Advancement of Concrete with Pineapple Leaf Residue as Cement and Date Seed Husk Granules as Coarse Aggregate

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***Abstract*— This project aims to make concrete more eco-friendly by using waste materials that are usually thrown away. In this study, pineapple leaf residue (PLA) is used to replace part of the cement, and date seed husk granules (DSHG) are used to replace part of the coarse aggregate in concrete. Pineapple leaves are first dried and burned to form fine ash, which contains silica and other minerals that can partly act like cement. Date seeds are cleaned, dried, crushed, and used as a lightweight replacement for stone aggregate. Different mixes are prepared by replacing cement with 0%, 5%, 10%, and 15% pineapple leaf residue, and replacing coarse aggregate with 0%, 2.5%, 5%, 7.5%, 10%, and 12.5% date seed husk granules. Tests are carried out to check the workability, compressive strength, split tensile strength, water absorption, and density of the concrete by using M30 grade of concrete. The results are compared with normal concrete to see how the waste materials affect its performance. The study helps in reducing construction waste, saving natural resources, and promoting the use of agricultural waste materials in the production of sustainable concrete.**

The experimental results are expected to show that small to moderate replacement levels can maintain acceptable strength while reducing the weight of concrete by using M30 grade of concrete. The ash from pineapple leaves may improve the bonding in the cement matrix due to its fine particles and silica content, while the use of date seed husk granules reduces the use of natural stone and makes the concrete lighter. Though higher replacement levels may lower strength, the resulting concrete can still be suitable for non-structural applications such as paving blocks, lightweight walls, and partitions. This research shows that pineapple leaf residue and date seed husk granules can be valuable alternatives in concrete production, supporting environmental protection and sustainable construction practices.

Keywords*— *pineapple leaf residue (PLA), date seed husk granules (DSHG), M30 grade of concrete

I. INTRODUCTION

Date Seed Husk Granules

Approximately 60–70% of the entire volume of concrete is made up of coarse aggregate, one of its main components. It is crucial in establishing concrete's strength, longevity, density, and general performance. Typically, coarse aggregates are made up of natural materials like gravel and crushed rock. The depletion of natural resources, environmental imbalance, and higher material expenses are the results of the ongoing extraction of natural aggregates. This has inspired academics to look for substitute materials that may partially replace natural aggregates in the manufacture of concrete.

The residue from the date fruit processing industry is known as date seed husk, an agricultural byproduct. Every year, particularly in areas where date farming is widespread, massive amounts of date seeds and husks are produced. Because these wastes are frequently burnt or thrown away, there are problems with waste management and the environment. The use of date seed husks in building materials can be a successful waste management technique that also advances sustainable development.

The date seed husk can be utilized in concrete as a partial substitute for natural coarse aggregate if it is made into granules of the proper size. Date seed husk granules can produce lightweight concrete because of their porous structure and relatively low density. However, before utilizing them, their mechanical qualities, such as water absorption, bulk density, and strength, must be thoroughly examined.

The utilization of date seed husk granules in concrete has a number of potential benefits, such as lower concrete weight, preservation of natural aggregates, cost-effectiveness in areas with a high concentration of date waste, and environmental advantages from waste use. Additionally, it's crucial to examine how it affects the compressive strength, workability, durability, and long-term behavior of concrete.

Figure 1: Date Seed Husk Granules

Pineapple Leaf Residue

Recycled After the pineapple harvest, the leftover pineapple leaves (PLR) are considered agricultural waste. In farms, particularly in tropical areas, a lot of pineapple leaves are thrown away. These remnants are often burnt in open fields or abandoned to rot, which causes waste management and environmental pollution issues.The chemical composition of pineapple leaves includes cellulose, lignin, a little bit of silica, and minerals. The residue may display pozzolanic qualities if it is adequately treated (dried, burned at a regulated temperature, and pulverized into a fine powder). Calcium hydroxide, which is released during the hydration of cement, interacts with pozzolanic materials to produce more bonding chemicals that might increase the strength of concrete.

Agricultural waste materials like Pineapple Leaf Residue are being researched as potential partial cement replacement materials as a result of rising environmental concerns about CO2 emissions and cement production. When used in concrete, PLR may:

- Lower cement usage
- Reduce carbon emissions
- Encourage environmentally friendly construction.

Figure 1: Pineapple Leaf Residue

Objectives

- To research and single out a particular engineering challenge.
- To examine pertinent literature and research gaps.
- To carry out experiments like compressive, split tensile, flexural strengths.
- In order to create sensible and long-lasting solutions by curing 7, 14, 28 days.
- To analyze the findings and come to a conclusion.

carbon.

II. LITERATURE REVIEW

Utilizing Agro-Waste as Aggregate in Cement Composites: A Comprehensive Review of Properties, Global Trends, and Applications

Ivanka Netinger Grubeša1,Dunja Šamec2, Sandra Juradin3 and Marijan Hadzima-Nyarko4

Amid growing environmental concerns and the increasing demand for sustainable construction practices, the exploration of alternative materials in building applications has garnered significant attention. This paper provides a comprehensive review of the use of agricultural waste as an aggregate in cementitious composites, with a particular focus on palm kernel shells, coconut shells, hazelnut, peanut and pistachio shells, stone fruit shells and pits, date and grape seeds, rice husks, maize (corn) cobs, and sunflower seed shells. For each type of agro-waste, the paper discusses key physical and mechanical properties, global production volumes, and primary countries of origin. Furthermore, it offers an in-depth analysis of existing research on the incorporation of these materials into cement-based composites, highlighting both the advantages and limitations of their use. Although the integration of agro-waste into construction materials presents certain challenges, the vast quantities of agricultural residues generated globally underscore the urgency and potential of their reuse. In line with circular economy principles, this review advocates for the valorization of agro-waste through innovative and sustainable applications within the construction industry**.**

Effects of Pineapple Leaf Fibre as Reinforcement in Oil Palm Shell Lightweight Concrete- Chin, Siew Choo and Tang, Mun Lin

This paper presents the mechanical behaviour of pineapple leaf fibre (PALF) in oil palm shell (OPS) lightweight concrete (LWC). Various fibre volume fractions were considered which include 0.5%, 1.0%, 1.5% and 2.0% of PALF. In this study, the PALF was extracted and treated with sodium hydroxide solution with a 10% concentration. The length of the PALF was made constant as 40 mm based on the optimum fibre length obtained from previous work. The experimental testing in this work includes slump test, compressive strength test, splitting tensile test and four-point bending test. Results showed that the compressive strength decreased at all ages with an increase in PALF volume fraction, whereas improvement in strength was observed in both splitting tensile strength and flexural strength. The inclusion of PALF increases the tensile and flexural strength up to 3.28 MPa and 6.55 MPa respectively. The findings revealed that 1.0% PALF is the optimum fibre volume ratio for tensile and flexural strength. The oven-dry density and demoulded density of all OPS concrete mixes fall within the range of 1526–1731 kg/m3 and 1787–1853 kg/m which are in the range of structural lightweight concrete. The splitting tensile strength of OPS and PALF reinforced OPS-LWC in this study falls in the range to that of conventional concretes. Flexural strength to compressive strength ratio showed that all PALF reinforced OPS concretes had ratios ranging 12–22% which were greater than the usual range for lightweight aggregate concrete. Hence, this indicates that PALF fibre can improve significantly the flexural strength of OPS lightweight concrete.

III. METHODOLOGY

MATERIALS

Cement, Fine Aggregate, Coarse Aggregate, Water are the commonly used materials .

Manufacturing Process Of Pineapple Leaf Residue

Collection: Healthy pineapple leaves are gathered right after the fruit is picked. Any leaves that are damaged or unhealthy are discarded to keep the quality high.

Washing: The collected leaves are rinsed thoroughly with clean water to eliminate any dirt, dust, or other unwanted materials. This step is crucial for cleanliness and safety.

Cutting: After washing, the leaves are chopped into small bits, roughly 1 to 3 centimeters in size. Cutting them smaller helps they dry more quickly and evenly.

Drying: The chopped leaves are dried out to get rid of any moisture. Sun drying takes about 2 to 3 days, while mechanical tray drying happens at temperatures of 50 to 60 degrees Celsius for 6 to 8 hours.

Drying continues until the leaves hold less than 10% moisture. This step is vital for preventing mold and extending how long the product lasts.

Grinding: The dried leaves are crushed into a fine powder using either a grinder or a pulverizer.

Sieving: The powder is then sifted through a sieve to ensure that the particles are evenly sized and to remove any larger fibers.

Packaging: Finally, the powder is placed into airtight and moisture-resistant containers and kept in a cool, dry area.traits of natural stone, making it valuable for various uses.

Manufacturing Process of Date Seed Husk Granules (DSHG):

Collection: Date seeds are collected as a by-product from date fruit processing industries.

Cleaning The seeds are washed thoroughly with clean water to remove pulp residues, dust, and impurities.

Drying Cleaned seeds are dried: Sun drying for 2–3 days or, Oven drying at 60–80°C for 24 hours

Drying reduces moisture content and prevents fungal growth.

Crushing: Dried seeds are crushed using a crusher or hammer mill to break the hard outer shell.

Husk Separation: The husk (outer covering) is separated from the inner kernel using mechanical sieving or air classification.

Grinding: The separated husk material is ground into granules of required size (0.5–3 mm).

Sieving: Granules are sieved to obtain uniform particle size.

Packaging: The final DSHG is packed in moisture-proof bags and stored in a dry place.

The Methodology describes the fill-ins used & mechanical attributes done over this paper:

1. Understudy of Date Seed Husk Granules (DSHG) to Coarse Aggregates & Pineapple Leaf Residue to Cement with a fixed proportion of 0%-15% in cement & a variable proportion of 0%-12.5% with frequency of 10% in Sand respectively.

2. Property check of Compressive Strength for cubes with a size of 150mm*150mm*150mm.

3. Property check of Tensile Strength for cylinder with dimensions of 150mm diameter & 300mm Height.

4. Property check of Bending Strength for Beam with a dimensions of 500mm*100mm*100mm.

Mix Ratio

Grade M30

Proportion- 1:1.4:2.4

W/C ratio- 0.42

Cement- 440 Kg/m^3

Fine Aggregate- 715 Kg/m^3

Coarse Aggregate- 1052 Kg/m^3

Water: 186 Litres

IV.EXPERIMENTAL RESULTS

COMPRESSIVE, SPLIT TENSILE STRENGTH, FLEXURAL STRENGTH TO DATE SEED HUSK GRANULES FOR 28 DAYS AT DIFFERENT PERCENTAGES

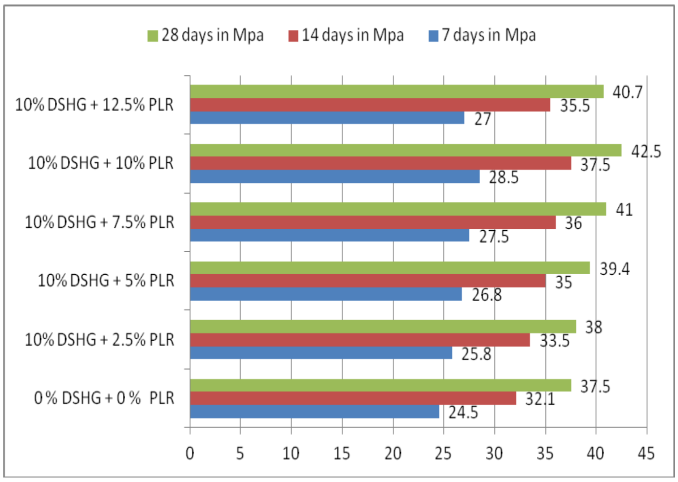
Mix % Replacement	Compressive Strength to Date Seed Husk Granules for 28 days in Mpa
0% DSHG	37.2
5% DSHG	38.1
10% DSHG	38.8
15% DSHG	36.7

Mix % Replacement	Split Tensile Strength to Date Seed Husk Granules for 28 days in Mpa
0% DSHG	4.05
5% DSHG	4.22
10% DSHG	4.61
15% DSHG	4.40

Mix % Replacement	Flexural Strength to Date Seed Husk Granules for 28 days in Mpa
0% DSHG	4.1
5% DSHG	4.2
10% DSHG	4.4
15% DSHG	4.1

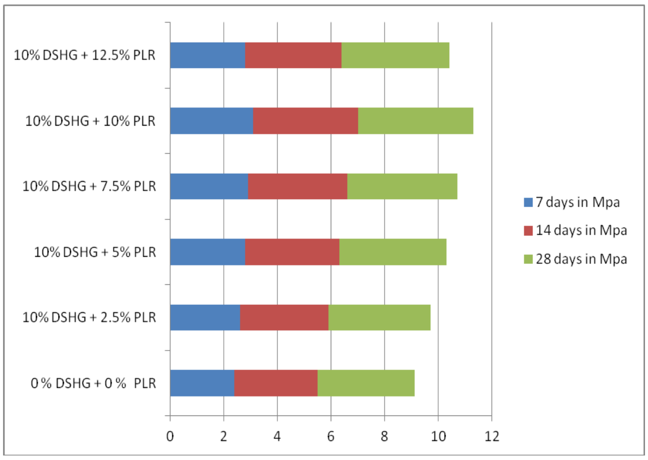
COMPRESSIVE STRENGTH TEST RESULTS

Mix % Replacement	7 days	14 days	28 days
0 % DSHG + 0 % PLR	24.5	32.1	37.5
10% DSHG + 2.5% PLR	25.8	33.5	38
10% DSHG + 5% PLR	26.8	35	39.4
10% DSHG + 7.5% PLR	27.5	36	41
10% DSHG + 10% PLR	28.5	37.5	42.5
10% DSHG + 12.5% PLR	27	35.5	40.7



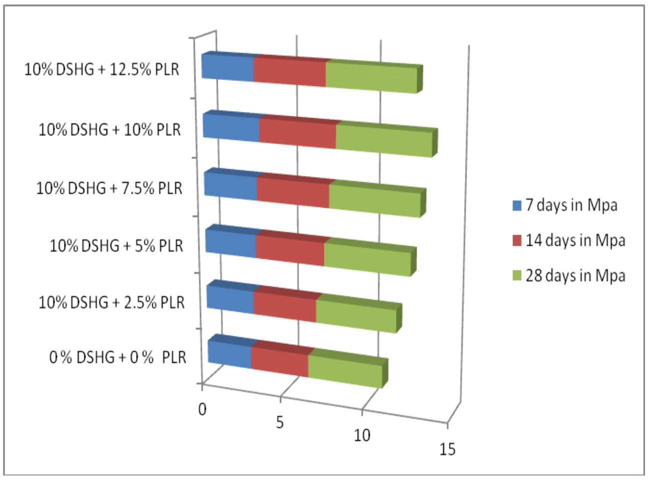
SPLIT TENSILE STRENGTH TEST RESULTS

Mix % Replacement	7 days	14 days	28 days
0 % DSHG + 0 % PLR	2.4	3.1	3.6
10% DSHG + 2.5% PLR	2.6	3.3	3.8
10% DSHG + 5% PLR	2.8	3.5	4
10% DSHG + 7.5% PLR	2.9	3.7	4.1
10% DSHG + 10% PLR	3.1	3.9	4.3
10% DSHG + 12.5% PLR	2.8	3.6	4



FLEXURAL STRENGTH TEST RESULTS

Mix % Replacement	7 days	14 days	28 days
0 % DSHG + 0 % PLR	2.8	3.6	4.5
10% DSHG + 2.5% PLR	3	3.9	4.8
10% DSHG + 5% PLR	3.2	4.2	5.1
10% DSHG + 7.5% PLR	3.3	4.4	5.3
10% DSHG + 10% PLR	3.5	4.6	5.5
10% DSHG + 12.5% PLR	3.2	4.3	5.2



V. CONCLUSION

The experimental study on M30 grade concrete with Date Seed Husk Granules (DSHG) and Pineapple Leaf Residue Powder (PLRP) led to the following findings:

1. Impact on Compressive Strength

- As the proportion of PLRP substitution increased to 10%, the compressive strength rose steadily.
- With 10% PLRP, the greatest 28-day compressive strength was achieved, surpassing the desired average strength of M30 concrete.
- A small decrease in strength was seen as a result of greater porosity and lower bonding when more than 10% (at 12.5%) was replaced.

2. Impact on Tensile Strength at Split

- The trend in split tensile strength was comparable to that of compressive strength.
- The best combination, which included 10% PLRP, had the greatest tensile strength.
- Increased tensile strength suggests improved interfacial bonding and matrix densification.
- Greater replacement levels caused just a little bit of strength loss as a result of excessive fines.

3. Impact on Flexural Strength

- The material's resistance to cracking improved as the PLRP concentration rose to 10% in the flexural strength.
- The best combination exhibited increased bending performance.
- A decrease in flexural strength of more than 10% was brought on by lower workability and poor inter-particle bonding.

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