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"Bio-Concrete Using Waste Material (Coconut Shell)"

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***Abstract:** This study presents the development of bio-concrete using waste coconut shell as a partial replacement for conventional coarse aggregate in concrete. The growing demand for sustainable construction materials has encouraged the use of agricultural waste to[2] reduce environmental impact. Coconut shell, an abundant and biodegradable waste material, is utilized to minimize the consumption of natural stone aggregates. The coconut shells were cleaned, crushed, and graded before being incorporated into the concrete mix. The properties of bio-concrete were evaluated through standard tests on workability, density, and compressive strength. Results indicate that coconut shell concrete produces a lightweight material compared to conventional concrete. Although there is a slight reduction in strength, the achieved values are adequate for non-structural and low-load applications. The material also shows improved thermal and acoustic insulation properties. The use of coconut shell helps in effective waste management and reduces landfill disposal. This approach contributes to lowering construction costs and carbon emissions. Bio-concrete using coconut shell supports sustainable and green building practices. It is particularly suitable for rural infrastructure and affordable housing projects. With further research and mix optimization, its performance can be enhanced. Therefore, coconut shell bio-concrete has strong potential as an eco-friendly alternative construction material.*

I. INTRODUCTION

The construction industry is one of the largest consumers of natural resources, especially coarse aggregates, which leads to depletion of stone quarries and environmental degradation. To address these environmental issues, the concept of bio-concrete using coconut shell waste has gained importance. In this study, coconut shell is used as a partial replacement of conventional coarse aggregate at proportions of 10%, 20%, and 30% by weight. Coconut shell is lightweight, durable, and eco-friendly, making it a suitable alternative material in concrete production. Studies have shown that adding coconut Sheel to concrete can improve compressive strength, impact strength, and flexural strength. The use of coconut shell as a replacement for coarse aggregate helps in reducing environmental waste, conserving natural resources, lowering the self-weight of concrete, and promoting sustainable construction practices. Thus, bio-concrete using coconut shell waste provides an effective solution for environmental waste management while contributing to green and sustainable development in the construction

II. LITERATURESURVEY

1) Of ConcretewithMechanicalPropertiesCoconut Shell.

Concrete with coconut shell is prepared by replacing natural course Aggregate with coconut shell. Coconut shell is a waste material and its use makes concrete economical and eco-friendly. The mechanical properties describe the strength and behaviour of this concrete under load. The compressive strength of coconut shell concrete is lower than normal concrete. This is because coconut shell is lighter and less strong than crushed stone. However, up to 10, 20, 30% replacement gives acceptable compressive strength. Tensile strength of coconut shell concrete is slightly reduced. Weak bonding between coconut shell and cement paste causes this reduction. Flexural strength of coconut shell concrete is moderate. The concrete becomes less brittle and slightly flexible in nature. Density of coconut shell concrete is lower than conventional concrete. This produces lightweight concrete and reduces dead load of structures. Lower weight helps in economical foundation design. Durability of coconut shell concrete is satisfactory under normal conditions. Proper curing improves its strength and life. Workability is slightly less due to water absorption of coconut shell. Use of admixtures improves workability. Coconut shell concrete shows good resistance to moisture. It is

2) : Coconut Shellparticlesasconcreteaggregate.

Coconut shell particles are obtained from discarded coconut shells, which are an agricultural waste product abundantly available in tropical countries like India. These shells are cleaned, crushed, and sieved to obtain particles of required sizes, making them suitable for use as partial replacement of coarse aggregate in concrete. Coconut shell is hard, lightweight, and has good abrasion resistance.

Due to its low density compared to conventional crushed stone aggregate, the use of coconut shell particles helps in producing lightweight concrete. This reduces the self-weight of the structure, which can be beneficial in low-cost housing and non-load-bearing applications. In concrete, coconut shell particles are commonly used as a replacement for coarse aggregate at different percentages such as 10%, 20%, and 30% by weight. Experimental studies have shown that concrete with coconut shell aggregate provides acceptable compressive strength for structural and non-structural applications, especially at lower replacement levels.

3) OBJECTI

- To utilize waste coconut shell material effectively in order to reduce environmental pollution and promote sustainable construction practices.
- To study the mechanical properties (compressive strength, tensile strength, flexural strength) of coconut shell bio-concrete.
- To evaluate the durability characteristics such as water absorption, permeability, and resistance to chemical attack.
- To compare the performance of coconut shell bio-concrete with conventional concrete.
- To reduce the overall weight of concrete by using lightweight coconut shell aggregate.
- To analyze the cost-effectiveness of producing bio-concrete using locally available agricultural waste.
- To promote eco-friendly and sustainable construction materials in the building industry.

III. EVALUATING PROGRAMME

A. Mix Design

Foronecubeof0.15*0.15*0.15M

1) Cementcontent=425.11*(0.15*0.15*0.15M)=1.434kg.
2) Watercontent=185*(0.15*0.15*0.15M)=0.624litter.
3) Coarseaggregate=1157.58*(0.15*0.15*0.15M)=3.906kg.
4) Fineaggregate=651.14*(0.15*0.15*0.15M)=2.197kg.
5) Replacing10%offineaggregatewithcoconut shell=3.906*(10/100) =0.390kg.
6) Replacing20%offineaggregatewithcoconut shell=3.906*(20/100) =0.781kg.
7) Replacing30%offineaggregatewithcoconut shell=3.906*(30/100) =1.171kg.

Cube volume = 1.1*(0.15)3 = 0.0037125 m^3

MIX (%)	CEMENT (kg)	FA (kg)	CA (kg)	Coconut Shell (kg)	WATER (lit)
0%	1.43	2.19	3.90	0	0.711
10%			3.51	0.390	
20%			3.11	0.781	
30%			2.78	1.171	

- Specimen Preparation

Coconut shells are collected, cleaned, dried, and crushed into suitable sizes (12–20 mm) to be used as partial replacement for coarse aggregate. The concrete mix is designed by replacing coarse aggregate with coconut shell at different percentages (such as 0%, 10%, 20%, and 30%) while maintaining a constant water-cement ratio.

All materials (cement, sand, coarse aggregate, and coconut shell) are measured by weight and mixed thoroughly. Water is added gradually to obtain uniform consistency. The fresh concrete is poured into standard moulds such as cubes (150×150×150 mm), cylinders (150×300 mm), and beams (100×100×500 mm). Proper compaction is done using a tamping rod or vibration table.

After 24 hours, the specimens are demoulded and cured in water for 7, 14, and 28 days before testing.

- Curing

Curing is the process of maintaining adequate moisture and temperature in concrete after casting to ensure proper hydration of cement and strength development.

After 24 hours of casting, the coconut shell bio-concrete specimens are carefully removed from the moulds. The specimens are then immersed in a curing tank filled with clean water at room temperature. Proper curing is carried out for different time periods such as 7, 14, and 28 days.

Curing improves the strength, durability, and bonding between cement paste and coconut shell aggregate. Adequate curing is essential to achieve the desired performance of bio-concrete.

- Slumpconetest:

SR.NO	Replacing percentage of fine aggregate with crumb rubber	rkability
1	10%	125mm
2	20%	110mm
3	30%	130mm

Table6.1.1.1ValuesofworkabilitybySlumpconetest

- Compressive Strength of Concrete

“Bio-Concrete Using Waste Material (Coconut Shell)”

The compressive strength test is conducted to determine the load-carrying capacity of coconut shell bio-concrete. Cube specimens of size 150 mm × 150 mm × 150 mm are used for testing.

After curing for 7, 14, and 28 days, the specimens are removed from water, surface dried, and placed in a Compression Testing Machine (CTM). The load is applied gradually and uniformly until the specimen fails.

The compressive strength is calculated using:

Compressive Strength=Load at FailureCross-sectional Area\text{Compressive Strength} = \frac{\text{Load at Failure}}{\text{Cross-sectional Area}}Compressive Strength=Cross-sectional AreaLoad at Failure

The results are compared with conventional concrete to evaluate the performance of bio-concrete made with coconut shell as partial replacement of coarse aggregate.

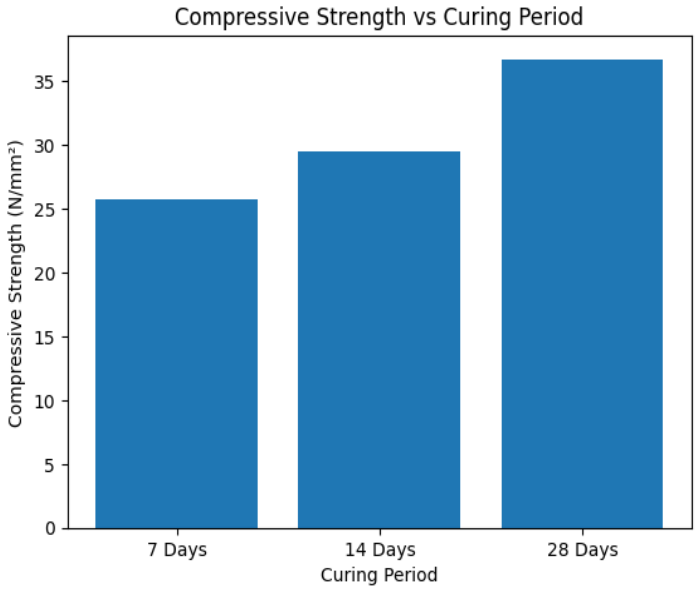


TestsonHardenconcrete:

Compressivestrengthofnormalconcretecube:

Curing	Compressive Strength (N/mm^2)
7days	25.75
14days	29.50
28days	36.75

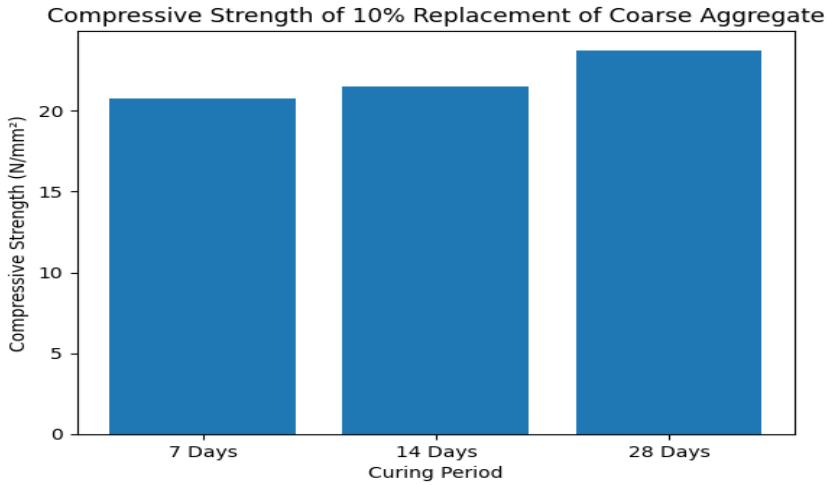
Table6.1.2.1Comp.strengthvaluesfornormalconcrete



Compressivestrengthof10%replacementofCourseaggregatecube:

Curing	ompressive Strength (N/mm2)
7days	20.75
14days	21.50
28days	23.75

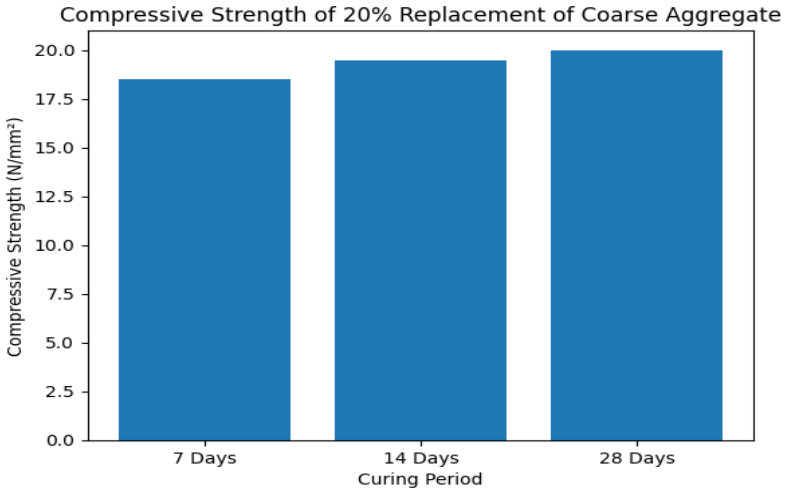
Comp.strengthvaluesfor10 %replacementofCourseaggregate



Compressivestrengthof20 %replacementofCourseaggregatecube:

Curing	Compressive Strength (N/mm^2)
7days	18.5
14days	19.50
28days	20.00

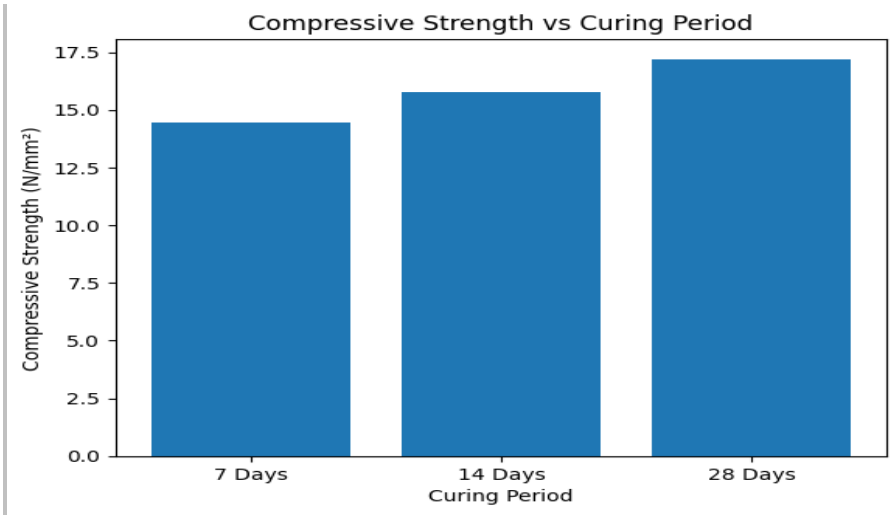
Comp.strengthvaluesfor20%replacementofCourseaggregate



Compressivestrengthof30 %replacementofCourseaggregatecube:

Curing	essive Strength (N/mm^2)
7days	14.45
14days	15.75
28days	17.20

Comp.strengthvaluesfor30 %replacementofCourseaggregate



COSTESTIMATIONANDHARDWARE

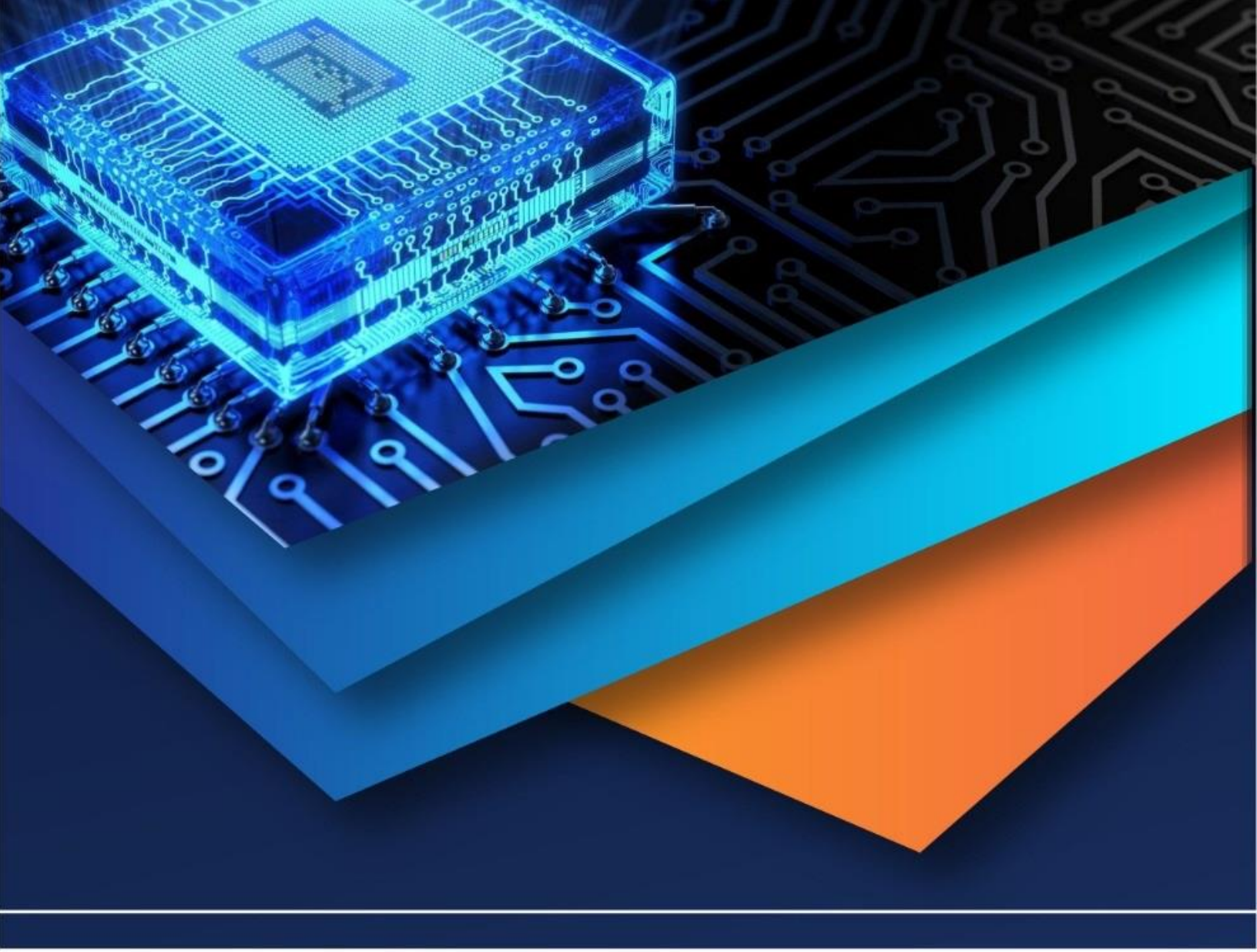
Sr. no	ameofParticularitem	Quantity	Costofitem
1	Coconut Shell	15kg	200/-
2	Cement(OPC)	50kg	360/-
3	Sand	50kg	550/-
4	Aggregate	50kg	650/-
	Total=		1760

IV. CONCLUSION

Bio-concrete using waste coconut shell is a sustainable and eco-friendly construction material that effectively utilizes agricultural waste while reducing the demand for natural aggregates. The use of coconut shell in concrete results in a lightweight material with acceptable strength for non-structural and low-load applications, along with improved thermal and acoustic properties. This approach helps lower construction costs, minimizes environmental impact, and supports green building practices. Although it is not suitable for heavy structural members, bio-concrete with coconut shell shows strong potential for low-cost housing, rural infrastructure, and precast products, making it a promising alternative material for sustainable development.

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[1] 1akshat Dhruw, 2aaditya Shukla, 3bhumika Pradhan, 4sanjana Gupta, 5yaditya Kumar, 6priyanka Verma
[2] GowriNandhan R S ¹, IsmayilHussain ², Sreelekshmi U S ³, Asish Prasad ⁴ ¹²³ B.tech Civil Engineering Student, Dept. of Civil Engineering, St. Thomas Institute for Science and Technology, Trivandrum ⁴ Assistant Professor, Dept. of Civil Engineering, St. Thomas Institute for Science and Technology, TrivandrumGowriNandhan R S¹, Ismayil Hussain², Sreelekshmi U S³, Asish Prasad⁴ ¹²³B.tech Civil Engineering Student, Dept. of Civil Engineering, St. Thomas Institute for Science and Technology, Trivandrum ⁴Assistant Professor, Dept. of Civil Engineering, St. Thomas Institute for Science and Technology, Trivandrum
[3] Md. Mostafizur Rahman Khan1, Shafayet Ullah2, Md. Taukir Ahmed3 Lecturer, Department of Civil Engineering, CCN University of Science & Technology, Chowdhury State, Kotbari, Cumilla.
[4] Study on Strength parcels of Concrete Containing Coconut Shell as Coarse Aggregate Brindhalakshmi M.L# and Gunasekar S## U.G Student, Department of Civil Engineering, K.S.Rangasamy College of Technology, Tiruchengode, Namakkal – 637215, Tamilnadu. India.# Assistant Professor, Department of Civil Engineering, K.S.Rangasamy College of Technology, Tiruchengode, Namakkal – 637215, Tamilnadu. India.



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