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A STUDY ON IMPLEMENTATION OF COCONUT SHELL AS A COARSE AGGREGATE IN CONCRETE – AN OVERVIEW

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Abstract - *Concrete is a superior building material created from natural aggregate. In emerging nations like India, the use of natural resources is continuously declining due to rising construction. There is a great demand right now for substitute materials for manufacturing concrete. Limitations on natural and local sources of trash disposal, as well as environmental issues, are becoming more and more significant. Coarse aggregate is a crucial element of the concrete mix for several building projects involving the building of homes and the development of infrastructure. The use of conventional aggregate must be reduced, and we must find alternative building materials such as recycled aggregate, recycled rubber tyres, ceramic waste, granite waste, coconut shell, palm kernel shell, e-plastic waste, palm kernel shell, waste glasses, etc. Coconut shell waste has the potential to be utilized as a coarse material in concrete. Coconut shell is an agricultural and industrial waste that presents significant management and disposal issues. This has raised serious concerns about environmental damage. Natural coarse aggregate can be substituted with waste from the coconut industry. Coconut shells could be used as a substitute for coarse aggregate to help with the issue of a lack of readily available resources because it is also cost-effective and environmentally beneficial. Making use of such materials also helps with disposal problems. The primary objective of this review study is to determine whether using coconut shells as a substitute for coarse aggregate in the production of light-weight concrete is feasible.*

Key Words: **Concrete, Coarse Aggregate, Coconut Shell, Lightweight Concrete.**

1. INTRODUCTION

Any improvement to a structure must include concrete. Aggregate, which will be little, is one of the real pieces employed in the significant manufacture of concrete. Find alternatives to natural aggregate to help the development movement. Many investigations are being conducted to develop alternative materials for the manufacturing of concrete. On the other hand, the issue of strong garbage is gradually expanding, while the issue of removal is also expanding as a direct result of the lack of dump site transparency **[1]**. A huge number of natural resources are used in the production of concrete. It is crucial to implement engineering approaches that concentrate on the preservation of natural assets and energies as a step to ensuring that prosperity is accessible to future generations. In the sphere of construction, researchers have been working on innovative technologies that provide an environmentally beneficial technique **[2]**. In the modern age, the primary application of waste as a substitute is in the construction sector. Multiple wastes, such as crushed glass, brick waste products, sugarcane bagasse ash waste, palm shells, and a wide variety of other wastes, are used as partial alternatives in the construction sector. One of the most frequently utilized wastes is coconut shells. As an alternative to natural coarse aggregates, coconut shell is used. Nowadays, coconut shell is an actual waste removal challenge all over the world. It releases dangerous compounds like atmospheric carbon dioxide and methane whenever we consume it, which has a significant negative influence on our ecology. Today, coconut shell is a popular choice for coarse aggregate. Prior studies have demonstrated that coconut shells can be utilized as an aggregate that is lightweight and can save on construction material prices **[3].**

2. WASTE COCONUT SHELL

Coconut shell is a palm-related agricultural trash that may be acquired from various temples and coconut oil producers. Coconut is cultivated in over 90 nations. They are widely available in Asia, Africa, and America. The first coconuts are thought to have appeared in Southeast Asia **[4]**. In addition to the fact that it is a widely accessible agricultural waste from nearby coconut enterprises, it also causes significant disposal concerns for the local ecosystem. In less developed nations where there is an excess of rubbish made from coconut shells, the waste from those shells could be used as a viable replacement material in the construction sector. In addition to bringing down the price of construction materials, this will also serve as a way of disposing of trash **[5].**

3. COCONUT SHELL UTILIZED AS A COARSE AGGREGATE

Coconuts are readily available in the environment, and since their shells do not decompose, they can be simply used in concrete, allowing them to meet almost every one of the properties of the initial kind of concrete. The construction sectors in affluent countries have recognized several Lightweight aggregates, which are manmade and natural materials that have substituted traditional aggregates,

lowering the size of the construction element **[6].** The characteristics of coconut shells that could render it appropriate for use as coarse aggregate for concrete are that its shells are not biodegradable, have excellent strength and modulus characteristics, have a high lignin content, resulting in a mixture that is highly weather resistant, and have a small cellulose content that soaks up a smaller amount of water **[7].**

4. LITERATURE REVIEW

The following findings are based on numerous study projects.

F.A. Olutoge (2010) examined the use of saw dust and palm kern shells (PKS) as fine and coarse aggregate replacements in concrete-reinforced slabs. 800 x 300 x 75-mm reinforced concrete slabs were built. Sawdust and Palm kernel shells were employed to substitute fine and coarse aggregates to varying degrees, ranging from 0% to 100% in a 25% stance. He also assessed compressive strength at 28 as well as flexural strength at 7, 14, and 28 days. They discovered that enhancing the amount of sawdust and palm kernel shell in concrete slabs reduced both compressive strength and flexural values**.** It has been determined that PKS and sawdust can be utilized to construct lightweight reinforced concrete slabs with a minimum replacement amount of 25% **[8].**

Sabarudin Bin Mohd and Tukiman (2009) the utilization of grained palm kernel shell and coconut shell as substitutes for aggregate in concrete was investigated. In this research, five distinct mixes of concrete were used, each with various percentages of raw material content, namely 0%, 25%, 50%, 75%, and 100%. They discovered that a mixture of grained palm kernel and coconut shell could serve as a substitution for light weight aggregate in concrete, as well as the ability to minimize the price of materials during construction due to the cheap and plentiful accessibility of appropriate waste from agriculture for concrete manufacturing **[9]**.

K. Gunasekaran et al. (2011) studied the properties of concrete constructed with coconut shells as a coarse aggregate. Strengths for bonding, splitting, flexural, durability, and impact resistance were also calculated. Two different water-cement ratios of 0.42 and 0.44 were considered for the proposed composition to examine the effects on the splitting tensile, strengths, and bending as well as the impact on the strength feature of coconut shell concrete. They discovered that the 28-day dry densities of the common blends of coconut shell concrete ranged from 1930 to 1970 kg/m3 **[10].**

Amarnath Yerramala and Ramachandrudu C (2012) examined the performance of concrete using coconut shells (CS) as a coarse aggregate substitute. They created normal concrete with regular aggregates and Coconut shell concrete using 10–20% coarse aggregate substitution with Coconut shell. Two Coconut shell-fly ash mixes were also created to examine the influence of fly ash on Coconut shell-substituted concretes. The constant w/c ratio in all of the concrete mixes was kept at 0.6. In the laboratory, properties such as water absorption, split tensile strength, compressive strength, and moisture migration were studied. The results indicated that as the coconut shell percentage rose, the density of the concrete reduced. They also found that workability declined as coconut shell replacement increased **[11].**

K. Gunasekaran et al. (2013) released a paper on a few of the durability characteristics of CSAC, or coconut shell aggregate concrete. For this project, recyclable lightweight aggregate made from coconut shells was used in the concrete. Among the durability parameters assessed are the rapid chloride penetration test, sorptivity, volume of permeable areas, absorption, temperature resistance, and salt ponding test. The test's findings demonstrated that the durability characteristics of the CSAC are comparable to those of other popular lightweight concretes (LWC) **[2].**

Sandhya R. Mathapati and Parag S. Kambli (2014) studied concrete's compressive strength using a coconut shell. The M20, M35, and M50 concrete mixtures will be replaced in this study with a variety of raw materials, including coconut shell content in the ratios of 0%, 10%, 20%, 30%, and 40%. For each concrete mix, six concrete specimens will be made. Compressive strength testing will take place at 7 and 28 days**.** It has been found that coconut shells work best as a lightweight, low-strength alternative to traditional coarse aggregate when used to produce concrete **[12].**

Kalyanapu Venkateswara Rao et al. (2015) investigated the strength characteristics of concrete made from coconut shells. This study used concrete with coconut shell aggregate. Cement, sand, coconut shell, and w/c ratios were changed to produce a number of trial mixes. Finally, it was decided which trial combinations would be most effective. The ideal concrete mix with coconut shell aggregate was chosen after taking into account the density, workability, durability, and strength requirements for various light weight concrete (LWC) structural uses. The findings indicate that, compared to ordinary concrete, the strength qualities of concrete will have been somewhat lowered by the substitution of coconut shells for aggregates at 10% and 20% substitution **[13].**

Jerin M. George et al. (2016) examined the concrete's characteristics using coarse aggregate made from crushed coconut shells**.** In this investigation, three different percentages (25%, 50%, and 100%) of crushed coconut shells were employed in place of coarse aggregate. Strength tests on the various mixtures revealed that coconut shell concrete with a 25% coarse aggregate substitution has qualities equivalent to the standard mix **[14].**

T. Subramani and A. Anbuvel (2016) examined the experimental performance of reinforced concrete beams

using coarse aggregate made of coconut shells. Coconut shell makes up 0% to 20% of the coarse aggregate in this project. Two CS and fly ash mixes were also created to study the influence of fly ash on CS replacement concretes. For this work, M25-grade concrete was cast. The outcomes indicated that as the percentage of CS increased, the density and workability of the concrete declined. They also found out that coconut shell concrete had lower split tensile and compressive strengths than control concrete **[15].**

Sangeetha G. et al. (2016) examined the partial substitution of aggregate by coconut shells and cement by clay. In this study, coconut shell was used in place of granite to create M-20-grade concrete. Concrete is produced by substituting coconut shells and clay at 0%, 10%, 20%, and 30% for coarse aggregate. The compressive strength was examined at 7, 14, and 28 days. These findings demonstrated the potential for using coconut shells and clay in concrete for construction with reinforced concrete. Its use is economical and environmentally friendly **[16].**

D.V. Naresh Kumar et al. (2017) the compressive strength of concrete was examined by adding fibre and utilizing coconut shell in place of the coarse material to some extent. They manufactured M30-grade concrete for this trial. Polypropylene and steel hooked-end fibres of 60 mm in length with a 0.5 mm diameter were used in this study. The results demonstrate that the strength qualities diminish as the fraction of coconut shell substituted with coarse aggregate rises **[17].**

Alif Syazani Leman et al. (2017) examined the compressive strength and workability of concrete made with coconut shell aggregate. In this investigation, concrete and coconut shells were combined in amounts of 0%, 5%, and 10% by weight. The experimental techniques employed in this work include the slump test and the compressive test. The outcome of the study shows that concrete with 0% and 5% coconut shells has an average level of workability, whereas concrete with 10% has a lower level of workability. Concrete that contains 5% or 10% coconut shell has less strength than regular concrete **[18].**

K. Gunasekaran et al. (2017) investigated the bond and mechanical strength of coconut shell concrete using quarry dust. This experiment looked at the characteristics of concrete utilizing coconut shell (CS) as coarse aggregate and quarry dust (QD) as fine aggregate. For this work, the mix design ratio (1:2.40:3.66:0.55) was taken for control concrete with quarry dust and (1:1.58:0.65:0.42) was taken for coconut shell concrete with quarry dust. The theoretical parameters were taken into account for evaluating concrete density, workability, flexure strength, compressive strength, and bond strength. This study demonstrates that the bond and mechanical qualities of both CSs concrete and regular concrete were improved when QD was used in place of sand **[19].**

Apeksha Kanojia and Sarvesh K. Jain (2017) this study's goal was to assess the results of using coconut shell for some of the conventional coarse aggregate when producing concrete**.** Two phases of this study's execution were used. They first created the traditional concrete of M20 grade without substitution, and then they created the concrete with a w-c ratio of 0.55 in which coconut shell was used in place of coarse aggregate in the amounts of 10%, 20%, 30%, and 40% by volume, respectively. The concrete for the next step was mixed with various amounts of coarse aggregate and coconut shell. Six ratios of CA and CS were considered to be (100:0), (95:5), (85:10), (80:20), and (75:25), respectively. After that, three different water-cement ratios—0.55, 0.50, and 0.45—were considered. On concrete, various tests were carried out. The outcome indicates that 7.5% of the density is reduced by 40% as a replacement. They further claim that the 5% replacement of coarse material does not need any more cement. and 3.6% more cement is needed for a 10% substitution **[20].**

Anandh Sekar and Gunasekaran Kandasamy (2018) examined the bond and mechanical features of coconut fibre in coconut shell concrete. The volume fractions of 1, 2, 3, 4, and 5% as well as the aspect ratios of 16.67, 33.33, 50, 66.67, 83.33, and 100 were evaluated on the coconut fibres for this work. The results demonstrate that conventional concrete, with a volume fraction of 3% and an aspect ratio of 83.33, and coconut shell concrete, with a volume fraction of 3% and an aspect ratio of 66.67, both achieved the maximum compressive strengths **[21].**

Naraindas et al. (2021) the combined influence of leftover agricultural waste materials on the features of concrete was examined experimentally. Sugarcane bagasse ash (SCBA) and Ash of coconut shell (CSA) were used as substitutes for cement in an amount of 0% to 20% of the total binder weight and fine aggregates in an amount of 0% to 40% of the total FA weight. The mix ratio was 1:1.5:3, and a water-cement ratio of 0.52 was employed to construct 300 concrete specimens (cubes and cylinders). It was demonstrated that when the amount of CSA and SCBA in the mixture grew, the workability, permeability, density, and mechanical features significantly decreased **[22].**

5. CONCLUSION

The literature review mentioned above reveals that coconut shells can serve as an alternative kind of coarse aggregate in concrete. We may make the concrete lighter by using coconut shells as a natural coarse aggregate. Utilizing coconut shells in the construction of concrete solves the issue of their disposal. Comparing crushed granite aggregate to coconut shell, the coconut shell is more resistant to impact, crushing, and abrasion. The coconut shell doesn't need to be processed in any way before being used as an aggregate. Coconuts are a naturally occurring fruit, and since their shells cannot biodegrade, They can be used in concrete to attain practically all of their original qualities by using

only a few simple techniques. By using coconut shell waste instead of traditional aggregate, we contribute to an eco-friendly environment and make concrete more cost-effective.

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