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Experimental Investigation on Concrete with Replacement of Coconut Shell as a Fine Aggregate

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ABSTRACT: The economy of the structure is affected by high cost of conventional construction material. With increasing concern over the excessive exploitation of natural aggregates, synthetic lightweight aggregate produced from environmental waste is a viable new source of structural aggregate material. The uses of structural grade lightweight concrete reduce considerably the self-load of a structure and permit larger precast units to be handled. Recently in the environmental issues, restrictions of local and natural access or sources and disposal of waste material are gaining great importance. Today, it becomes more difficult to find a natural resource. Use of the waste materials not only helps in getting them utilized in cement, concrete and other construction materials, but also has numerous indirect benefits such as reduction in land fill cost, saving in energy, and protecting environment from possible pollution effect. It also helps in reducing the cost of concrete manufacturing. In the present work, coconut shell as partial replacement for coarse aggregate in concrete is studied. The concrete with ground coconut shell was found to be durable in terms of its resistance in water, acidic, alkaline and salty. Density of coconut shell is in the range of 550 - 650 kg/m³ and these are within the specified limits for lightweight aggregate. The characteristic properties of concrete such as compressive strength, flexural strength, impact resistance, bond strength & split tensile strength using the mix made by replacing coarse aggregate with crushed coconut shell aggregate were reviewed in the present work.

KEYWORDS: Coconut shell, coarse aggregate, light weight concrete.

I. INTRODUCTION

Following a normal growth in population, the amount and type of waste materials had increased accordingly. Many of the non-decaying waste materials in the environment will remain in the environment for hundreds perhaps thousands of years. The non-decaying waste materials cause a waste disposal crisis, thereby contributing to the environmental problems. However, the environmental impact can be reduced by making more sustainable use of this waste. This is known as the Waste Hierarchy. Its aim is to reduce, reuse, or recycle waste, the latter being the preferred option of waste disposal.

Infrastructure development across the world created demands for construction material. Concrete is the premier civil engineering material. Concrete manufacturing involve consumption of ingredients like cement, aggregates, water & admixtures. Among all the ingredients, aggregates form the major parts. Two billion of aggregate are produced each year in the United States. Production is expected to increase to more than billion tons per year by the year.

Typical concrete is a mixture of fine aggregates, coarse aggregates, cement and water. Because of its convenient use, it is not only used in building construction but also in other areas roads, harbours, bridges and many more. The usage of concrete is very wide. It is one of the most important constituent materials. It is comparatively economical, easy to make offers continuity solidity and indeed it lays the role of developing and improving our modern society. Coarse aggregates not only constitute the bulk of concrete but also contribute the most towards its compressive strength through high particle strength and close particle interlock.

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But, the construction industry worldwide is facing a shortage of this natural resource. The recycling of demolished masonry rubble as coarse aggregate in concrete is an interesting possibility due to its environmental benefits. It is not only a viable alternative to natural coarse aggregate but also solves the major problem of disposal of demolition of waste. Recycling construction and demolition waste into aggregate would ultimately lead to fewer quarries and landfills

II. METHODOLOGY

The material to be used in this project is the coconut shell. Coconut shell is a waste product from our kitchen. Mostly commonly a domestic waste. While wastes generated by industrial and agricultural processes have created disposal and management problems which pose serious challenges to efforts towards environmental conservation, their use contributes to resource conservation, environmental protection and the reduction of construction costs, since waste materials can be obtained at little or no cost, while making significant contribution to the conservation of natural resources and maintenance of ecological balance.

The methodology pattern consists of following steps:

- 1) Review of literature
- 2) Material collection
- 3) Testing of materials
- 4) Mix design
- 5) Control mix & Coconut shell in concrete
- 6) Casting and curing
- 7) Fresh concrete test & Hardened concrete test
- 8) Results & discussion
- 9) Conclusion

III. TESTING OF SPECIMEN

Testing is done for both fresh concrete & hardened concrete. The test conducted for both the concrete types are listed below

1. *Fresh concrete test*

Visual observations during mixing and compaction of all the concretes suggested that the concretes were homogeneous; there was no segregation and bleeding, the mixes were compactable. The fresh state performance of the CS concretes was comparable with control concrete. The concretes had low slump the slump values of the concretes were between 20-26mm. The slump decreased with increase in CS percentage.

[1] Slump Cone Test

The slump test is the most commonly used method. Consistency is a term very closely related to workability. It is a term which describes the state of fresh concrete. It is used for the determination of the consistency of freshly mixed concrete, where the maximum size of the aggregate does not exceed 38 mm.

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The input image is obtained and further preprocessing is done.

Table 1 Slump Cone Test Value

Type of concrete	Initial value (cm)	Final value (cm)	Slump (cm)
Control Mix	30	27	3
5% coconut shell powder in Concrete	30	26	4
10% coconut shell powder in Concrete	30	24	6
15% coconut shell powder in Concrete	30	23	7
20% coconut shell powder in Concrete	30	26	4
25% coconut shell powder in Concrete	30	25	5

[2] Flow Table Test

The flow table test or flow test is a method to determine consistency of fresh concrete. Flow table test is also used to identify transportable moisture limit of solid bulk cargoes. It is used primarily for assessing concrete that is too fluid (workable) to be measured using the slump test, because the concrete will not retain its shape when the cone is removed.

Table 2 Flow Table Test Value

Type Of Concrete	%
Control mix	120
5% coconut shell powder in Concrete	110
10% coconut shell powder in Concrete	100
15% coconut shell powder in Concrete	95
20% coconut shell powder in Concrete	80
25% coconut shell powder in Concrete	65

[3] Compaction Factor Test

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959. This test gives behaviour of concrete under the action of external forces. It measures the compactability of concrete, by measuring the amount of compaction. This test is suitable for mixes having medium and low work abilities

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Vol. 8, Issue 11, November 2019

Table 3 Compaction Factor Test Value

Type of Concrete	Value
Control Mix	0.75
5% coconut shell powder in Concrete	0.70
10% coconut shell powder in Concrete	0.65
15% coconut shell powder in Concrete	0.50
20% coconut shell powder in Concrete	0.45
25% coconut shell powder in Concrete	0.40

2. Hardened concrete test

Hardened concrete gains strength with time and testing these hardened concrete for quality check is important for structures. Different types of tests are available to check different properties of hardened concrete which are discussed

[1]Compressive strength test

To calculate the compressive strength of concrete cubes the universal testing machine (UTM) having capacity of 300 tonne was used. In this test the strength obtained in tonne.

Table 4 Compressive Strength Test Value

Proportion	7 days (N/mm ²)	14 days (N/mm ²)	28 days (N/mm ²)
0%	15.1	17.5	28.6
5%	14.6	15	26.2
10%	13.8	14.5	25.4
15%	13.7	14.7	22.2
20%	12.67	13.5	21.5
25%	10.52	12.1	20

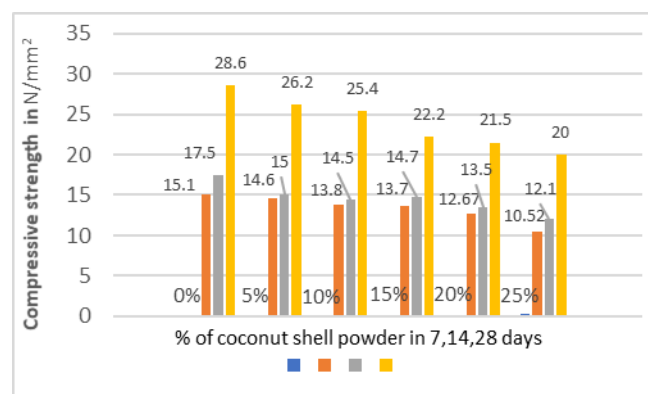


Chart 1 Compressive Strength Test of Coconut Shell Added Concrete for 7,14, 28 days

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[2] Split Tensile Strength Test

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 to determine the load at which the concrete members may crack.

Table 5 Split Tensile Strength Test Value

Proportion	7 days (N/mm ²)	14 days (N/mm ²)	28 days (N/mm ²)
0%	2.1	2.5	2.7
5%	1.95	2.4	2.6
10%	1.92	2.35	2.57
15%	1.5	2.20	2.43
20%	1.2	2.15	2.26
25%	1.1	2.0	2.20

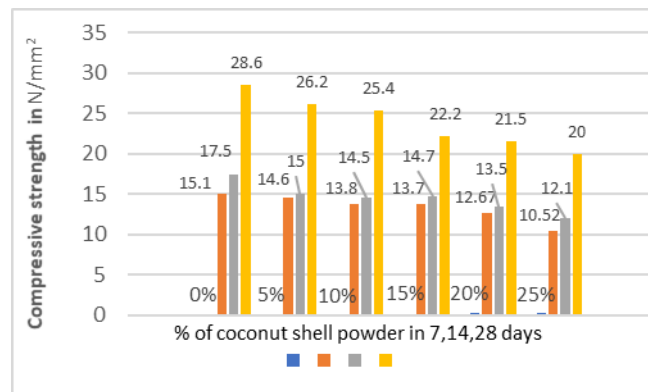


Chart 2 Split Tensile Strength Test of Coconut Shell Added Concrete for 7,14, 28 days

[3] Flexural Strength Test

For this test the beams of dimension 100mmX100mmX500mm 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.

Table 6 Flexural strength of Coconut Shell Added Concrete for 7,14,28 days

Proportion	7 days (N/mm ²)	14 days (N/mm ²)	28 days (N/mm ²)
0%	2.3	2.5	3.6
5%	2.1	2.4	3.3
10%	2.0	2.35	3.1
15%	1.4	2.20	2.4
20%	1.1	2.15	1.7
25%	1	2.0	2.20

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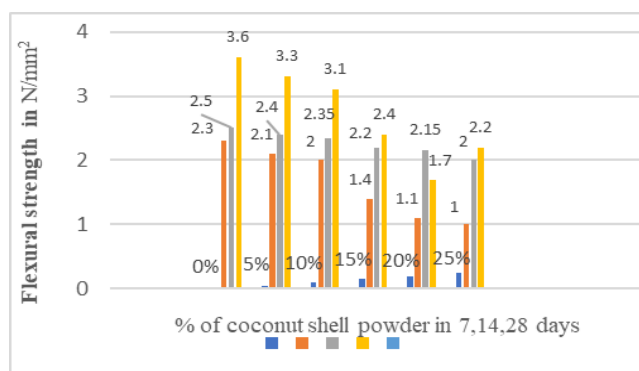


Chart 3 Flexural Strength Test of Coconut Shell Added Concrete for 7,14, 28 days

IV. CONCLUSIONS

The partial replacement of coconut shell with fine aggregate at 5%, 10%, 15%, 20%, 25% decreased the overall strength of concrete such as compressive strength, split tensile strength test & flexural strength test. But, it attained the target strength at 5%, which can be used for construction. Therefore it can be used for low cost housing, concrete roads & structures which may not need much more strength. Also, here addition of coconut shell reduces the overall weight of conventional concrete, thus acting as a lightweight concrete. Also, heat reduction is achieved by using this as a fine aggregate. Thus it can be used in humid areas. Also setting time of concrete is increased thus, favorable in long distance concrete distribution. Compared with other conventional fine aggregate here coconut shell powder is cheap as 1 metric ton of m-sand cost 1600 Rs/- whereas 1 metric ton of coconut shell powder cost 1000 Rs/-

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