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Rubber and Oil Palm Empty Fruit Bunches (EFB) as a Composite Material for Cement Roof Tile

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ABSTRACT

This study delves into the environmental advantages of incorporating recycled rubber and oil palm empty fruit bunches (OPEFB) into cement roof tile composites. The integration of these materials not only benefits the environment but also proves economically advantageous by minimizing expenses related to landfill and incineration. The study focuses on developing composite samples (labelled A to D) with varying percentages of OPEFB fibers, subjecting them to tests for density, thermal conductivity, and water absorption. Fabricating cement roof tile moulds tailored for specific testing further enhances the study's comprehensiveness. The findings elucidate the intricate interactions between cement, rubber, and OPEFB fibres, impacting the tiles' physical characteristics. Increasing EFB fiber content from 0 to 15 wt. % in the composite material results in a gradual decrease in density from 336.944 kg/m³ to 327.778 kg/m³. Water absorption shows a peak at 5 wt. % EFB fiber (13.08%), with a subsequent decrease at 10 wt. % (10.77%), followed by a rise at 15 wt. % (13.87%). The thermal conductivity varies among compositions, with the sample without EFB fiber having the highest value of 0.141 W/m°C. While offering promising advantages, variations in water absorption and unexpected trends in thermal testing underscore the need for further research and refinement to optimize material properties and ensure compliance with industry standards, thereby enhancing the practical applicability of these sustainable composite materials.

Keywords: sustainable composites; recycling rubber; oil palm empty fruit bunches (OPEFB); cement roof tile.

1. INTRODUCTION

There has been extensive study about thermal and physical properties of cementitious composites reinforced with natural fiber or rubber tire waste, including many ways to modify the fiber surface to increase the fiber's compatibility and bonding to the cement matrix (Abdullah et al., 2011). The coefficient of heat conductivity decreases as the fiber content increases (Kroehong et al., 2018). However, As the amount of fibre in the composite grows, so does its porosity (Lertwattanaruk & Suntijitto, 2015). For the best outcomes, they even suggested that the fibre aspect ratio should fall between 100 and 200 (10-30mm). The addition of fibre is increasing the composite's heat conductivity. The coefficient of heat conductivity decreases as the fibre content increases (Kroehong et al., 2018). At greater fibre contents, OPEFB composites have a slightly lower thermal conductivity than coir fibre composites; at lower fibre levels, both composites have the same thermal conductivity (Lertwattanaruk & Suntijitto, 2015). As for the effect of rubber content, the rate of heat transfer was found to decrease with the increasing rubber content. Comparing the same size, the smallest value is found at 30%, and increased gradually at the rubber content of 20% and 10% (Raut & Gomez, 2016).

2. METHODOLOGY

The samples were treated using an alkaline treatment to improve their mechanical and durability properties. OPFEB fiber is treated with 5% NaOH and soaked for 12 hours. The size for recycled rubber crumbs is 20 mesh (Raut & Gomez, 2016). The rubber particles pretreated with NaOH have better bonding relationships with cement matrixes and higher compressive strength.

First, water with plasticizer was added to the cement powder and blended for 2 minutes. A plasticiser is a substance or material added to concrete to make it softer, improve workability and strength, and reduce water requirements. Then, when applicable, the 30g modified rubber particles were gradually added into the mixer and blended for 3 minutes and/or the treated fibers were added and blended for another 5 minutes. The mixture was poured into a mold and cured for 24 hours. Afterward, the composite was taken out from the mold and cured for 28 days. The sample mixed with different percentage OPEFB fiber as shown in Table 1.

Table 1. Composition of Samples

Sample	**Portland cement type I (g)**	**Modified rubber (g)**	**OPEFB fibre (g)**	**Plasticize (g)**	**W/C ratio**
A (C+MR30%)	100	30	0	0.8	0.5
B(C+MR30%+OPEFB5%)	100	30	5	0.8	0.5
C(C+MR30%+OPEFB10%)	100	30	10	0.8	0.5
D(C+MR30%+OPEFB15%)	100	30	15	0.8	0.5

3. RESULTS AND DISCUSSION

The appearance of Rubber-EFB (Empty Fruit Bunch) fiber cement tiles is influenced by the combination of rubber, EFB fibers, and cement, resulting in a distinctive and versatile building material. Adherence to MS 797 standards reveals that water absorption percentages for EFB fiber composites surpass the specified limit of 4.4%, ranging from 10.51% to 13.87%. The increase in porosity due to the fiber content results from internal structural pores present within the fiber itself (Rao & Ramakrishna, 2021).The sample without EFB fiber (0 wt. %) exhibited the highest thermal conductivity at 0.141 W/m°C, surpassing values for samples with 5, 10, and 15 wt. % EFB fiber. Table 2 shows the full results for U-value (thermal transmittance) and R-value (thermal resistance).

Table 2. U-value (thermal transmittance) and R-value (thermal resistance) of sample

EFB fibre	U-value (thermal transmittance) (W/m^2K)	R-value (thermal resistance) (m^2K/W)
0 wt. %	344.83	0.0029
5 wt. %	185.19	0.0054
10 wt. %	96.15	0.0104
15 wt. %	217.39	0.0046
Standard	0.60 (maximum)	1.67 (Minimum)

4. CONCLUSION

The study examined the physical properties of Rubber-EFB fiber cement tiles, focusing on appearance, density, water absorption, and thermal conductivity. The study found that EFB fiber content significantly influenced color variation, texture evolution, and pattern development. Density decreased with increasing EFB fiber, but this necessitates a comprehensive evaluation of mechanical and thermal properties for specific applications. Water absorption exceeded Malaysian Standard MS 797 limits, suggesting potential limitations in practical applicability, especially in moisture-sensitive environments. Thermal testing revealed unexpected trends, highlighting the need for a nuanced understanding of the material's behavior. The assessment against MS 2680:2017 standards revealed challenges in meeting insulation criteria, emphasizing the need for material composition adjustments for future research exploration.

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REFERENCES

Mohd Nubli Shahmi, Z. A., & Ibrahim. (2022). Roofing Tiles Innovation Based on Seashells, Coconut Fiber and Sodium Lignosulfonate. 2022 Jurnal Kejuruteraan, Teknologi Dan Sains Sosial, Volume 8(Issue 1).

Hancharoen, K., Kamhangrittirong, P., & Suwanna, P. (2020). Enhancement of thermal and sound insulation properties of cement composite roofing tile by addition of nanocellulose coated pineapple fiber and modified rubber tire waste. Key Engineering Materials, 861, 465–472.

Kroehong, W., Jaturapitakkul, C., Pothisiri, T., & Chindaprasirt, P. (2018). Effect of oil palm fiber content on the physical and mechanical properties and microstructure of High-Calcium Fly Ash Geopolymer Paste. Arabian Journal for Science and Engineering, 43(10), 5215–5224.

Lertwattanaruk, P., & Suntijitto, A. (n.d.). Properties of natural fiber cement materials containing coconut coir and oil palm fibers for residential building applications. Construction and Building Materials, 94, 664–669. https://doi.org/10.1016/j.conbuildmat.2015.07.154

Raut, A., & Gomez, C. P. (2016). Thermal and mechanical performance of oil palm fiber reinforced mortar utilizing palm oil fly ash as a complementary binder. Construction and Building Materials, 126, 476–483.

Sukontasukkul, P. (2009). Use of crumb rubber to improve thermal and sound properties of pre-cast concrete panel. Construction and Building Materials, 23(2), 1084–1092.