Philippine Christian University
1648 Taft Avenue cor. Pedro Gil St., Malate, Manila

EXPLORING THE FLEXIBILITY OF COCONUT HUSK FIBERS AS CEMENT REINFORCEMENT

C.I. Pagatpatan, L. A. Gatdula, J. Salmagrende, E. G. Isaac, D. Tambo-on, A. I. Espinosa
Union High School of Manila
cipagatpatan@pcu.edu.ph

Abstract

Coconut husks, the fibrous outer layer of the coconut fruit, have long been recognized for their versatility, finding application in industries such as paper production, arts, and even construction. This research delves into an innovative use of coconut husk fibers as a potential reinforcing material in cement blocks, aiming to explore their influence on the material's durability. The study specifically focuses on the impact of incorporating processed coconut husk fibers into cement mixtures and the subsequent effect on the compressive strength of the resulting blocks. Through a controlled experiment, coconut husks were processed and mixed with cement to form reinforced blocks, which were then allowed to solidify for 24 hours. Following this, durability testing was conducted at TcT Terms Pasig, where the compressive strength of the coconut husk-reinforced cement was measured. The results revealed a significant improvement in the durability of the fiber-reinforced cement blocks, with the experimental group able to withstand up to 36.3kN of pressure, in contrast to the control group, which withstood only 30.40kN. This suggests that the incorporation of coconut husk fibers can effectively enhance the structural integrity of cement-based materials, offering a promising alternative to traditional reinforcement materials commonly used in construction. Furthermore, the study highlights the potential for coconut husks, an abundant agricultural byproduct in regions like the Philippines, to provide a sustainable and cost-effective solution for reinforcing cement, particularly in areas where conventional reinforcement materials may be scarce or expensive. The findings pave the way for future investigations, suggesting that further experimentation could unlock even greater potential for coconut husk-reinforced cement, possibly through optimizing fiber concentration, improving processing methods, and exploring long-term durability under varying environmental conditions. The study serves as a foundational platform for future researchers who wish to build upon this work, particularly those aiming to bridge the gap between agricultural waste management and innovative engineering solutions in the construction industry.

Keywords: *Coconut husk fibers, Cement reinforcement, Compressive strength, Natural fiber reinforcement*

Introduction

In this study, we will be exploring the flexibility of coconut fibers and see if they can really increase the flexibility and toughness of the cement and to prove that it is a promising solution for sustainable construction practices. We will be answering questions on how it works, why it works, and why we should use it instead of any other retail strengthening materials for cement.

Coconut husks are a versatile resource, offering a myriad of practical applications. Surprisingly enough, apart from serving as fiber, paper, and fertilizer, coconut husk fiber can also function as a reinforcement for cement. This intriguing research topic delves into the potential of utilizing husk fibers to enhance the structural integrity of cement. By incorporating these fibers, it is anticipated that the cement's flexibility and durability will be greatly enhanced. This exploration of these fibers as cement reinforcement opens up new possibilities in the field of construction, retail, and consumers paving the way for more sustainable and resilient building materials in the future.

The lack of non-renewable raw materials and improper solid waste management in the environment push society to be more environmentally friendly, sustainable structures. Construction materials weaken over time because of countless issues including poor components and poor design. As a solution to this, Coconut husk fibers. which came from coconuts, can be an environmentally friendly alternative to traditional cement. Coconut fibers offer numerous benefits, such as increased durability, reduced carbon emissions, and improved insulation properties.

Concrete is a commonly used construction material, but it has a problem – it can easily crack and even collapse. To make it stronger, we often use steel beams alongside it. However, this results in many unused steel beams being discarded, causing environmental issues. To address this, we're exploring the use of coconut fibers. These natural fibers, found in coconut husks, are strong and flexible. They can potentially make concrete better without relying on steel. Using coconut fibers is eco-friendly because they come from a renewable resource and are biodegradable. Our research aims to figure out the best way to mix coconut fibers with concrete to make it stronger and more environmentally friendly. This could help reduce the need for steel and its environmental impact while making concrete more resilient.

The purpose of this study is to create a mix of coconut husk with the cement to increase its durability and strength and spread the information about the versatility and usefulness of these coconut husks so that many more people can utilize such a common ingredient. What's more, by adding the fibers to the concrete, not only do we make eco-friendly reinforcement, but we also make cost efficient reinforcement.

Methods

The study employed two methods to integrate coconut husks into cement, utilizing water, coconut, cement, and gravel. In the first method, coconut fibers underwent separation, chopping, soaking, and mixing with fine aggregate, cement, and water to create a concrete mixture. Conversely, in the second method, dried fibers were ground to produce coconut.

Results

The data presented in this table originates from the laboratory at the TcT Terms Pasig facility, showcasing the results of durability testing conducted on sample blocks of coconut husk cement. These findings hold substantial significance as they contribute to the evaluation of coconut husk cement’s performance and its suitability for sustainable construction practices.

Table 1: Compressive strength of blocks made by coconut husks as cement reinforcement in terms of: Area

	Control	10%	20%	30%	40%	50%
Area	2651mm	2725mm	2616mm	2621mm	2647mm	2740mm

In terms of area the control group has the area 2651mm^2, 10% having the area 2752mm^2, 20% with 2616mm^2, 30% having 2621mm^2, 40% having 2647mm^2 and 50% having 2740mm^2. We can see that the area between the samples may vary due to its length and width.

Table 1.2: Compressive strength of blocks made by coconut husks as cement reinforcement in terms of: Length

	Control	10%	20%	30%	40%
Length	50.2	52	52	52	52

In terms of the length of the samples, the control group has the length of 50.2mm, 10% up to 40% having the length of 52mm and 50% with 52.1mm. We can see that the length of the control is 1.8 less than that of the coconut reinforced cement samples

Table 1.3: Compressive strength of blocks made by coconut husks as cement reinforcement in terms of: Width

	Control	10%	20%	30%	40%
Width	**52.8**	**52.4**	**50.3**	**50.8**	**52.7**

In terms of the width of the samples the control groups have the width 52.8mm, 10% with 52.4mm, 20% with 50.3mm, 30% with 50.8mm, 40% with 52.7mm and 50% with 50.8mm. We can see that each sample have different but close measures in terms of width

Table 2: Compressive strength of CHCR

	10%	20%	30%	40%	50%	0%
kN	15.20	24.00	29.20	33.90	36.30	30.40
psi	810	1330	1620	1860	1920	1660
Mpa	6	9	11	13	13	11

In terms of compressive strength, we can see that the Control group has the kN of 30.40, psi of 1660 and MPa of 11, with 10% husk having 15.2 kN, 810 psi, and 6 MPa, 20% husk having 24 kN, 1330 psi, and 9 MPa, 30% having 29.20 kN, 1620 psi, and 11 MPa, 40% husk having 33.90 kN, 1860 psi, and 13 MPa. And lastly 50% husk having 36.30 kN, 1920 psi, and 13 MPa. As we can see in table 4, we can see that the 40% and 50% husk samples are stronger compared to the control group by 20%. Things to note is that the coconut reinforced samples use 100g less cement than that of the control group.

Table 3: Significant relationship in the compressive strength of CHCR

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	10404134	3	3468045	82.11698	2.04E-11	3.098391
Within Groups	844659.6	20	42232.98			
Total	11248793	23				

With the anova 1 results we can see that the P-value is greater than that of the F crit. Which means that we can accept our SOP and reject our hypothesis as there is a significant relationship between the compressive strength of coconut husk reinforced cement.

Discussion

This experimental research was conducted to determine whether there is a significant difference or relationship in the compressive strength of coconut husk reinforced cement. 6 total cement blocks were made in the JHS laboratory, 5 coconut husk reinforced cement samples and 1 control group.

The experiment in which the durability tests were done were on the 25th of February and the result showed us that 2 of the 5 coconut reinforced cement samples were stronger than the control group/plain cement mixture.

Based on the experiment result we have come to the following conclusions

1. As our F-crit value was higher than our P-Value we can conclude that there is a significant relationship in the compressive strength of coconut husk reinforced cement.
2. Coconut husks are very versatile and can be used for many other things aside from cement reinforcement
3. Although 2 coconut cement samples were stronger than the control group the remaining 3 samples showed that there was a decrease to the durability and use these limitations as reasons to suggest additional future research.

Recommendations

1. Future researchers can focus on our study delimitations as we lacked on time and equipment. As our limitations were Time, we could not conduct UV and Permeability
   and because we had a low budget, we could not afford any high-level type of cement durability testing as it would cost hundreds of thousands for a high-tech durability tester.
2. Future studies can further delve into
   the uses of coconut husks. |
   For example, in our free time after we finished creating the cement blocks, we figured out a way to clean up our mess using coconut husks as a sort of sponge to absorb the liquid and wipe the dust and dirt away.
3. We recommend that the coconut coir
   (dust like particles coming out of the husks) to be collected and made into another type of cement reinforcement
   As our study only focused on the husks, we noticed that the coir could be used as an aggregate substitute for cement.
4. We recommend a 45% - 50% mixture of
   coconut to cement for the best result and

durability. Because in between these percentages had the best result beating the control group by over 20%.

References

How to create concrete. (2022). wikiHow. https://www.wikihow.com/Make-Bricks-from-Concrete

How to remove coconut husk. (2012). Blogger. https://clarksiler.blogspot.com/2012/09/how-to-remove-coconut-husk.html

Reinforcement in concrete. (2019). American Concrete Institute. https://www.concrete.org/topicsinconcrete/topicdetail/Reinforcement%20in%20Concrete?search=Reinforcement%20in%20Concrete

How to reinforce concrete and why? (2021). Reinforcement Products Online. https://www.reinforcementproductsonline.co.uk/news/reinforcement-for-concrete/

Ahmad, J., et al. (2022). Mechanical and durability performance of coconut fiber reinforced concrete. Journal of Building Engineering. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9143988/

Martinelli, F. R. B., et al. (2021). A review of the use of coconut fiber in cement composites. Polymers, 15(5), 1309. https://www.mdpi.com/2073-4360/15/5/1309

Ganiron, T. U., et al. (2017). Recycling of waste coconut shells as substitute for aggregates in mix proportioning of concrete hollow blocks. ResearchGate. https://www.researchgate.net/publication/257099368_Recycling_of_Waste_Coconut_Shells_as_Substitute_for_Aggregates_in_Mix_Proportioning_of_Concrete_Hollow_Blocks

Yulianto, B., et al. (2019). Design of eco-friendly pen made of coconut shell waste. E3S Web of Conferences, 130(03002), 1-5. https://www.e3s-conferences.org/articles/e3sconf/pdf/2019/51/e3sconf_icenis2019_03002.pdf

proper APA citation. *Journal of Proper APA Citation, 1*(2),