AN EXPERIMENTAL STUDY TO REUSE FABRIC WASTE AS ALTERNATIVE PARTITIONING MATERIAL IN BUILDING INTERIORS

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Introduction

The construction sector is a significant contributor to the global material consumption and environmental degradation. In response to fulfilling these demands of the construction industry, researchers have adopted the practices of repurposing waste materials to create novel construction materials (Sizirici, Fseha, Cho, Yildiz, & Byon, 2021). Among these alternative approaches, there are a few researches tried to utilize different textile waste as construction materials in the world. Further, it is important to mention that Sri Lankan garment sector generate loads of textile waste and discharge those to landfills, lead to create massive environmental issues though it contributes on 50% of the gross domestic products of the country (Arachchige, Vithanage, Wadanambi, Wandana, Wijerathne, & Wimalarathne, 2019). Most importantly, it was noticed that there is no established textile waste management system in Sri Lanka, though the factories dump significant amount of waste to the environment. University of Leeds (2020) recorded that only 1% of textile waste can be recycled. Further, 60% of textile waste is plastics, which makes the global fashion industry the second most polluter after the global oil industry. Hence, this study was aimed to investigate the possible methods of reusing the textile waste into a substitute construction material and fulfill the demands in construction industry. This research is predominantly focused on non-load bearing partitioning materials which is developed through fabric waste and three types of adhesives namely PVA, binder glue, and cashew glue prepared domestically.

Experimental Design

This research experiments on how waste fabrics can be used to create non-load bearing partitions. The literature review covered alternative building materials, Sri Lanka's textile industry, and the properties of common partitioning materials. The study comprises of two distinct phases.

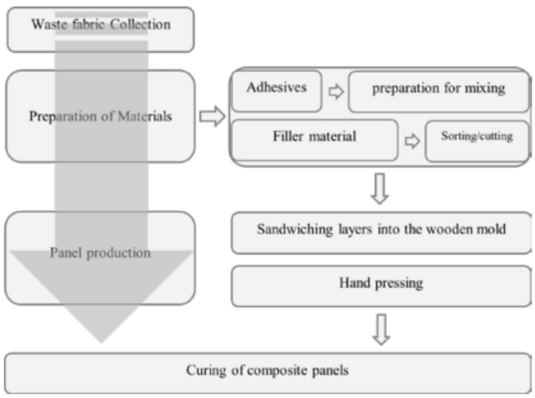

Figure 1: Process of making composites.

The first phase of this study involves the production of a diverse range of composite specimens by utilizing discarded textiles and various bonding agents.

The design of adhesives prioritizes accessibility, natural composition, and environmental sustainability. The garment factories facilitated convenient availability of surplus fabrics, while a variety of toolkits were fashioned in-house. The framework utilized for generating samples is illustrated in Figure 1. The unit size served as the primary focus of attention. The dimensions of 150 mm x 150 mm x 10 mm (W x L x H) were well-suited to accommodate both the fabric classification of the pieces and the project scope. Upon completion of the requisite adhesive and filler materials, the procedure was executed in accordance with the guidelines as shown in Figure 1. Table 1 displays the utilized quantities, which were subsequently subjected to dryed for the purpose of testing. Figure 2 shows the stage by stage manufacturing process done in the workshop representing the steps strating from 'a' is preparation and measuring adhesives, 'b' & 'c' is the moulding/sandwiching the layers and finally 'd' is the drying process.

Table 1 : Adhesive to filler ratio

Adhesive	Adhesive To filler ratio	
	Adhesive+ H20 (g)	filler(s)
PVA	110	100
Cashew gum	230	100
Binder	115	100

a
.
b.
c.
d.

Figure 2: Manufacturing process

Results and Discussion

The specimens mentioned in the study display a common pattern, although with noticeable differences as shown in the figure 3. The results indicate that the adhesive characteristics of cashew glue and binder-based panels and specimens follow a similar trend, while PVA-based panels exhibit a distinct behavior. When comparing these samples based on their maximum tensile strength and elongation, cashew glue-based samples fare better.

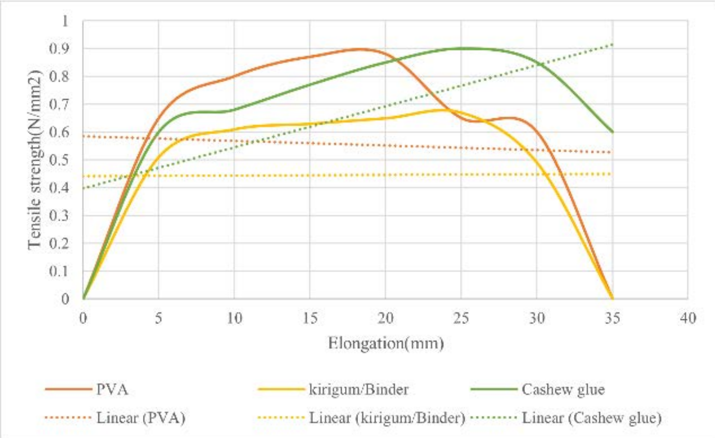

Figure 3: Overview of measured values of test

The elastic deformation of each material was nearly identical, and the measured elongation was 5mm. Although elastic deformation of each sample is identical, the plastic deformation is variable, indicating that the fraction points of these samples vary. In terms of the overall behavior of the samples, the sample containing cashew glue performed well. In the sound absorption test results are summarized in the figure 4 and the collected data show that the smallest difference observed was 6.6 dB. The tested samples were demonstrated an absorption of 9.5 dB, while the highest absorption of all samples was 35.8 dB.

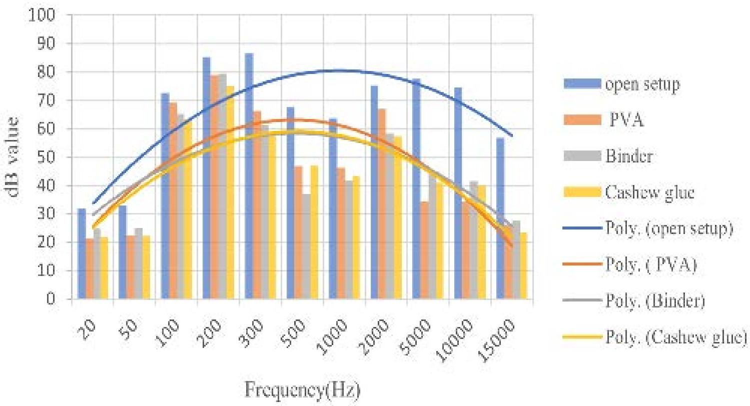

Figure 4: Trend comparison on all three

Figure 5 shows sectional cut of a sample and its layers. Man-made fabrics had gaps, but natural fibers like cotton, wool, linen, and others were perfectly bonded. Hence, synthetic fabrics weakens the bonds between layers of the composite material and makes testing more likely.

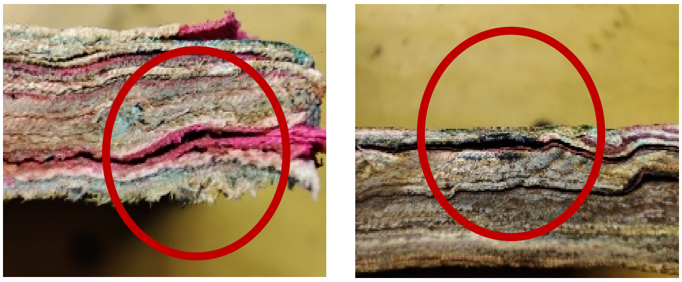

Figure 5: Red circled area shows the gaps between layers.

Conclusion

The study involved the utilization of adhesives, such as PVA, binder, and a self-made adhesive derived from cashew. The aim of the study was to create a readily available partition panel and economical natural materials derived from waste. The most optimal adhesive option was discovered to be homemade glue on account of its cost-effectiveness and efficacy. PVA adhesive demonstrated favorable adhesive characteristics when used with textiles. Diverse fabric types demonstrated distinct characteristics and results; whereby natural fabrics demonstrated superior adhesive bonding. The non-load-bearing partition wall materials underwent limited testing, with only tensile and sound tests being conducted due to temporal constraints. The tensile test results revealed that the cashew glue-based sample performed the best among the tested samples. Nevertheless, there is room for improvement in future works. In terms of sound absorption coefficient, the samples performed similarly to commonly used construction materials like plywood and plasterboard. The samples demonstrated an average sound absorption of 9.2dB indoors, outperforming the outdoor sound levels of 50 to 65dB, where the samples achieved a 25dB absorption rate. Comparing all the test results, the cashew-based panel stood out as the most favorable option. It exhibited strong adhesive properties, penetrating the fabrics and outperforming PVA and binder-based samples. Considering the literature, experimental results, the cashew glue-based composite panels proved to be the most effective. However, it is important to note that this experiment represents only the preliminary stages of research, serving as a starting point for further studies.

References

Arachchige, U. S. P. R., Vithanage, K. D., Wadanambi, R. T., Wandana, L. S., Wijerathne, W. M. M. P., & Wimalarathne, N. R. G. S. S. (2019). *Environmental impacts of textile industry in Sri Lanka*. International Journal of Scientific & Technology Research, 8(09), 251.

Sizirici, B., Fseha, Y., Cho, C.-S., Yildiz, I., & Byon, Y.-J. (2021*). A review of carbon footprint reduction in the construction industry, from design to operation*. Materials (Basel), 14(20), 6094.

University of Leeds. (2020, December 3). *Tackling Sri Lanka's Waste Textile Mountains*. Medium. Retrieved September 10, 2022