweight aggregate (LWA) plays important role in today's move towards sustainable concrete, Lightweight aggregates contributes to sustainable development by lowering transportation requirements, optimizing structural efficiency that results in a reduction in the amount of overall building material being used, conserving energy, reducing labor demands and increasing the survive life of structural concrete.
Amarnath Et Al (2012): studied the strength of coconut shells(CS) replacement and different and study the transport properties of concrete with CS as coarse aggregate replacement. They concluded that a. Increase in CS percentage decreased densities of the concrete. b. With CS percentage increased the 7 days' strength gain also increased with corresponding 28 days curing strength.

Kulkarni (2013): studied that Aggregates provide volume at low cost, comprising 66 percent to 78 percent of the concrete. Conventional coarse aggregate namely gravels and fine aggregate is sand in concrete will be used as control. While natural material is coconut shell as course aggregate will be investigating to replace the aggregate in concrete. Lightweight concrete is typically made by incorporating natural or synthetic lightweight aggregates or by entraining air into a concrete mixture. Coconut shell exhibits more resistance against crushing, impact and abrasion, compared to crushed granite aggregate. Coconut shell can be grouped under lightweight aggregate. There is no need to treat the coconut shell before use as an aggregate except for water absorption. Coconut shell is compatible with the cement. The 28-day air-dry densities of coconut shell aggregate concrete are less than 2000 kg/m3 and these are within the range of structural lightweight concrete. Coconut shell aggregate concrete satisfies the requirements of ASTM C 330.

Dewanshu (2014) et al. were investigated the Coconut shell as partial replacement of coarse aggregate in concrete. The aim of this research is to spread awareness of using coconut shell partial replacement of coarse aggregate in concrete and determining its compressive strength and density. The conclusions for the research are the compressive strength of the concrete decreased as the percentage shell substitution increased. Also increased in percentage replacement by coconut shell increase workability of concrete. Coconut shell can be used as partial replacement of coarse aggregate in R.C.C. concrete.

Damodhara et al. (2014) were investigated the use of coconut shell as coarse aggregate. In this study, coconut shell is used as light weight aggregate in concrete. The project paper aims at analyzing flexural and compressive strength characteristics of with partial replacement using M30 grade concrete. The project also aims to show that coconut shell aggregate is a potential construction material and simultaneously reduces the environment problem of solid. The conclusions for the result are, CSC where 25% of the coarse aggregate is replaced, shows properties similar to the nominal mix and 50% replaced CSC shows properties similar to light weight concrete which can be used as filler materials in framed structures, flooring tiles, thermal insulating concrete etc.,

Kambli & Mathapati. (2014) prepared three different Mix Designs for M20, M35, M50 grades of concrete. Percentage replacement by coconut shell varied as 0%, 10%, 20%, 30%, 40% respectively. It is concluded in this study that for M20 grade concrete cubes with 30% replacement of CS aggregates had given strength of 23 MPa at 28 days. Concrete cubes with 30% replacement of CS aggregates had given strength of 42 MPa at 28 days for M35. For M50 grade concrete cubes with 30% replacement of CS aggregates had given strength of 51 MPa at 28 days.

Shraddha and Shrikant (2014) replaced conventional coarse aggregate with coconut shell and concluded that- with 50% replacement of coarse aggregates by coconut shells, the strength attained reduces invariably from 10%-20% as compared to the conventional coarse aggregate concrete. With 50% replacement of coarse aggregates by coconut shells, the flexural strength attained reduces invariably from 10%-15% as compared to the coarse aggregate concrete Siti Aminah Bt Tukiman and Sabarudin Bin Mohd (2009) replaced the coarse aggregate by coconut shell and grained palm kernel in their study. Percentage of replacement by coconut shell were 0%, 25%, 50%, 75% and 100% respectively. Conclusion is that the combination of these materials has potential of being used as lightweight aggregate in concrete and also has reduce the material cost in construction

III.MATERIALS AND METHODOLOGY

Concrete is a composite material composed of coarse aggregate bonded together with fluid cement that hardens over time. Most concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements, such as cement fondue. However, asphalt concrete, which is frequently used for road surfaces, is also a type of concrete, where the cement material is bitumen, and polymer concretes are sometimes used where the cementing material is a polymer Materials used in this study are:

Cement is a binder, a substance used in construction that sets, hardens and adheres to other materials, binding them together. The most important types of cement are used in the production of mortar in masonry, and of concrete, which is a combination of cement and an aggregate to form a strong building material.

Cements used in construction are usually inorganic, often lime or calcium silicate based, and can be characterized as being either hydraulic or nonhydraulic, depending upon the ability of the cement to set in the presence of water.

AGGREGATES

Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and portland cement, are an essential ingredient in concrete. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete.

Aggregates, which account for 60 to 75 percent of the total volume of concrete, are divided into two distinct categories-fine and coarse as shown in Fig. 2. Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 3/8 inch sieve. Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter. Gravels constitute the majority of coarse aggregate used in concrete with crushed stone making up most of the remainder.

Natural gravel and sand are usually dug or dredged from a pit, river, lake, or seabed. Crushed aggregate is produced by crushing quarry rock, boulders, cobbles, or large-size gravel. Recycled concrete is a viable source of aggregate and has been satisfactorily used in granular sub bases, soil cement, and in new concrete.

After harvesting, aggregate is processed: crushed, screened, and washed to obtain proper cleanliness and gradation. If necessary, a benefaction process such as jigging or heavy media separation can be used to upgrade the quality. Once processed, the aggregates are handled and stored to minimize segregation and degradation and prevent contamination.

Aggregates strongly influence concrete's freshly mixed and hardened properties, mixture proportions, and economy. Consequently, selection of aggregates is an important process. Although some variation in aggregate properties is expected, characteristics that are considered include.

FINE AGGREGATE	SIZE VARIANCE
Coarse sand	2-0.5mm
Medium sand	0.5-0.25mm
Fine sand	0.25-0.06mm
Silt	0.06-0.002mm
Clay	<0.002mm

COARSE AGGREGATE

IS 383-1970 defines coarse aggregate as most of which is retained on 10mm sieve and containing only so much finer material is permitted for various types. In most cases, the ideal finished piece would be 100% aggregate. A given application's most desirable quality (be it high strength, low cost, high dielectric constant, or low density) is usually most prominent in the aggregate itself; all the aggregate lacks is the ability to flow on a small scale, and form attachments between particles. The matrix is specifically chosen to serve this role, but its abilities should not be abused.

The angular aggregates consist well defined edges formed at the intersection of roughly planar surfaces and these are obtained by crushing the rocks as shown in Fig.

3. Angular aggregates result maximum percentage of voids (38-45%) hence gives less workability. They give 10-20% more compressive strength due to development of stronger aggregate-mortar bond. So, these are useful in high strength concrete manufacturing.

- Grading
- Durability
- Particle shape and surface texture
- Abrasion and skid resistance
- Unit weights and voids
- Absorption and surface moisture

Grading refers to the determination of the particle-size distribution for aggregate. Grading limits and maximum aggregate size are specified because these properties affect the amount of aggregate used as well as cement and water requirements, workability, pump ability, and durability of concrete. In general, if the water-cement ratio is chosen correctly, a wide range in grading can be used without a major effect on strength. When gap-graded aggregate are specified, certain particle sizes of aggregate are omitted from the size continuum. Gap-graded aggregate are used to obtain uniform textures in exposed aggregate concrete. Close control of mix proportions is necessary to avoid segregation.

SHAPE AND SIZE MATERIAL

Particle shape and surface texture influence the properties of freshly mixed concrete more than the properties of hardened concrete. Rough-textured, angular, and elongated particles require more water to produce workable concrete than smooth, rounded compact aggregate. Consequently, the cement content must also be increased to maintain the water-cement ratio. Generally, flat and elongated particles are avoided or are limited to about 15 percent by weight of the total aggregate. Unit-weight measures the volume that graded aggregate and the voids between them will occupy in concrete.

The void content between particles affects the amount of cement paste required for the mix. Angular aggregates increase the void content. Larger sizes of well-graded aggregate and improved grading decrease the void content. Absorption and surface moisture of aggregate are measured when selecting aggregate because the internal structure of aggregate is made up of solid material and voids that may or may not contain water.

The amount of water in the concrete mixture must be adjusted to include the moisture conditions of the aggregate.Abrasion and skid resistance of an aggregate are essential when the aggregate is to be used in concrete constantly subject to abrasion as in heavy-duty floors or pavements. Different minerals in the aggregate wear and polish at different rates. Harder aggregate can be selected in highly abrasive conditions to minimize wear.

STONE DUST

Coal mines any inert dust spread on roadways as a defense against the danger of coal dust explosions. The stone dust used is of a type that does not cake in mine air. Ground limestone is satisfactory in most conditions. About 5% less limestone is required than shale, and gypsum has about two to three times the efficiency of shale. Gypsum appears to owe its high efficiency to its hydrate water. Inert dusts are effective because they absorb heat that the coal dust would otherwise receive from the flame.

COCONUT SHELL

a) Coconut shell has high strength and modulus properties.

b) It has added advantage of the high lignin content. High lignin content makes the composites more weather resistant.

c) It has low cellulose content due to which it absorbs less moisture as compare to other agricultural waste.

d) Coconuts are being naturally available in nature and since its shells are no biodegradable; they can be used readily in concrete, which may fulfill almost all the qualities of the original form of concrete.

In this work coconut shell was used as partial replacement of coarse aggregate which is crushed granite. Coconut shells were unruffled from the local temple after that it was cleaned, sun dried, removed fibers to evaluate its properties. Coconut shell needs no pre treatment, except for water absorption. Coconut shell has very high water absorption. Due to this property, before use coconut shells were soaked in potable water for 24 hours.

Coconut Shell

MATERIAL TEST

COLOR TEST OF CEMENT:

The color of the cement should be uniform. It should be grey colour with a light greenish shade.

PRESENCE OF LUMPS

The cement should be free from any hard lumps. Such lumps are formed by the absorption of moisture from the atmosphere. Any bag of cement containing such lumps should be rejected.

CEMENT ADULTERATION

The cement should feel smooth when touched or rubbed in between fingers. If it is felt rough, it indicates adulteration with sand.

TEMPERATURE TEST OF CEMENT

If hand is inserted in a bag of cement or heap of cement, it should feel cool and not warm.

FLOAT TEST

If a small quantity of cement is thrown in a bucket of water, the particles should float for some time before it sinks.

SETTING TEST

A thick paste of cement with water is made on a piece of glass plate and it is kept under water for 24 hours. It should set and not crack.

STRENGTH OF CEMENT TEST

A block of cement 75 mm ×75 mm and 75mm long is prepared and it is immersed for 7 days in water. It is then placed on supports 15cm apart and it is loaded with a weight of about 34 kg. The block should not show signs of failure.
The briquettes of a lean mortar (1:6) are made. The size of briquette may be about 75 mm ×75 mm ×75 mm. They are immersed in water for a period of 3 days after drying. If cement is of sound quality such briquettes will not be broken easily.

DATE OF PACKING

Strength of cement reduces with time, so it is important to check the manufacturing date of the cement. Generally, the cement should be used before 90 days from the date of manufacturing.

TESTS ON COARSE AGGREGATE BULK DENSITY OF COARSE AGGREGATE

The bulk density is the weight of the material in a given volume and it is measured in kilograms per litre. The bulk density of an aggregate is affected by several factors, including the amount of moisture present and the amount of effort introduced in filling the measure. Bulk density shows how densely the aggregate is packed, when filled in a slandered manner. it depends on the particle size distribution and shape of the particle.

SPECIFIC GRAVITY OF COARSE AGGREGATE

(i) Take 2 kg of aggregate. Sample larger than 10mm.

(ii) Wash the sample thoroughly to remove finer particle and dust.

(iii) Place the sample in a wire basket and immerse it in distilled water at a temperature between 22oC and 32oC with a cover of at least 5 cm of water above the top of the basket.

(iv) Remove the entrapped air by lifting the basket containing the sample 25 mm above the base of the tank and allowing it to drop per second, care being taken to see that the sample is completely immersed in water during the operation.

(v) With the sample in water at a temper of 22oC-32oC (W).

(vi) Remove the basket and aggregate from water and allow To drain for a few minutes.

(vii) Empty the aggregate from the basket to a shallow tray as shown in Fig. 5.

(viii) Immerse the empty basket in water jolt 25 times and then the weight in water (W1).

(ix) Place the aggregates in oven at a temperature of 100oC to 110oC for 24 ± 0.5 hours.

(x) Remove it from the oven and cool it and find the weight. (W2).

CALCULATION

Apparent Specific Gravity = (Weight of a substance / wt of an equal volume of water)

= W3/ (W3- (W1-W2))

MIX DESIGN

Mix design is a process of selecting suitable ingredients and determining their relative proportions with the objective of producing concrete of having certain minimum workability, strength and durability as economically as possible.

It is a performance based mix where choice of ingredients and proportioning are left to the designer to be decided. The user has to specify only the requirements of concrete in fresh as well as hardened state. The requirements in fresh concrete are workability and finishing characteristics, whereas in hardened concrete these are mainly the compressive strength and durability. A mix design was conducted as per IS 10262-1982 to arrive at M20 mix concrete

Procedure for concrete mix design calculation as per IS 10262-2009 based on strength and durability, workability, economy is discussed in this article. To produce concrete of required strength and properties, selection of ingredients and their quantity is to be found which is called concrete mix design as shown in Fig. 6. Proper mix design will solve every problem arises in concrete while placing or curing etc. The mix design also helps to produce economical concrete.
Generally, cement is more costly than other ingredients of concrete. So, quantity and quality of cement is designed by proper mix design concept. In this article we are going to discuss about the concrete mix design concept as per IS 10262- 2009.

Quantity of materials required for each mix

Materials	**Mix 1 (Plain**	**Mix 2(5%**	**Mix 3 (10%Co**	**Mix 4 (15%Co**
Cem	1.4	1.4	1.4	1.4
Wat	700	700	700	700
Fine	2.1	0.63	0.63	0.63
Ston	_	1.47	1.47	1.47
Coar	4.2	3.99	3.78	3.57

SLUMP CONE TEST

Workability of coconut shell

TEST	0 %	5%	10%	15%
SLUMP (MM)	29	27	26	27

COMPACTION FACTOR

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959. The apparatus used is Compacting factor apparatus.

Table. 7 Compaction table

TEST	0%	5%	10%	15%
COMPACTION (Kg)	8.5	7.97	7.35	7.20

IV.RESULTS

In this study the density and strength characteristics of concrete produced by volume replacement of 5%, 10%, 15% replacement of crushed granite with coconut shells were investigated. The conclusions for the research are the compressive strength of the concrete decreased as the percentage shell substitution increased. Also increased in percentage replacement by coconut shell increase workability of concrete. Coconut shell can be used as partial replacement of coarse aggregate in R.C.C. concrete.

The Following Recommendations Are Made At The End Of The Study.

- Further studies should be carried out to ascertain the possibility of using coconut shell concrete as a structural material.
- Durability studies on coconut shell concrete should be carried out its beh.
- Developing countries like Ghana should encourage the use of agricultural wastes in construction as an environmental protection and cost reduction measure
- Our study had many limitations, of which the time was a major concern. The strength properties of CSC depends on the aggregate properties of coconut shells and its individual strength characteristics.
- Experiments on impact value, crushing value etc can be done in order to analyze the strength properties of coconut shells. When CSC is used along with reinforcement, the surface bonding between coconut shell aggregates and steel come.

Following Values Are The Compressive Strength Of Cubes After 7, 14, 28 Days Of Curing.

Compressive strength of cubes

% OF COCONUT SHELL	COMPRESIVE STRENGTH AT 7 DAYS (mpa)	COMPRESSIVE STRENGTH AT 14 DAYS (mpa)	COMPRESSIVE STRENGTH AT 28 DAYS (mpa)
0 %	13	19	28
5%	10	15	21
10 %	15	21	26
15 %	12	18	22

V. CONCLUSION

Results of experiment on compressive strength, water absorption and sorption for different coconut shells replaced concrete have been presented with those of control concrete. However, performance of coconut shell aggregate concrete having a marginal variation than normal aggregate concrete. The main points of this study are

- Due to addition in stone dust workability of concrete is increased when compared to normal concrete.
- The possibility exists for the partial replacement of coarse aggregate with coconut shell to produce lightweight concrete.
- Coconut shell exhibits more resistance against crushing, impact and abrasion, compared to crushed granite aggregate.
- Coconut shell can be grouped under lightweight aggregate. There is no need to treat the coconut shell before use as an aggregate except for water absorption.
- Coconut shell is compatible with the cement.
- The 28-day air-dry densities of coconut shell aggregate concrete are less than 2000 kg/m3 and these are 184 within the range of structural lightweight concrete.

VI. FUTURE SCOPE

The effect of coconut shells on high strength concrete should be studied and thus the use of coconut shell concrete can be extended to industrial and commercial buildings. Since the corrosion study is not done, the applicability of coconut shell concrete in constructions could be tested.

Coconut shell is a good insulator in itself and as such it can improve the thermal properties of concrete. This is particularly useful in a tropical country like Indian where the mercury levels are quite high for most part of the year, so as to maintain the room temperature with in comfort levels of its inhabitants. It can also reduce the load on air conditioning system thus reducing the power consumption.

The acoustic properties of concrete of reinforced with other natural fibers have been studied in the past using an impedance tube apparatus and the results are fair enough to justify the use of coconut shells as an alternative which is a good absorbent due to the presence of surface pores.

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