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Production Of Eco Faperbrick From Used Fabric And Paper Wastes

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ABSTRACT – Fabric and paper waste pose significant environmental challenges, with textile and clothing discards adding to landfill problems and paper waste poses deforestation concerns. Repurposing these materials offers a sustainable solution, reducing their environmental footprint. This project focuses on transforming fabric and paper waste into eco-friendly bricks, addressing production processes and assessing mechanical strength and moisture content. The methodology involves combining fabric and paper waste using a homemade starch-based glue as a binding agent. The molding process employs simple equipment and compression techniques, followed by the removal of excess glue and thorough drying. Tensile strength and water absorption tests are conducted on samples with varying fabric to paper waste ratios of 80:20, 85:15, 90:10, and 95:5. Comparisons reveal the 80:20 ratio of fabric to paper as optimal ratio with 2.67MPa, showing promising structural integrity suitable for indoor construction. By repurposing these waste materials into eco-friendly bricks, the project not only tackles waste-related environmental issues but also contributes to sustainable construction materials. It demonstrates a practical approach to waste management while promoting eco-consciousness and viable construction solutions.

KEYWORDS : Eco Brick; Paper; Fabric; Mechanical Properties

1.0 INTRODUCTION

The mounting environmental challenges posed by fabric and paper waste demand innovative solutions to mitigate their adverse impacts. Textile and clothing discards exacerbate landfill problems, while paper waste contributes to deforestation concerns. Form a record 195,300 tons of textile waste were discarded in Malaysia in 2018, and SW Corp Malaysia reported that the percentage of textile waste that ended up in landfills increased from 2.8% in 2012 to 6.3% in 2018. The waste of textiles is becoming a global issue and has been for many years, especially in Malaysia [1]. Nowadays, people from all walks of life will buy different types of clothing and want to be a trend fashion. If the cloth is not unfashionable then they won't wear it again and put aside. After a long-time the number of clothes not to wear will increase because fashion is changing. Past research has focused on making eco-friendly cement bricks by incorporating polyester fabric wastes and manufacturing eco-friendly bricks using microdust cotton waste. Polyester fabric waste is valued for its durability, tensile strength, and resistance to various environmental factors, making it a suitable additive to enhance the structural integrity of cement bricks [2]. Similarly, cotton microdust waste, with its fibrous nature, can improve the binding properties and thermal insulation of bricks, contributing to energy efficiency and sustainability in construction materials [3].

Paper is a thin substance made from cellulose fibers that are sourced from wood, rags, or grasses then followed by pressing and drying. In Malaysia, landfills receive around 57,000 tons of paper per month, enough to fill 456,000 cubic meters of space. This is the equivalent of felling 680,000 trees that might be sold [4]. Because of the growing population over the past ten years which cause high demand of paper that logging process will increase from time to time and the logging process will reduce the amount of tree that can cause environment pollution. So, there are much of waste product produces every year that contribute to environment pollutant unless recycle it for other applications. Past research has utilized paper pulp, lime, and fly ash to create eco-friendly bricks. Paper pulp is lightweight and has good binding properties, which can enhance the brick's structural integrity. Lime acts as a natural cement, providing excellent workability and durability, while fly ash, a byproduct of coal combustion, improves the brick's compressive strength and reduces the overall environmental impact by recycling industrial waste [5].

This paper presents an examination of the eco-friendly brick production process, with a particular focus on optimizing the fabric to paper waste ratio to achieve optimal mechanical performance. Tensile strength and water absorption tests are conducted on samples with varying ratios, enabling the identification of the most promising composition for structural integrity. This study could contribute to advancing sustainable waste management practices and fostering eco-conscious construction solutions in the future.

2.0 MATERIALS AND METHODS

The preparation of the ecobricks was done based on a study by Kagitci, 2022 [6]. This research will be carried out in four stages as follows:

2.1 Stage 1: Material preparation

Washing, collection, separation and sorting of fabric and paper waste was done. The wastes are subsequently subjected to the drying process. At a dryer set at 40°C, the drying process is completed. The components are then sliced or shrunk into tiny bits to produce loose, severed fibre once they have dried fully. The waste was shred in size from 4-6 mm to 15-20 mm.

2.2 Stage 2: Preparation of starch-based binder

The binder was prepared with the following steps. Initially, 71.25g of corn starch powder was mixed with 450ml water in a beaker, followed by the addition of 37.5 ml of glycerine. The mixture was stirred vigorously until it became homogeneous. Subsequently, 37.5 ml of vinegar was added to the mixture and thoroughly mixed. To initiate the cooking process, a hotplate magnetic stirrer was turned on and the mixture was placed on it. The temperature was set to set to 290°C, and the mixture was stirred rapidly and continuously until it thickened. It is important to note that the binder should not be cooked for more than 12 minutes to ensure optimal results.

2.3 Stage 3: Preparation of Eco-Faperbrick mixture

20g of shredded fabric and 30g of shredded paper were required for the experiment. Additionally, water was needed to soak the paper. The tools used in the procedure included a tray, safety gloves, and a weighing scale. Firstly, the paper was softened by soaking it in water for at least an hour. After soaking, the paper was filtered out of the water to remove excess moisture. Then, the previously prepared binder was mixed with the soaked paper and fabric shreds. It was crucial to ensure thorough mixing by blending and swirling the components for approximately 10 minutes. This step is important to achieve a proper and uniform distribution of the binder throughout the mixture. Following these steps and using the specified materials, the preparation of the eco-Faperbrick mixture was effectively carried out.

2.4 Stage 4: Moulding process

The liquid is poured into a square mould made of galvanized steel that has been drilled with tiny holes. The inside surface of the mould, which has the dimensions (190x90x50) mm, should be lined with baking paper greased with Vaseline. This helps in easily removing the samples from the mould without causing damage due to sticking. The mould is then compressed using G-clamps. This step is crucial to remove excess binder from the mixture, as using too much binder can damage the sample's homogeneous porosity once it sets. The final product sample takes the shape of a square after compression. These samples are then placed inside an oven and dried at 100°C for three to four hours, or until they solidify. Once dried, they are removed from the oven and taken off the baking paper and mould. With this, the eco-Faperbrick manufacturing process is complete.

Tensile test was performed using the ASTM D3039 standard test procedure to evaluate the force necessary to stretch the sample to breaking point. As with the test for compressive strength, all four samples were evaluated to get an average, which helped to consolidate the results in regards to accuracy. The sample was cast in a mould corresponding with its shape with measurements of 250 mm 3 mm 25 mm and tested by the Universal Testing Machine. The goal of this test is to determine the sample's ultimate tensile strain, tensile strength, and tensile yield strength.

The moisture absorption test was performed to determine how much water the brick absorbs. As immersed in water for 24 hours, first-class bricks should absorb a maximum of than 20% and second-class bricks should absorb no more than 22%. To do this, the weight of the brick is recorded, and it is subsequently submerged in water for 24 hours. After that, it is removed and weighed. The weight gain is discovered. It's measured as an amount of water absorption. The maximum allowable value is 20%.

3.0 RESULT AND DISCUSSION

The average tensile strength for each of the samples are presented in Figure 1. Based on the test conducted, sample 80:20 (fabric:paper) has the highest average ultimate tensile strength of 2.675 MPa where it can withstand the highest amount of stress before breaking.

Sample with ratio of 85:15 fabric to paper ratio shows the lowest average ultimate tensile strength of 1.269 MPa. It has the least resistance to stress and is more prone to breaking. Other than that, sample 90:10 (fabric:paper) shows the average ultimate tensile strength of 1.591 MPa, where it is slightly lower strength compared to sample 95:5 fabric to paper ratio. On the other hand, sample 95:5 has the average ultimate tensile strength of 1.898 MPa, where it exhibits the second highest strength among the four samples. Between the ratio of 85% to 95% of fabric, the tensile strength increased 0.63 MPa, showing that higher fabric ratio, contributed to higher tensile strength.

These findings demonstrate the impact of the fabric-to-paper ratio on the composite materials' mechanical characteristics, particularly their ultimate tensile strength. Bigger difference of fabric to paper ratio makes the composite less homogenous which contributed to lower compatibility between two different material. When the different in ratio of material becomes smaller, the material will create better binding between each other, hence increased the tensile strength [7]. The overall ultimate tensile strength of the composites tends to decline as the fabric percentage rises from 80% to 95%. The observed trends are consistent with previous studies on fabric and paper composites, which support the understanding that the composition of the composite materials significantly affects their mechanical behaviour, including tensile strength. Variables such as the type and proportion of fabric or paper used, the binding agents, and the manufacturing process all contribute to these results. For instance, the fibre length and orientation in fabric, the quality and treatment of paper pulp, and the curing conditions can all influence the tensile strength and overall mechanical performance of the composites [8].

Variations in the typical ultimate tensile strength and other elements relating to the composition of the fabric and paper are relevant. Compared to paper, which is made up of tightly packed fibres, fabrics often have a lesser inherent strength because of their interlaced or entangled fibre structure. Lower average tensile strength results are the result of the overall tensile strength being impacted when the fabric content rises in the composite samples. From this result, it is concluded that sample 80:20 is the best proportion and will be used in the production of the eco-Faperbrick prototype.

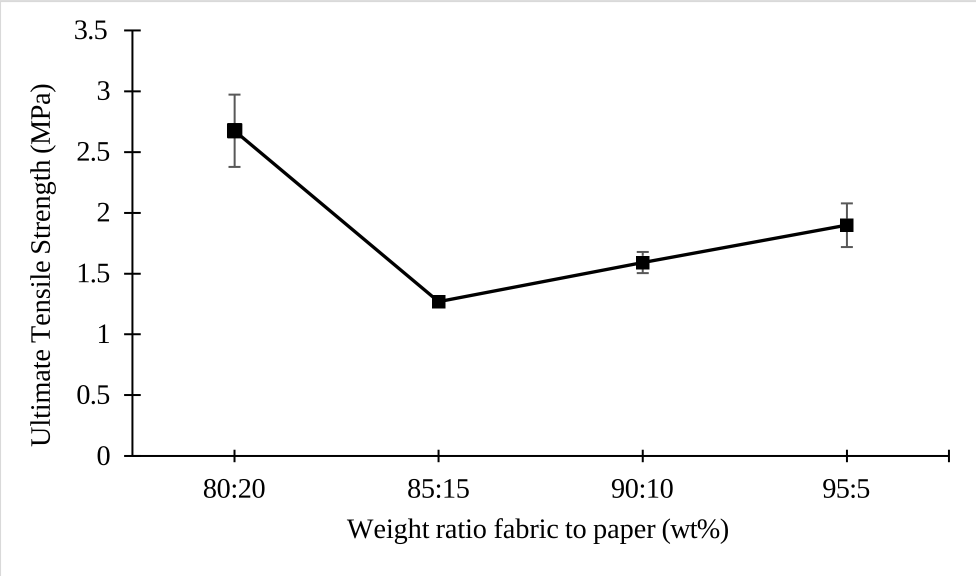

Figure 1. Ultimate tensile strength of different weight ratio fabric to paper.

Table 1 shows the result of water absorption on waterproof samples. Water absorption of a sample indicates how much water the samples can absorb after 24 hours. Sample 80:20 to 95:5 shows no significant changes with different % only 2.32%. It can be concluded that the difference in ratio does not significantly affect the water absorption capacity of the samples. This may be due to the effect of waterproofing layers that has been applied to the molded composite.

Table 1. Water absorption on waterproof samples.

Samples	Initial weight (g)	Initial weight (g)	Water absorption (%)
80:20	27.50	30.53	11.02
85:15	32.36	36.29	12.49
90:10	33.26	37.25	11.99
95:5	31.49	35.69	13.34

4.0 CONCLUSION

In conclusion, the study highlights the critical influence of fabric-to-paper ratio on the mechanical properties of composite materials, particularly their ultimate tensile strength. From tested samples of 80 to 95 % fabric ratio, sample 80:20 (fabric:paper) emerges as the optimal proportion, showcasing the highest average ultimate tensile strength of 2.675 MPa, indicative of superior stress resistance. Conversely, sample 85:15 exhibits the lowest average ultimate tensile strength at 1.269 MPa, reflecting its susceptibility to breakage under stress. These results align with prior research, emphasizing the pivotal role of composite composition in determining mechanical behavior. The study underscores sample 80:20 as the preferred ratio for eco-Faperbrick prototype production, offering both robust tensile strength and minimal water absorption, thus promising sustainability and durability.

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