

EVALUATION OF MECHANICAL CHARACTERISTICS OF REINFORCED CEMENT CONCRETE BY PARTIAL REPLACEMENT OF COCONUT SHELL AS COARSE AGGREGATE AND COCONUT FIBER AS ADDITIVE

Submitted in fulfilment of the requirements of the award of
Bachelor of Engineering Degree in Civil Engineering

By

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**DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF BUILDING AND ENVIRONMENT**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **CHINNI TARUN KUMAR (REG.NO.39200010), PANEM PRASANTH REDDY (REG.NO.39200031)** who carried out the project entitled "**EVALUATION OF MECHANICAL CHARACTERISTICS OF REINFORCED CEMENT CONCRETE BY PARTIAL REPLACEMENT OF COCONUT SHELL AS COARSE AGGREGATE AND COCONUT FIBER AS ADDITIVE**" under my supervision from August 2022 to April 2023.

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DECLARATION

ACKNOWLEDGEMENT

We, **CHINNI TARUN KUMAR, PANEM PRASANTH REDDY (39200010)** here by declare that the Project Report entitled **"EVALUATION OF MECHANICAL CHARACTERISTICS OF REINFORCED CEMENT CONCRETE BY PARTIAL REPLACEMENT OF COCONUT SHELL AS COARSE AGGREGATE AND COCONUT FIBER AS ADDITIVE"** done by us under the guidance of **Dr. R. Nirmala** at **SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY** is submitted in fulfillment of the requirements for the award of Bachelor of Engineering Degree in Civil Engineering.

DATE: 19-04-2023

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ABSTRACT

The present study investigates the viability of replacing some of the coarse material in concrete with coconut shell and incorporating coconut fiber as an additive to produce lightweight aggregate concrete. This strategy tries to alleviate the high price of traditional building materials, and the excessive exploitation of natural resources. The research objectives involve assessing the properties of coconut shell for use in reinforced concrete, evaluating the workability and strength of concrete with varying proportions of coconut shell and fiber, and analyzing the cost implications of producing eco-friendly concrete. The results of the experiments show that adding coconut fibre to concrete increases its strength by a certain amount, beyond which it decreases. Furthermore, replacing coarse aggregate by 10% coconut shell reduces the density and breaking strength of the concrete, while increasing its slump. These findings suggest that using coconut shell in place of certain coarse aggregate may result in a lightweight concrete material that is less strong and less dense. The study also identifies an optimal amount of coconut fiber that can be added to the concrete mix to maintain its strength. Overall, this study offers insightful information about using coconut shell and fibre to produce concrete, highlighting the need for careful selection and optimization of these materials to ensure the desired properties of the concrete.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL

Coconut shells and coconut fibers are sustainable and eco-friendly materials that can be used as aggregates and reinforcement in concrete. Coconut shells are the outer hard coverings of the coconut fruit, while coconut fibers are obtained from the husk of the fruit. Both materials are abundant and can be sourced from coconut-producing countries, making them an attractive alternative to traditional construction materials. Coconut fibres may be utilised as a reinforcing agent and coconut shells can be used as a substitute for coarse gravel in concrete in the building sector. Light and having a high intensity-to-weight ratio are coconut shells, which makes them suitable for use in less weight concrete applications. On the other hand, coconut fibers are known for their high tensile strength and low density, making them ideal for reinforcing concrete.

Every year, millions of tons of solid waste from coconut shells are generated, and this amount is expected to increase over time. To solve this problem, different coconut waste products have been employed as partial or full replacements for coarse aggregates in the making of concrete, including the husk of coconuts, the shell of a coconut, coir fibre, and coconut shell powder. Agricultural waste products like coconut shell and coir fibre may be used successfully in concrete, according to studies. More than 96 nations cultivate coconut, with India alone dedicating 2.076 million hectares to the crop and producing 16.837 million tonnes of coconuts annually. In addition to enhancing the quality of the concrete, the use of these materials encourages the correct disposal of agricultural wastes like coconut fibre and shell, minimising the environmental effect.

Coconut shells can serve as an alternative material for crushed stones due to their chemical composition, which is composed of 33.61% cellulose, which is 36.51% the lignin and 0.61% of the ash and resembles wood. Coconut shells hold less moisture than other agricultural trash due to their low content of cellulose. The use of coconut shell-solid composite in construction requires no pretreatment and is compatible with cement. There are two forms of fibre made from coir that are taken from coconut shells: brown fibre from ripe coconuts and white fibre from new coconuts. The Indian coir industry generates around 7.5 million tons of coir fiber waste annually. The benefits of coir fibers include resistance to moths, parasites, and decay, protection against high temperatures and noise, heat resistance, non-absorbent properties, durability, safety, and resilience even after extended use. Coir fibers are also non-toxic and biodegradable, while possessing properties such as being fire-resistant, moisture-resistant, strong, static-free, and easy to clean.

Although coconut shells have been utilized for several purposes, a substantial amount of coconut shell wastes remain underutilized. Concrete made using coconut shell as aggregate offers one practical answer to the problems associated with handling coconut trash. Numerous research on the use of the coconut shell aggregate in pavement have been carried out during the last ten years. As an agricultural waste product, coconut shells are widely available throughout tropical regions around the world. In fact, coconut shell is a major contributor to the nation's pollution issue, generating approximately 3.18 million tones of waste annually. Incorporation of waste materials into concrete can lead to an improvement in its strength.



Fig. 1.1: Coconut shell

Fig 1.1 provides a description the different sizes of coconut shells that can be used as an ingredient in concrete mixtures. Coconut shells are a flexible and environmentally friendly material that may be utilised in lighter concrete uses in place of conventional coarse aggregates. Depending on the required qualities of the combination and the particular application, the measurement of the coconut shells utilised for concrete might vary. The use of coconut shells in concrete offers many advantages, including reducing the environmental impact of construction, lowering the weight of concrete, and improving thermal and acoustic insulation properties.

The two forms of coir fiber—brown fibres taken from mature coconuts and white fibres taken from young coconuts—are separated from the coconut's outer shell. Brown fibers are mainly used in the construction industry. The coir industry in India produces a significant amount of coir fiber waste, estimated to be around 7.5 million tons annually. Coir fibres provide a number of benefits, including being moth-proof, resilient to rot and fungus, resistant to high temperatures and sound, heatproof, non-absorbent, long-lasting, secure, and able to revert to their initial form following extensive usage. Coir fibres are also compostable and harmless. They also possess property-based benefits, such as being difficult to burn, moisture-resistant, sturdy, completely free of static electricity, and easy to clean.



Fig. 1.2: Coconut fiber

The creation of outstanding durability building materials like exceptionally strong concrete and the progress of construction methods using automated tools are both important shifts that the construction industry is going through. Coco strengthened concrete and fiber-reinforced concrete (FRC) are two of these cutting-edge materials that are gradually winning over engineers in the construction field. The creation of fibres, binder materials, manufacturing techniques, and the usage of coconut shells in the building sector have all grown significantly in recent years. Fig 1.2 illustrates the application of coconut fiber as reinforcing material in the concrete. Coco fiber is a natural and sustainable material that can be developed from the coco fruit's husks. It has excellent tensile strength and low density, making it an ideal material for reinforcing concrete structures. These advantageous characteristics make CRC and FRC composites a workable substitute for cutting-edge construction. Their uses in construction range from constructing new ones to renovating older ones, including bridges, buildings, and offshore platforms, among other sorts of structures.

Coconut shells have emerged as the most superior natural shell with high modulus and strength properties, making them an attractive material for reinforcement in concrete. Similarly, coconut fibers are known for their ductility, making them a favorable reinforcement material in concrete as well. Additionally, these materials are biodegradable, making their impact on the environment negligible. In addition to offering a waste disposal solution, using coconut waste from coconut-based production facilities to create materials with excellent strength also turns out to be a financially advantageous choice. Their non-abrasive nature and easy availability further add to their appeal. Ongoing research is exploring the feasibility of coconut shells and fiber threads are in vertical reinforcements in interconnected frameworks without mortar, which could offer an affordable solution for earthquake-resistant housing.

Table 1.1: Properties of Coconut shell and Coconut fiber

S.No	Coconut shells	Coconut fiber
1.	Due to its excellent strength and modulus characteristics, this material has a great potential.	Coconut fiber has excellent tensile strength, which makes it an ideal material for reinforcing concrete.
2.	Water absorption was found be maximum for 35 Wt%	Additionally, it was established that the husk of coconut released roughly 87% of its phosphate and 10% percent its total nitrogen.
3.	Significantly stronger.	4-6 times stronger to withstand tension compared to other fibres.
4.	65%cellulose in a coconut shell.	Higher amount of potassium.
5.	Biodegradable and compostable.	Biodegradable and compostable
6.	Heat and fire resistance.	Commonly known as coir.

WATER ABSORPTION

Coconut shell concrete displays a lower water absorption rate, indicating that during the mixing process, only a small amount of water is absorbed by the coconut shell. However, some researchers have found that the coconut shell may absorb as much as 24% of water, which can be remedied by soaking it in water for a day. The coconut shell is capable of absorbing a little amount of water while mixing thanks to this procedure. The disparity in findings among researchers could be attributed to their varying methods. Untreated coconut shells tend to absorb more water than those that have been treated, and the mixing process is heavily influenced by the method used.

1.2 SCOPE OF PRESENT INVESTIGATION

- Strength is improved by using the shell of coconut and coir fibre.
- Concrete may be made for less money by using coconut shells or other discarded resources from nature.
- To build an ecofriendly concrete with the help of coconut shells and coir.

1.3 OBJECTIVES OF THE PROJECT

- To identify the characteristics of coconut shell that will be utilised in reinforced concrete
- To determine the workability of the concrete made with coconut shell and coconut fiber in different proportions.
- To determine the compressive strength of the concrete made with coconut shell and coconut fiber in different proportions.
- To determine the split tensile strength of the concrete made with coconut shell and coconut fiber with different proportions.
- To determine the flexural strength of the concrete made with coconut shell and coconut fiber with different proportions.

CHAPTER 2

LITERATURE REVIEW AND METHODOLOGY

2.1 GENERAL

In the literature review on concrete made with coconut shells and coconut fiber, several studies were found that examined various aspects of this composite material. These studies included comparisons between coconut-based concrete and traditional concrete, research studying how fibre and coconut shell content affect the characteristics of concrete, analyses of bonding behavior and interfacial adhesion, assessments of fire resistance and examinations of curing conditions and additive use, and reviews of challenges and potential applications. Overall, the literature showed that research in this field is ongoing and that coconut-based concrete has significant potential as a sustainable and cost-effective building material.

2.2 LITERATURE

Gunasekaran, (2015) In his research study, the effectiveness of coconut shell durability under three distinct curing conditions—complete soaking in water, intermittent salivating, and complete air drying—was examined.. In addition to this, the strength and resistance of the shells at elevated temperatures ranging from 100 to 400°C were also examined. Analysis of features such as intake, sorptivity, the amount of porous voids, fast chlorine penetrability, and concentration of chloride profile were the main goals of the study. For the creation of Coco Shelled Aggregate Concrete (CSAC), the following mix design proportions were used: 1:1.47:0.65:0.42 by the quantity of cement. The study's findings showed that CSAC's durability traits were comparable to those of other common lightweight concrete materials, and it was discovered that effective curing was crucial for obtaining higher durability. These results led the researchers to the conclusion that coconut shells may be a viable substitute for material in the manufacture of concrete.

Sangeetha (2016) produced two mixtures with clay and the shell of a coconut.

The study aimed to investigate the use of coconut shells as a substitute for aggregate in concrete. The research involved varying levels of substitution, with coconut shell and clay replacing coarse aggregate by 0%, 10%, 20%, and 30% of mass. The concrete mix design generated grade M20 concrete with a water-to-cement ratio of 0.50. The findings, however, indicated that concrete breaking strength decreased with increasing substitute %. Nevertheless, the study comes to the conclusion that it is feasible to include clay and coconut shells into concrete for building with reinforced concrete that is both affordable and environmentally beneficial.

Apeksha Kanojia and Sarvesh Jain (2017) noticed the effects of significantly substituting coconut shells for natural stone aggregate when making concrete. This study involved two phases, where the first phase involved designing conventional concrete without any replacement of the coarse aggregate. In the second phase, coconut shell was used in lieu of the coarse aggregate in varied volumes of 10 percent, 20 percent, 30 percent, and 40%, with a ratio of water to cement of 0.55 and concrete of the M20 grade. Three alternative water-cement ratios were also employed, along with various ratios of coarse gravel and coconut shell. The parameters considered were density, breaking strength, and cement requirement, and the water-cement ratio was used to establish the goal strength. The study found that replaced standard aggregates with waste coconut shell made the concrete lighter, with approximately 7.5% reduction in density for a 40% substitution. It was also observed that 5% replacement of coarse aggregate did not require additional cement, and for 10% replacement, Just 3.6% more cement was needed. The study suggests that coconut shell can be used as a suitable alternative to standard aggregate for concrete production, which is cost-effective and environmentally friendly.

Gunasekaran, (2017) was investigated the characteristics of concrete using Quarries Dust (QD) as fine aggregate and Coco Shells (CS) as coarse aggregate. In this investigation, both the control concrete with QD and the concrete made using coconut shells and quarry dust (QD) had the same mix layout and ratio by the amount of sand, cement, aggregate, and water. All of the mixtures underwent testing for workability, the density, compressive, split tensile, and impact resistance. The findings show that using QD improves the mechanical qualities of concrete regardless of whether CS aggregate or control concrete is used.

Shrikant Harle (2017) is done an investigation on This study examined using coconut shell as a changed for some of the coarse aggregates in concrete. They tested the density, workability, and breaking strength of the concrete with 10%, 20%, and 30% coconut shell substitution. They found that when more than 20% coconut shell was used, the concrete became lighter. However, the density and breaking strength decreased while the workability increased as the coconut shell substitution increased.

Sravika, (2017) investigated using quarry dust and coconut shell as a partial replacement for coarse and fine aggregate. The study concentrated on replacing 30% of the fine aggregate with quarry dust and replacing some of the coarse material with coconut shell. Coconut shell was replaced in proportions of 10%, 20%, 30%, and 40% by weight. M-20 (1:1.5:3) in a water-to-cement ratio of 0.50 was the specified mix. The tensile and breaking strengths of three types of concrete—standard, coconut shells, and quarry dust—were examined. The findings revealed that using coconut shell as a replacement up to 20% of the time enhanced the concrete's strength, while using it 30% of the time caused a steady loss of strength.

Ralf Winterberg (2010) delivers a report that provides an in-depth illustration of the potential consequences and capabilities of concrete reinforced with fibres. Based on their analysis, the researchers have concluded that fiber reinforced concrete is a promising and rapidly developing area of construction materials. They suggest that fibres are incorporated into concrete has the potential to yield significant cost and time savings by reducing the labor-intensive processes involved in the preparation, placement, and maintenance of conventional reinforcement methods. Furthermore, they emphasize the need for continued research and development in this field to maximize its potential benefits and applications in the construction industry

Majid Ali, (2012) most likely looked into the relationship between the bond strength of coconut fibre and concrete, as well as various factors like embedment length (1 cm, 2 cm, 3 cm, and 4 cm), fibre dimensions (thin: 0.15-0.20 mm, medium: 0.20-0.30 mm, thick: 0.30-0.35 mm), pre-treatment method (soaked fibre, CaAl fibre, and heated fibre), and mix design ratio (1:2:2, 1:3:3, and 1:4:4). For all of the combinations, a water-to-cement ratio of 0.48 was utilised. The binding strength and energy needed for the fibre pullout test were determined under experimental settings.

The results revealed that the bond strength between fibers and concrete was highest when the fibers were 3 cm in length, thick in diameter, treated with boiled water, and when the concrete mix has ratio with 1:3:3. Additionally, the effects of fiber pullout energy were also examined in this study.

Majid Ali, (2012) studied the damping ratio and fundamental frequency of Coir Fibre Concrete Reinforced beams in order to better understand their mechanical properties. The beams used in the study had fibre dimensions of 2.5, 5, and 7.5 cm and fibre percentage of 1%, 2%, 3%, and 5%. The dynamic and static modules of the beams were compared. With a ratio of water to cement of 0.48, the concrete mix was made up of one part cement, two parts sand, and Two parts aggregate. The results showed that CFRC beams' fundamental frequency decreased structural damage and their damping improved. A lower both static and dynamic modulus of elasticity was observed for CFRC with higher damping. According to the study's findings, CFRC functioned at its peak when its fibre length and content were both 5 cm.

Saravana Raja Mohan, (2012) conducted the investigation with the goal of adding treated coconut fibre into concrete made from fly ash composites to improve their qualities. The project entailed creating a composite material out of treated coconut fibre and fly ash concrete. On the structural characteristics of the composite, the impact of substituting 43 grade Ordinary Portland Cement with fly ash at various percentages (10%, 15%, 20%, 25%, and 30%) and adding treated natural coconut fibre with a length of 40mm at various proportions (0.15%, 0.30%, 0.45%, and 0.60%) were examined. According to the findings, fly ash-based coconut fibre reinforced concrete performed better than regular concrete.

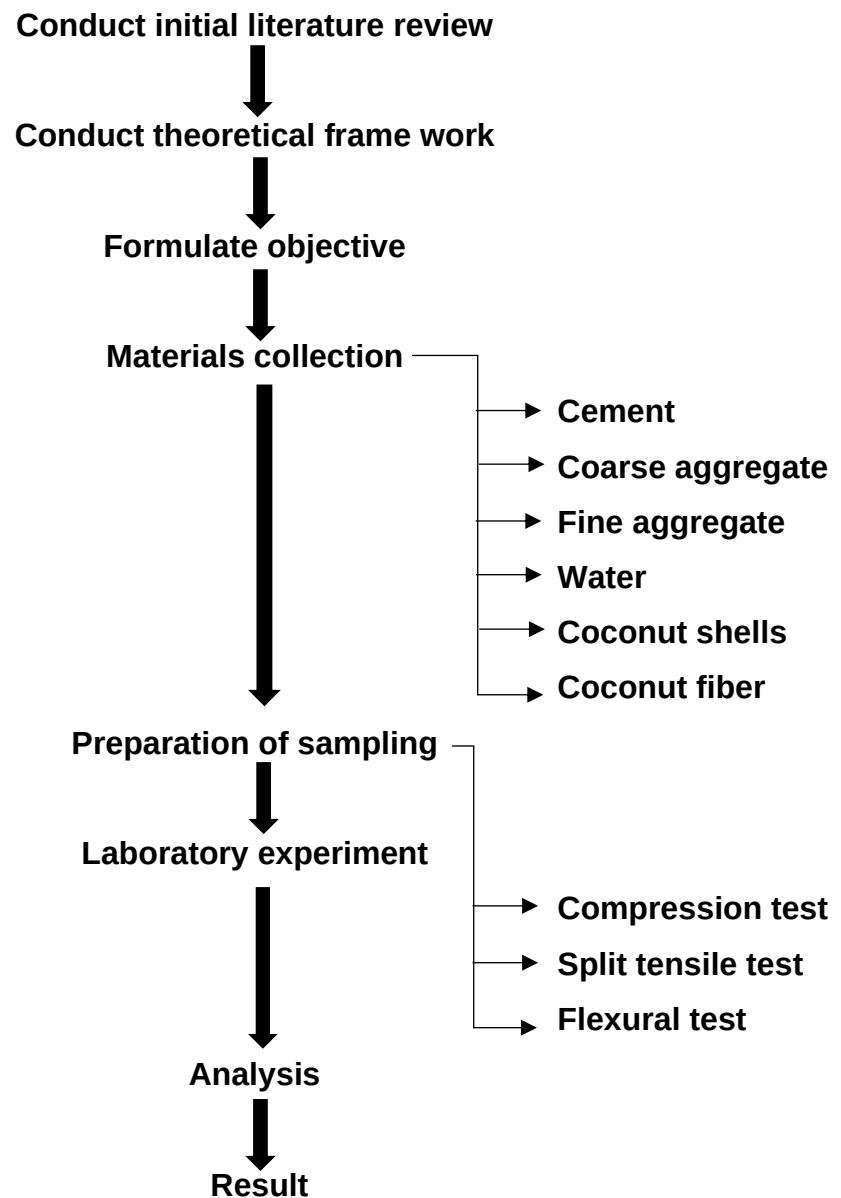
Mahyuddin Ramli, (2013) We investigated how reinforced concrete that had coconut fibre added to it performed in harsh environmental conditions. Three distinct sorts of habitats were taken into consideration: simulated seawater and air conditions, as well as continuous immersion in the ocean. Breaking strength and bending strength tests were conducted for each condition to analyze the properties of concrete. Coconut fibers were added at four different rates, i.e., 0.6%, 1.2%, 1.8%, and 2.4%. The findings indicated that the inclusion of coconut fibres subjected to tropical air conditions improved the constructions' breaking and bending strengths by as much as 13% and

9%, respectively. However, the coconut fibres had a negative impact on the concrete's strength when the samples were repeatedly exposed to seawater.

Pusit Lertwattanakruk and Anchisa Suntijitto (2015) studied the characteristics of natural fiber-based composite construction materials that are appropriate for humid and hot climates. The study concentrates on the thermal, mechanical, and physical properties of oil palm and coconut coir fibres. Cement, crushed limestone, water, sand, and natural fibres were used in the study in varied amounts, with cement making up 5 percent, 10 percent, and 15 percent of the total ingredients. The used water-to-cement (w/c) ratio was 0.25. The results of the experiments demonstrated that decreasing materials density, cracking, and flexibility occurred as the fraction of natural fibre replacement increased. The study came to the conclusion that fibre concrete materials might be employed in residential construction.

Onkar,(2018) introduced the creation and evaluation of composite materials utilising coir fibres and used groundnut shells as waste, with a comparative analysis between the two. Groundnut shells were crushed to particle sizes of 0.1 cm, 0.15 cm, and 0.2 cm, and epoxy resins were added in a proportion of 70:30 by weight of the fibers. Mechanical tests were performed to ascertain the material's tensile, bending, and water absorption strengths. The results revealed that the coir fibre composite outperformed the groundnut's shell composite in terms of performance.

2.3 METHODOLOGY



Concrete made with coconut shell and coconut fiber involves several steps. First, the materials used in the concrete are tested to determine their suitability for use. After that, the mix is created in accordance with industry standards to get a sufficient amount of water. The coconut shells are used as a lightweight aggregate, replacing some of the coarse aggregate in the mix, while the coconut fibers are used as reinforcement, in the form of processed fibers or raw fiber meshes coated with coconut oil. Slump tests are carried out to make sure the mix is usable and the mixing procedure is carried out carefully enough to prevent bleeding. Before testing, the cubes are carefully dried in the sun after being adequately cured for seven to twenty-eight days. To assess if employing coconut shells and fibres as an alternative to conventional materials is successful, the strength qualities of the resultant concrete are contrasted to those of regular concrete.

In a prior work, the strength characteristics of standard concrete and concrete reinforced with coconut shell and fibre were compared, and the influence of fibre form on strength was explored. Tests were conducted using raw and processed coconut fibre meshes of 5 cm x 5 cm and covered with the oil of coconut at 4%, 5%, and 6% fibre contents, respectively. The appropriateness of ingredients for concrete was initially assessed using material testing. To guarantee there was no bleeding, the mix was created in accordance with IS 10262: 2009, and the procedure for mixing was followed as per protocol. The cubes were dried before testing after being cured for seven days and 28 days, respectively, in order to verify workability.

CHAPTER 3

MATERIALS AND EXPERIMENTAL INVESTIGATION

3.1 GENERAL

Coconut shells and coconut fibre are added to the same components used in ordinary concrete to create concrete produced with coconut shells and coconut fibre. Cement, fine aggregate (often sand), coarse aggregate (typically gravel or crushed stones), water, and the additional shells of coconut and coconut fibre make up the main ingredients of this concrete mix.

Coconut fibre is utilised as a reinforcing ingredient to increase the strength and longevity of the concrete, while the shell of the coconut is used to partially replace coarse aggregate. Depending on the individual purpose and desired qualities of the concrete, different amounts of coconut shells and fibre may be added in the mixture.

The use of coconut shell and coconut fiber in concrete offers several advantages, such as reduced weight, improved insulation properties, and increased sustainability due to the use of natural and renewable materials. However, it is necessary to carefully evaluate the properties of the resulting concrete to ensure that it meets the necessary strength and durability requirements for its intended use. Overall, concrete made with coconut shell and coconut fiber is a promising and sustainable approach to construction that offers a range of benefits. By utilizing these materials, we can reduce waste and environmental impact, while still achieving desirable properties in our concrete mix.

3.2 MATERIALS

- Cement
- Coarse aggregate (gravel or crushed stone)
- Fine aggregate (sand)
- Water
- Coconut shells (crushed)
- Coconut fibers (chopped)

3.2.1 Cement

In the construction business, cement is an adhesive used to bind aggregates like gravel, sand, and other stones and crushed rock together to create concrete. The cement's colour and granular texture were displayed in Fig. 3.1, which gave the substance a visual representation. It is the most frequently used building material in the globe and is essential to the growth of contemporary infrastructure.

Limestone, clay, and various other ingredients are heated in a kiln to a temperature of around 1450°C to create cement. In order to control how quickly cement sets, the resultant material, known as clinker, is next crushed into fine particles and combined with tiny quantities of gypsum.

Properties of cement

Strength: Cement has high breaking strength, which means it can withstand heavy loads without cracking or breaking. This property makes it ideal for use in structures such as bridges, buildings, and roads.

Durability: Cement is highly durable and can withstand harsh environmental conditions such as freeze-thaw cycles, chemical attack, and abrasion. This property makes it suitable for use in structures that are exposed to harsh environmental conditions.

Setting time: The period of time required for cement to solidify and become stronger after being combined with water is known as the setting time. The quantity of gypsum injected to the mixture can be changed to alter the cement's setting time.

Workability: Good workability is exhibited by cement, enabling it to be easily mixed, placed, and compacted into various shapes and sizes.



Fig. 3.1: Cement

3.2.2 Coarse aggregate

Coarse aggregate is a construction material that is used in the production of concrete. Fig 3.2 illustrates the coarse aggregate that was incorporated into the concrete mix during the preparation process. The image showcases the size, shape, and texture of the coarse aggregate, providing a visual representation of the material that was used. It is the biggest part of concrete and normally accounts for 60 to 75 per cent of the overall volume. Gravel, crushed rock, or recycled concrete are examples of materials that are used to make coarse aggregate.

Properties of coarse aggregate

Size and shape: Coarse aggregate comes in a range of sizes and shapes, from round river gravel to angular crushed stone. The working ability, capacity, and lifespan of the concrete may all be impacted by the size and form of the aggregate.

Density: The density of coarse aggregate varies depending on the material used. Typically, the density of coarse aggregate varies from 1400 to 1600 kg/m³.

Strength: The cohesiveness of the particle as well as their individual strength determine the capacity of coarse aggregate. The concrete's strength may be impacted by the coarse aggregate's strength.

Absorption: Coarse aggregate can absorb water, which can affect the water-cement ratio of concrete mix. The absorption of coarse aggregate can also affect the working ability and durability of the concrete mix.

Durability: The durability of the coarse aggregate is necessary as it can affect the overall durability of concrete mix. The coarse aggregate should be resistant to weathering and chemical attack to ensure the longevity of the concrete.



Fig. 3.2: Coarse aggregate

Tests on coarse aggregate

Fineness modulus test

The fineness modulus test is used to measure the size distribution of coarse aggregates. It is an major test in determining the suitability of aggregates for use in concrete and other construction materials. Here are the steps involved in conducting the fineness modulus test on coarse aggregate. Additionally, Table 3.1 lists the results for the coarse aggregate's fineness modulus, a measurement of the distribution of particle sizes. The table displays the fineness modulus values and outcomes for various coarse aggregates in numerical form.

- A representative sample of the coarse aggregate was taken by using a sample splitter or by quartering.
- The sample is weighed and the weight was recorded.

- A series of sieves with squared apertures is used to sieve the aggregate. The sieves were placed from largest to smallest, with the biggest sieve at the top.
- A mechanical shaker is used to shake the sieves for a predetermined amount of time (often 10 minutes), or until no more material passes through the sieves.
- Each sieve's material that was kept was weighed, and its masses were recorded.
- Calculations were done to determine the percentage of each sieve's passage and the total weight remained on each sieve.
- By multiplying the total percent of particles retained on each filter by 100, a fineness modulus was computed. The fineness modulus was the resultant value.

Table 3.1: Fineness modulus of coarse aggregate

s.no	BIS sieve size	Weight retained in grams	%of weight retained	Cumulative % Of wt retained	Cumulative % Of weight passed
1	80mm	0 g	0 %	0%	100%
2	40mm	0 g	0 %	0%	100%
3	20mm	2000 g	41%	41%	59%
4	10mm	2091 g	58.2%	92.2%	0.8%
5	4.75mm	4 g	0.8%	100%	0%
6	2.36mm	0 g	0%	100%	0%
7	1.18mm	0 g	0%	100%	0%
8	600micron	0 g	0%	100%	0%
9	300micron	0 g	0%	100%	0%
10	150micron	0 g	0%	100%	0%

Total for 5000 gm of coarse aggregate was used in this test

Therefore the fineness modulus of coarse aggregate is

$$\begin{aligned}
 &= \text{cumulative \% of weight passing} / 100 \\
 &= 0+0+41+99.2+100+100+100+100+100+100/100 \\
 &= 740.2/100 \\
 &= 7.4
 \end{aligned}$$

Hence the fineness modulus of course aggregate is 7.4

3.2.3 Fine aggregate

Fine aggregate is a construction materials that is used in the production of concrete mix. It is the smaller component of concrete and typically makes up about 25 to 40 percentage of the total amount of the concrete mix. Fine aggregate is made up of materials such as M-sand, crushed stones, or gravel.

Properties of fine aggregate

Gradation: The size distribution of the particles in fine aggregate is important as it can affect the workability, durability and strength of the concrete mix. A well-graded fine aggregate with a range of particle sizes will produce a more workable concrete with better strength and durability.

Fineness modulus: The particle size of the fine aggregates is determined by the fineness modulus. It is computed by multiplying the total percentage of fine material retained on each sieve in a predetermined sequence by 100 and adding the results. The strength and workability of the concrete can be impacted by the fineness modulus.

Specific gravity: The weight of certain amounts of the material divided by the weight of a corresponding amount of water gives the fine aggregate its specific gravity. The volume and weight of the concrete mix, as well as its durability and strength, can be influenced by the specific gravity of the fine aggregate.

Absorption: The ratio of water to cement of a concrete mixture can be impacted by the ability of fine aggregate to absorb water. The ability to work and longevity of the concrete might also be impacted by the fine aggregate's absorption.

Shape: The shape of the fine aggregate particles can affect the workability and strength of the concrete. Angular particles tend to produce more workable concrete with better interlocking and greater strength, while rounded particles tend to produce less workable concrete with lower strength.



Fig. 3.3: Fine aggregate

Tests on fine aggregate

Fineness modulus test

A technique for figuring out the particulate size distribution for fine aggregates, like sand, is the fineness modulus test. The construction sector frequently uses this quick and easy test. Table 3.2 shows the values for the fine aggregate's fineness modulus. The distribution of the total weight of the particles recovered on each sieve, organised in a decreasing sequence of size, is shown in the figure.

- A sample of the fine aggregate is taken.
- The sample's weight was calculated to the closest 0.1 gramme. An accurate representation of fine aggregate might be produced with the sample's weight.
- The sample was sieved with a set of sieves arranged in order of decreasing size.
- The largest sieves were placed on top, while the tiniest ones were placed at the bottom. The requirements of the test procedure and the type of aggregates being tested determined the diameters of the sieves that were utilised.
- The sieves were shaken manually or using a mechanical shaker for a minimum of 10 minutes to ensure that all the particles were separated and properly classified.
- To the closest 0.1 grammes, the material that was retained on each filter was weighed. A table was used to record the weight.

- A graph was created and a calculation of the total amount of the material remained on every sieve was made.
- By dividing the total amount of the material held by the sieves by 100, the modulus of fineness was calculated. The fineness modulus was the outcome.

Table 3.2: Fineness modulus of Fine aggregate

s.no	BIS sieve size	Weight retained in grams	%of weight retained	Cumulative % Of wt retained	Cumulative % Of weight passed
1	4.75mm	0 g	0 %	0%	100%
2	2.36mm	0 g	0 %	0%	100%
3	1.18mm	500 g	50%	50%	50%
4	600micron	150 g	15%	65%	35%
5	300micron	210 g	21%	86%	14%
6	150micron	100 g	10%	96%	4%
7	75micron	40 g	4%	100%	0%
8	pan	0 g	0%	100%	0%

Total for 500 g of fine aggregate was used in this test

Therefore The fine aggregate's fineness modulus is

$$= \text{cumulative \% of weight passing} / 100$$

$$= 0 + 0 + 50 + 65 + 86 + 96 + 100 + 100 / 100$$

$$= 49.7 / 100$$

$$= 4.97$$

Hence The fine aggregate's fineness modulus is 4.97

Specific gravity test

To ascertain the density of the particles of the substance, a fine aggregate sample is subjected to a specific gravity test. The strength and quality of the aggregate, which in turn impacts the qualities of concrete and other building components, are revealed by this test, making it crucial in the construction sector.

- Approximately 500 grammes of a typical quantity of the finest gravel were collected.
- To get rid of any moisture, the specimen was dried for 24 hours at 110 °C in an oven. In a desiccator, the specimen was permitted to recede to ambient temperature.
- An empty pycnometer was weighed to the nearest 0.1 gram.
- The pycnometer was weighed once again after being filled with room-temperature water. It was noted that the weight was W1.
- A sufficient amount of fine aggregate was added to the pycnometer to completely fill it. The sample was dispersed uniformly and without air pockets using a spatula.
- The mixture of aggregate and water in the pycnometer were weighed to the closest 0.1 grammes. It was noted that the weight was W2.
- Calculate the specific gravity of the fine aggregate.

W1= weight of empty pycnometer(610g)

W2=weight of pycnometer with 2/3 of fine aggregate(1170g)

W3=weight of pycnometer with 2/3 of fine aggregate and 1/4 of
water(1790g)

W4=weight of pycnometer with water(1410g)

Specific gravity = $(w_2 - w_1) / (w_2 - w_1) - (w_3 - w_4)$

= $1170 - 610 / (1170 - 610) - (1790 - 1410)$

=3.11

Hence, the fine aggregate's specific gravity is 3.1

3.2.4 Coconut shells and Coconut fiber

Coconut fibres and shells can also be utilised in the making of concrete, either as a reinforcing material or as a partial substitute for conventional aggregates. Here are some characteristics of concrete made using coconut fibres and shells.

Properties of coconut shell and coconut fiber

Coconut shells: Given their small weight, coconut shells can serve as a partial substitute for conventional aggregates in concrete. Both the amount of weight of the cement as well as the environmental effect of concrete manufacturing can be decreased as a result. However, using the shells of coconuts can also cause the stability of the concrete to decrease, thus the amount of coconut shell used must be carefully considered.

Coconut fibers: Coconut fibers are strong and can be used as a reinforcement material in concrete. This can help to increase the tensile strength of the concrete and also improve its durability. Additionally, coconut fibres can be used to lessen concrete's tendency to break.

Sustainability: The uses of coconut shells and fibers in concrete can also have positive sustainability impacts. Coconut waste materials are often discarded, creating environmental issues. Utilizing them for concrete production not only provides a beneficial use for these materials but also helps to reduce the environmental impact of concrete production.

Tests on coconut shell

Fineness modulus test

An indicator of the average particle size of a granular substance like gravel, sand, or crushed stone is the fineness modulus. A small amount of the material is generally sieved through a succession of sieves with increasingly lower net sizes, and the cumulative amount of particles recovered on each sieve is calculated. In table 3.3, the results of the fineness modulus of coconut shell are presented. The data in the table shows the values obtained from the sieve analysis of a representative sample of broken coconut shells, which were cleaned to remove any debris or extraneous materials.

And the table 3.4 represents the comparison of fineness modulus between the coconut shell and coarse aggregate. It is not common to perform a fineness modulus test on coconut shells because they are not typically used as a construction material. However, if you wanted to determine the fineness modulus of coconut shells for research or experimental purposes, you could follow these general steps:

- Collected a representative sample of coconut shells.
- Cleaned the shells to remove any debris or extraneous materials.
- Weighed out a representative sample of the broken shells.
- the sample was sent through a sequence of sieves with increasingly lower mesh sizes, commencing with the biggest sieve on top, to perform a sieve analysis.
- computed the average percentage of the substance retained on each filter using the weight of the substance remained on each sieve.
- Plotted the cumulative percentage of material retained versus the sieve size, and used the resulting curve to determine the fineness modulus of the coconut shell.

Table 3.3: Fineness modulus of Coconut shells

s.no	BIS sieve size	Weight retained in grams	%of weight retained	Cumulative % Of wt retained	Cumulative % Of weight passed
1	80mm	0 g	0 %	0%	100%
2	40mm	15 g	1.5 %	1.5%	98.5%
3	20mm	650 g	65%	66.5%	33.5%
4	10mm	290 g	29%	95.5%	4.5%
5	4.75mm	30 g	3%	98.5%	1.5%
6	2.36mm	15 g	1.5%	100%	0%
7	1.18mm	0 g	0%	100%	0%
8	600micron	0 g	0%	100%	0%
9	300micron	0 g	0%	100%	0%
10	150micron	0 g	0%	100%	0%

Total for 1000 gm of coconut shell was used in this test

Therefore the fineness modulus of coconut shell is

$$= \text{cumulative \% of weight passing} / 100$$

$$= 0 + 1.5 + 66.5 + 95.5 + 98.5 + 100 + 100 + 100 + 100 + 100 / 100$$

$$= 762/100$$

$$=7.6$$

Hence the fineness modulus of coconut shell is 7.6

As a result, the modulus of fineness of coconut shell is 7.6, whereas the fineness modulus of coarse particles is 7.4.

Table 3.4: Comparative table of coconut shell and coarse aggregate

BIS sieve size	% of weight retained of coars aggregate	% of weight retained of coconut shell
80 mm	0%	0%
40 mm	41%	1.5%
20 mm	58.2%	65%
10 mm	0.8%	29%
4.75 mm	0%	3%
2.36 mm	0%	1.5%
1.18 mm	0%	0%
600micron	0%	0%
300micron	0%	0%
150micron	0%	0%

3.3 Experimental methods

Four different concrete mixes were created using a designed mix proportion of 1:2.1:3.32 correspondingly for fine aggregate, cement, and coarse aggregate. To obtain the required qualities, the proportion content of coconut shells and fibre was changed for each blend. The first mix, referred to as M25, served as the control with a target breaking strength of 25 N/mm².

For the three other mixes, designated M1, M2, and M3, varying percentages of coco shells and coconut fiber was added to the concrete while maintaining the same designed mix proportion. Specifically, M1 included 10% coconut shells and 0.3% coconut fiber, M2 included 10% coconut shells and 0.5% coconut fiber, and M3 included 10% coconut shells and 0.7% coconut fiber.

The fine and coarse aggregates were combined to create each mix for a duration of over two minutes. The cement was next added, and the mixture was continued for another minute. In order to guarantee that the mixture was homogeneous, water was lastly injected to the mixers and vigorously stirred.

Four concrete mix are designed with varied coconut shell and coconut fiber contents:

M25 - Concrete of fck 25 N/mm²

Table 3.5: Mixes and its proportions

Mix	Grade	Proportion of mix
Mix 1	M 25	Conventional mix
Mix 2	M 25	Concrete with 10%of coconut shells and 0.3%of coconut fiber
Mix 3	M25	Concrete with 10%of coconut shells and 0.5%of coconut fiber
Mix 4	M25	Concrete with 10%of coconut shells and 0.7%of coconut fiber

3.3.1 Compression test

This test is carried out to ascertain the concrete's breaking strength. In this test, a concrete sample is inserted in a compression-testing device and put under pressure until it breaks. The compression strength of concrete is defined as the greatest cracking force that the material can endure before failing.

7-Day Test: This test is carried out to determine the concrete's early strength growth. A sample of concrete is cast and cured for 7 days under standard laboratory conditions. After 7 days, the sample is tested for breaking strength using a compression-testing machine.

28-Day Test: To ascertain the maximum strength of concrete, this test is conducted. Under conventional laboratory circumstances, an item of concrete is moulded and

allowed to cure for 28 days. The sample is evaluated for breaking capacity using a compression-testing apparatus after 28 days.

The size of a compression test cube for concrete depends on the standard being followed and the intended use of the concrete. However, the most commonly used size of a compression test cube is 150 mm x 150 mm x 150 mm (approximately 6 inches x 6 inches x 6 inches) for most construction projects.



Fig. 3.4: Cube mould



Fig. 3.5: Casting of cubes and workability



Fig. 3.6: Compression testing machine



Fig. 3.7: Cube mould under testing

Fig. 3.5 depicts the process of casting cubes and the assessment of workability. The figure provides a visual representation of casting cubes. The compression testing apparatus used to assess the breaking capacity of concrete cubes is seen in Fig. 3.6. The equipment and its numerous parts are depicted in the illustration clearly. Fig. 3.7 displays the cube mould during testing. The figure depicts a close-up view of the mould, with a concrete cube placed inside, and the machine applying the load. It provides a visual representation of the testing process and the equipment helped to evaluate the breaking strength of concrete cubes.

3.3.2 Split tensile strength

Split tensile strength is a gauge of concrete's tensile strength, or its capacity to withstand pulling forces. The test involves applying a breaking load to a cylindrical concrete specimen and then measuring the force required to split the specimen along its length.

The standard test method for measuring split tensile strength is ASTM C496, "Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens". This test method specifies the equipment, specimen preparation, and testing procedure for measuring the split tensile strength of concrete.

For split tensile strength testing, a cylindrical piece of material with an overall diameter of 150 mm and a height of 300 mm may also be utilised if the maximum dimension of coarse aggregate used in the mix of concrete is less than 50 mm. However, the specimen's diameter and height should be raised if the maximum dimension of the coarse aggregate is larger than 50 mm.



Fig. 3.8: Cylindrical mould



Fig. 3.9: Casting of cylinders and workability



Fig. 3.10: Compression testing machine



Fig. 3.11: Cylindrical mould under testing

In Fig 3.9 the process of casting cylinders and its workability are depicted. Figure 3.10 illustrates the breaking testing machine used to test the strength of the cylinders. In Figure 3.11 the cylindrical mould used in the testing process is shown being tested.

3.3.3 Flexural strength

Flexural strength is a gauge for a material's resistance to bending or flexing. It is typically determined by performing a three-point or four-point bend test, in which a sample of the material is supported at two points and loaded at a third or fourth point. The maximum stress the material can withstand before it fractures is then calculated as the bending strength.

It is typically determined by performing a tensile test, in which a sample of the material is pulled apart by two opposing forces until it fractures.

The procedures for determining bending strength and UTS vary depending on the specific material being tested and the testing equipment being used. However, in both tests, a load is applied to an example of the material, and the resultant stress or strain is measured. The outcomes may then be used in comparing the strengths of several materials or to gauge how well a certain material performs in various scenarios.

It is important to note that both bending strength and UTS are just two of many factors that can affect the performance of a material. Other properties, such as hardness, toughness, and ductility, may also be important depending on the application. Therefore, it is important to consider all relevant factors when selecting a material for a particular application.

Overall, understanding the bending strength of materials is essential for selecting the appropriate materials for different applications and ensuring the safety and durability of structures and products.



Fig. 3.12: Casting of prisms and workability



Fig. 3.13: Prism mould under testing

Fig 3.11 depicts the process of casting prisms and evaluating their workability. After the mixture is properly compacted, it is left to cure and harden. Fig 3.12 illustrates the prism mould being tested in a compression testing machine. The prisms are placed on the machine and subjected to a load until they fail. The greatest load that the prismatic can withstand before failing is noted and used to determine the mixture's bending strength.

CHAPTER 4

ANALYSIS AND DISCUSSION

4.1 GENERAL

Concrete made with coconut shell and coconut fiber has gained attention as a sustainable alternative to conventional concrete due to its low environmental impact and high strength. Here are some general points to consider when analyzing and discussing this type of concrete:

Compression test, split tensile tests, and bending test are common methods used to determine the strength of concrete. In compression testing, a sample of the concrete is subjected to breaking forces until it fails. Split tensile testing involves applying tensile forces perpendicular to the axis of a cylindrical sample. Bending testing involves bending a sample of the concrete to determine its strength under bending stresses.

These tests are typically conducted at specific time intervals, such as 7 and 28 days after casting the concrete. The test findings can be utilised for comparing various mix designs or to assess how adding components like coconut shell and fibre would affect the durability and strength of the concrete.

4.2 ANALYSIS AND RESULT

While concrete made with coconut shell and fiber has unique properties that can improve its strength and durability, there are also some additional factors to consider such as cost, curing conditions, compatibility with admixtures, moisture content, and standardization. These factors should be carefully evaluated when considering the use of such type of concrete in construction

4.2.1 Compression test results

7 days compression test

Seven-day compression test results provide an indication of the early strength development of concrete. This test measures the breaking strength of concrete after it has been cured for seven days under specific conditions. The test is conducted by

crushing a cylindrical or cubic sample of concrete in a compression testing machine.

The breaking strength of concrete is typically reported in megapascals (MPa) or pounds per square inch (psi). The test's outcomes are used to assess the concrete's quality and determine if it has attained the necessary strength for its original use.

Results from seven-day compression tests might be helpful when early strength is crucial, such when erecting a structure or a bridge. While the breaking breaking point of concrete at seven consecutive days may not precisely represent the ability to break of the concrete at later ages, it is vital to note that concrete's strength increases over time. In order to assess the concrete's long-term strength and durability, compression tests are frequently carried out between 28 and 90 days after the cement mixture has been laid.

Table 4.1: Compression test values for 7-days test

S.No	Mix code	Weight in kg	Load in KN	Avg load	Compression strengthN/mm ²
1	Mix 1	8.54	330	376.67	16.75
2		8.94	300		
3		8.61	500		
4	Mix 2	8.16	300	310	13.77
5		8.21	330		
6		7.63	300		
7	Mix 3	8.26	320	330	14.66
8		7.93	320		
9		7.79	350		
10	Mix 4	7.86	300	293.34	13.03
11		7.98	310		
12		7.78	270		

Table 4.1 displays the results of compression tests conducted on various concrete mixture after seven days of curing. The weight of each mix is also provided alongside the corresponding compression strength values.

Following a seven-day curing period, the bursting strength of every one of the 4 concrete mixtures—the control mixture M25 and the three containing various amounts of coconut shells and fiber—was measured. Using compression testing equipment, the break strength values were calculated and expressed in units of N/mm².

The seven-day compression test results provide an initial indication of the strength of each concrete mix and allow for comparison of the effectiveness of incorporating coconut shell and fiber into the mix.

28 days compression test

A common technique for determining the cracking strength of concrete is the 28-day compression test. For this test, a concrete specimen that is cylindrical or cubical is cast and treated under particular circumstances. After 28 days of treatment, a testing device is used to apply a breaking force to the specimen.

A vertically mounted specimen is loaded steadily with force until it breaks on a testing device. The specimen's breaking strength is computed by dividing its maximum load by its cross-sectional area. The highest load that the sample can sustain is recorded.

Table 4.2: Compression test values for 28-days test

S.No	Mix code	Weight in kg	Load in KN	Avg load	Compression strength N/mm ²
1	Mix 1	8.62	670	700	31.28
2		8.48	720		
3		8.58	710		
4	Mix 2	8.66	590	590	26.4
5		7.98	580		
6		7.59	600		

7	Mix 3	8.24	680	666.67	29.89
8		8.1	650		
9		8.45	670		
10	Mix 4	7.92	570	553.34	24.72
11		7.82	540		
12		7.66	550		

Table 4.2 presents the compression test results for a 28-day testing period along with the corresponding weight of each mould. The table displays the breaking strength values for each mix, indicating the load capacity of the concrete specimens after 28 days of curing. The weight of each mix used for the test is also provided.

By dividing the highest load the concrete sample can support by the cylinder's cross-sectional area, one may calculate its breaking strength. The 28-day compressive test findings are used to confirm that the concrete used in building satisfies the project's necessary strength requirements.

The test is a crucial quality control method that ensures the long-term performance and durability of concrete buildings. Concrete's breaking strength is affected by a number of variables, such as the concrete's age, curing conditions, and mix design.

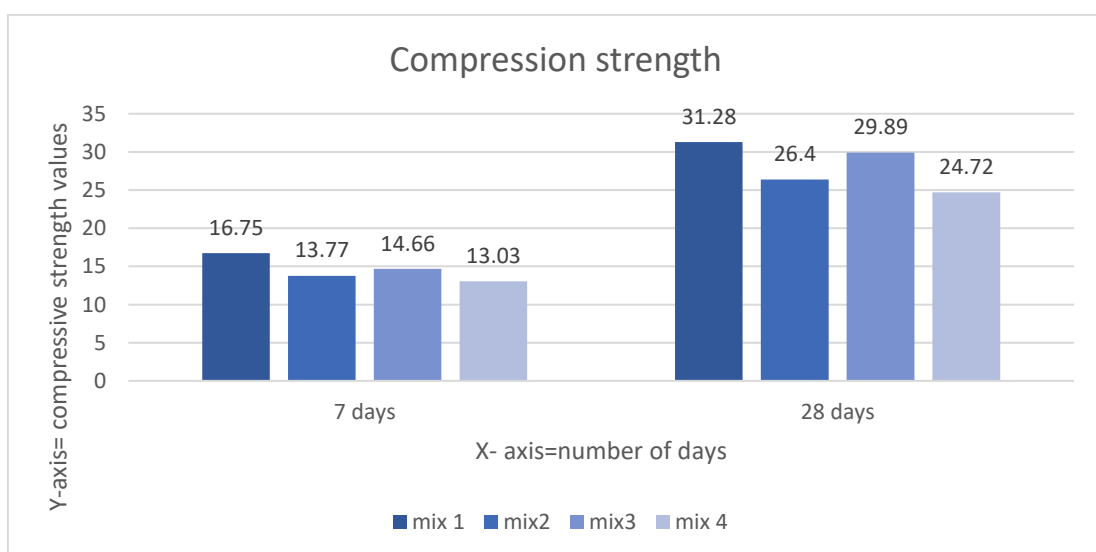


Fig. 4.1: Graph for compression strength

4.2.2 Split tensile strength results

7 days Split tensile strength test

The kind of test performed to figure out how strong concrete is is the 7-day split tensile capacity test. For this test, a concrete specimen that is cylindrical or cubical is cast and cures under particular circumstances. The specimen is tested using a testing device employing a splitting tensile force after seven days of cure.

The specimen is supported horizontally on a pair of parallel plates, and a load is applied through a steel cylinder positioned between the plates at a constant rate until the specimen fractures, at which point the highest load which the specimen can withstand is produced.

The split tensile strength is estimated by dividing the highest load by of cross-sectional area of the sample. The test assesses the capacity of the concrete to withstand the tensile force, which is significant in assessing the structural health of the concrete.

The 7-day split tensile strength test is commonly used in construction projects, particularly for evaluating the strength of concrete used in structures such as bridges, buildings, and roads. This test is also used to ensure that the concrete meets specific strength requirements, as well as to monitor the quality of concrete during the construction process.

Table 4.3: Split tensile test values for 7-days test

S.No	Mix code	Weight in kg	Load in KN	Avg load	Compression strength N/mm ²
1	Mix 1	13.19	180	167.5	1.18
2		13.54	155		
3	Mix 2	11.97	120	125	0.88
4		12.19	130		
5	Mix 3	12.02	150	150	1.06
6		12.39	150		

7	Mix 4	11.68	110	115	0.81
8		11.73	120		

Table 4.3 presents the split tensile test results obtained for each mix at 7-days, along with the corresponding weight of the mix used. The split tensile test measures the tensile strength of concrete by applying a load perpendicular to the direction of the concrete's surface. The results of the test are recorded in megapascals (MPa), and indicate the ability of the concrete to resist cracking under tensile stress.

A common test procedure for determining the tensile strength of cylinder or cube form concrete samples with a grade of M 25 is the 7-day tensile strength split test. After seven days of curing, the test entails applying a splitting tensile strain to the cured specimen using a testing equipment. The specimen's maximum load tolerance is noted, and the split tensile strength is computed by dividing the greatest load by the cross-sectional region of the specimen. This test is frequently employed in building projects to check if the concrete satisfies particular strength standards and to evaluate the solidity of the concrete.

28 days Split tensile strength test

A common technique for assessing the tensile strength of concrete is the 28-day split tensile strength test. For this test, a concrete specimen that is cylindrical or cubical is cast and sealed under particular circumstances. The specimen is tested using a testing machine employing a splitting tensile force after 28 days of cure.

A force is given to the sample through a cylinder of steel positioned between two parallel plates while the specimen is horizontally supported by two parallel plates. The maximum force that the sample can sustain is recorded when the load is applied steadily until the specimen cracks. By dividing the greatest load by the specimen's cross-sectional area, the split tensile strength is computed.

In order to verify that the concrete satisfies specified strength standards and to evaluate the structural integrity of the concrete, building projects frequently utilise the 28-day split tensile strength test. The outcomes of this test may also be used to plan concrete buildings, calculate the ability to bear weight of current structures, and assess

the concrete's quality as it is being built. In conclusion, the 28-day split tensile strength test is a critical procedure for assessing the toughness and longevity of concrete in a variety of applications.

Table 4.4: Split tensile test values for 28-days test

S.No	Mix code	Weight in kg	Load in KN	Avg load	Compression strength N/mm ²
1	Mix 1	13.66	280	290	3.01
2		13.20	300		
3	Mix 2	12.07	240	250	2.47
4		12.23	260		
5	Mix 3	12.27	270	275	2.81
6		12.02	280		
7	Mix 4	11.52	230	225	2.29
8		11.88	220		

Table 4.4 presents the split tensile test results for the concrete specimens containing coconut shell and coconut fiber aggregates, with corresponding weights for each mix, after the 28 days of curing. The table shows the split tensile strength values in MPa for each mix, along with the corresponding weights of the specimens.

In the 28-day split tensile strength test, a cylindrical or cubical concrete specimen is cast and cured under specific conditions. After 28 days of curing, the specimen is subjected to a splitting tensile force using a testing machine.

The load required to fracture the specimen is recorded, and the split tensile strength is calculated by dividing the maximum load by the cross-sectional area of the specimen. This test is commonly used in construction projects to ensure that the concrete meets specific strength needs and to assess the structural integrity of the concrete.

The test is typically performed by a certified laboratory technician in accordance with standard testing procedures, and the results are reported to the client or contractor. The information obtained from the test can be used to verify compliance with regulatory

requirements, assess the excellence of the concrete , and evaluate the suitability of the concrete mix for various applications.

Overall, the 28-day split tensile strength test is an important for evaluating the tensile strength and durability of concrete and is a widely accepted and standardized test method in the construction industry.

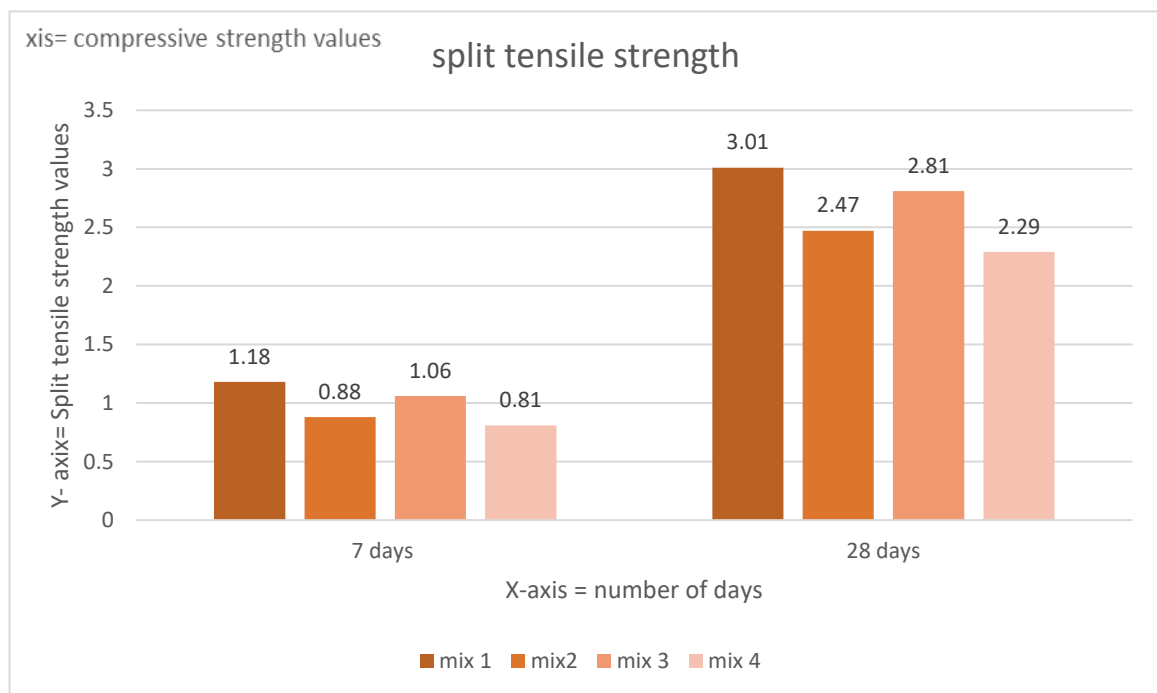


Fig. 4.2: Graph for Split tensile strength

4.2.3 Flexural strength results

7 days Flexural strength test

The 7-day bending strength test is a standard procedure for evaluating the strength of concrete in bending applications. In this test, a rectangular or prismatic concrete specimen is casted and then cured under specific conditions. After 7 days of curing, the specimen is subjected to a bending force using a testing machine.

The specimen is supported by two points, and the weight is put on to the specimen's centre until it breaks. The specimen's maximum load is noted, and the bending strength

is computed using the specimen's measurements and the applied force.

The 7-day bending strength test is commonly used in construction projects to assess the suitability of concrete for various applications that involve bending, such as beams, slabs, and other structural elements. The results of this test can also be used to monitor the quality of concrete during the construction process and ensure that the concrete meets specific strength requirements.

Overall, the 7-day bending strength test is an important procedure for determining the strength and durability of concrete in bending applications and is a widely accepted and standardized test method in the construction industry.

Table 4.5: Flexural test values for 7-days test

S.No	Mix code	Weight in kg	Load in KN
1	Mix 1	12.86	6
2	Mix 2	11.24	5
3	Mix 3	12.16	6
4	Mix 4	11.52	5.5

Table 4.5 presents the values of the bending test conducted on specimens of each mix at 7 days of age, along with the weight of each mix.

The seven-day bending strength test is used as an indicator of the overall strength of the concrete, as it allows for an early assessment of the strength of the material. This test is particularly important for applications where the concrete will be subjected to bending or other types of stress that can cause it to fail.

Overall, the seven-day bending strength test is a critical part of the quality control process in construction, as it helps to ensure that the concrete being used is strong

enough to meet the demands of the application.

28 days Flexural strength test

The 28-day bending strength test is another commonly used test in the building industry to evaluate the strength of concrete. It is similar to the seven-day bending strength test, but the difference is in the duration of the curing. The test involves subjecting a concrete beam or cylinder to a load that creates a bending moment, just like in the seven-day test.

However, instead of testing the concrete after just seven days of curing, the 28-day bending strength test is performed after the concrete has cured for a full 28 days. This extended curing period allows the concrete to reach its full strength potential, which means that the test results are more representative of the long-term performance of the material.

The 28-day bending strength test assures that the concrete being utilised has the necessary strength to sustain the stresses it will be exposed to over time, which makes it a crucial quality control measure for building projects. If the concrete satisfies the strength criteria stipulated in the building and design plans, it will be determined by the test results.

Table 4.6: Flexural test values for 28-days test

S.No	Mix code	Weight in kg	Load in KN	Compression strength N/mm ²
1	Mix 1	12.92	7.6	2.05
2	Mix 2	11.52	6.5	1.73
3	Mix 3	111.89	7.5	1.94
4	Mix 4	11.67	6.3	1.59

Table 4.6 displays the results of the bending test performed on specimens of every mix after 28 days of age, accompanied by the corresponding weight of each mix. The completion of the 28-day bending strength test indicates that a concrete specimen has been cured for a full 28 days and subjected to a bending moment until failure. The force required to cause the concrete to fail has been measured, and the resulting value is used to determine the bend or flex strength of the material.

In order to make sure that the concrete utilised in a project is durable enough to sustain the stresses it will be exposed to over time, the 28-day bend test is an essential quality control tool in the construction industry. The results of the tests are used to confirm that the concrete satisfies the strength specifications stated in the design and building plans.

The completion of the 28-day bending strength test is an important milestone in the construction process, as it allows the project team to verify that the concrete has achieved the required strength and can be safely used in the construction of the project. If the results of the test indicate the concrete does not meet the required strength, corrective measures can be taken before the construction continues.

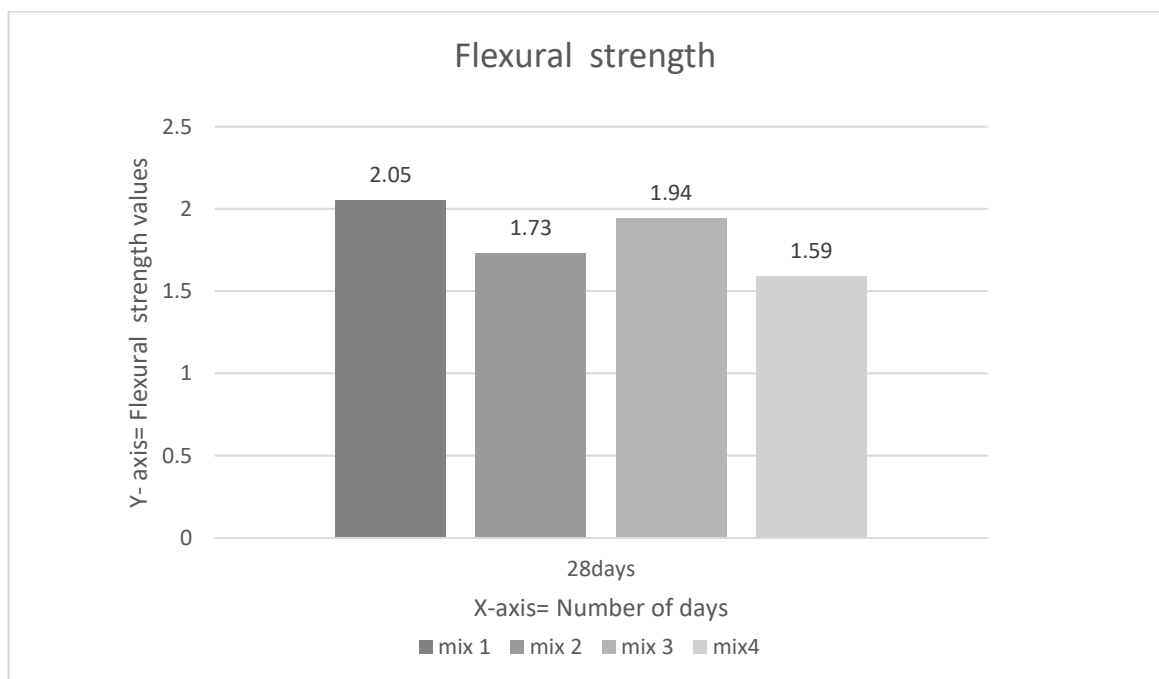


Fig. 4.3: Graph for Flexural strength

CHAPTER 5

CONCLUSION

5.1 GENERAL

The project focuses on the partial substitution of traditional coarse particles in concrete with coconut shell and fibre. In the experiment, concrete specimens with varying amounts of coconut shell and fibre were subjected to a number of tests, including those for breaking strength, split tensile strength, and bending strength. The tests' findings demonstrated that while the strength values of the coconut shells and fibre concrete were lower than those of conventional concrete, they were still within acceptable bounds for structural application. Additionally, the density of the concrete was reduced as a result of the inclusion of coconut shells and fibre, suggesting a potential usage for it in light concrete applications. The experiment demonstrates the possibilities of employing coconut fibre and shell as sustainable substitutes for traditional coarse aggregates in the manufacture of concrete.

5.2 CONCLUSION

In light of the research study observations, the following inferences are possible:

- It was determined from the testing results that adding coconut fibre to concrete boosted its strength by a specific amount. The results showed that adding coconut fibre up to a 0.5% percentage boosted the concrete's strength. The reason for this increase was that the coconut fiber acted as a reinforcement material, enhancing the bond between the cement paste and the aggregate. However, beyond this percentage, the strength of the concrete gradually decreased. This was because the excessive amount of coconut fiber led to a non-homogeneous mixture, resulting in a weaker concrete structure. The concrete's workability deteriorated as the amount of coconut fibre in the mixture

- As the coconut fibre content of the concrete increased, its workability decreased. This is because coconut fiber is a relatively stiff and coarse material, which can make it difficult to mix uniformly with the other ingredients in the concrete. As the proportion of coconut fiber increases, the mixture becomes more and more heterogeneous, resulting in a decrease in workability.

This can make it challenging to place and compact the concrete properly, leading to potential defects and reduced overall strength.

- From a strength perspective, the use of coconut fiber in concrete showed a good impact in the experiments. However, the results were not significantly higher than those obtained with conventional concrete mixes, and were deemed only satisfactory.
- Based on the analysis of cost estimation values for the quantities required to produce 1 cubic meter of each type of concrete, it was found that the cost of producing sustainable or eco-friendly concrete was slightly higher compared to conventional concrete. Since coconut shell and fibre are not frequently utilised in the creation of normal concrete, the greater expense of adding them to the concrete mix might be the cause of this. However, it is important to note that the difference in cost was not significant and could be offset by the potential environmental benefits of using sustainable materials in construction.

5.3 LIMITATIONS

- As the percentage of coconut fiber increases, the concrete becomes more difficult to mix, place, and finish. The quality and quantity of coconut fiber can vary depending on factors such as location, season, and processing methods. This can make it difficult to obtain a consistent material for construction.
- Different sizes of coconut shells could have varying effects on the concrete, and using only one size may not fully represent the potential of using coconut shells in concrete.
- Plasticizers are commonly added to concrete mixes to improve their flow and workability, making it easier to place and compact the concrete. Without a plasticizer, the mixture can become more stiff and difficult to work with, making

it harder to achieve proper compaction and potentially leading to defects and reduced strength.

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