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Value Addition of Waste Material by Concocting Particle Board

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Abstract- Using modern technology particle boards have been prepared and use in wildly. Currently, the higher demand for this particle board fails to support the needs. Nowadays which is consuming in numerous ways such as restrooms driveways, passageways, industrial unit, abodes, sports complex, offices, libraries, drizzly areas and many internal portion and exterior locations. In Sri Lanka there are abundant of resources and agro-forestry residues whose potentials are yet to be fully utilized for economic advantage. This study was explored the properties of particle board fashioned by sawdust and waste paper. The boards were produced manually by compressing soaked mixtures of paper pulp and sawdust in wooden and mettle molds with a compressive load 100:0, 60:40, 40:60 and 0:100 of paper to sawdust (Dry), respectively. The compacted mixtures were allowed to sun drying for three days to confirm free from moisture. Density, compressive and tensile tests, thermal conductivity, and electrical conductivity were carried out. According to the analysis, 60% paper 40% saw dust sample of particle board displays the virtuous characteristics than other samples. It exhibits peak value of flexural strength and compressive strength while the purely made by sawdust shows the low value than this. The percentage of saw dust rises the open pores and reductions the value of compressive strength and flexural strength while it shows that low value of tensile stress. And also sample II revels the higher value of density 691.13 kgm^{-3}. In addition to that the thermal conductivity and electrical conductivity also reinforced to this sample II (60% paper 40% saw dust). So, 60% paper 40% saw dust particle board could be endorsed for manufacturing interior wall partitions, notice board and use for decoration etc…. In addition to that this makes the green environment and value added the waste materials.

Key words: Saw dust, Paper pulp, Particleboard, Flexural strength and Compressive strength

I. INTRODUCTION

Nowadays particle board are used in all over the world. The ancient period these boards are manufactured locally with using the saw dust and have been emphasized. Production of particleboard by using waste materials is very profitable [1,2]. However, the efficiency of the board is an important factor for construction. This has been improved by utilizing the locally available sources such as agricultural and industrial wastage. Considering environmental impact and the strength, it is essential to select an alternative material to reduce the impact of particleboard manufacturing as well as increase the effectiveness [3]. There are several raw materials and methodology were practiced. Therefore, many research shows that some admixtures have been used to increase the effectiveness of the board. Such admixtures are saw dust, gypsum, banana stems, recycled plastic, and paper etc. The main aim of this research was disseminate to analysis the strength of board by exploiting the natural agro waste materials.

Particleboard initiated in Germany and created in 1887, and which was called as "artificial wood" made by wood dust and combined under high temperature and pressure [4]. In timber industry major by product is saw dust that pollutes the environment [5] which can be converted as valuable commodity as a raw material of partition board, notice board, roof sheeting and shelves etc… Sawdust is a minuscule piece of wood [6] which exhibits the similar characteristics of wood but some structural properties have been distorted. It is a massive waste generated by wood industries and poses the problem of disposing.

In 13^{th} century the first water powered paper was introduced in the Middle East to medieval Europe [7]. It contains cellulose fibers derived from wood, rags, grasses or other vegetable source. Normally paper products encloses 90-99% of cellulose fibers and which effect the chemical and physical properties of the paper.

II. MATERIALS AND METHOD

Charcoal

Charcoal is produced when the wood or other material is burning by removal of the water and other components. It is lightweight black carbon. It is used to purification and increase the effectiveness of filter.

Activated Carbon

Its similar to charcoal which have small pores, These pores support to the adsorption by increasing the surface area. Activated carbon is used to mainly purification.

Bleaching Powder

Calcium hypochlorite is the main active component which is called as bleaching powder. This is act as bleaching agents and used for water treatment. The smell is similar to chlorine but yellow in colour.

The raw materials were collected. The saw dust was collected from saw mills and the waste papers were collected from Departments in the Eastern University and from book shops. Initially saw dust was oven dried for one hour at 60^0C for prevent from moisture. The waste papers were torn manually using scissors. Then the torn papers were soaked in the water by adding 0.5 g of activated carbon. The sawdust was also soaked in water to allow for softening. Then the soaked paper and saw dust were washed properly and charcoal was added to eliminate water. Again paper was soaked separately for three hours by adding 3g of bleaching powder. At the same time saw dust also was soaked in the water for four hours with 3g of bleaching powder. Then they were washed properly and drained to remove the water. After that 100g of wheat flour, 40 ml of acetic acid, and 20 ml of boiled water were mixed with pulp and soaked sawdust as the binder with the different percentage as shown in Table 01. The partition board was prepared by using molds of equal size and they were compressed by placing a mass of 8 kg on each of them. The mass placed on the samples were left for two days after which the boards with the molds were dehydrated in sunlight for 3 days for complete drying. The same ratios of sample's disk also prepared to measure the thermal conductivity and electrical conductivity.

Table 1:. Composition of Paper and Sawdust in the Partition board

Sample	Paper %	Saw dust %
I	100	__
II	60	40
III	40	60
IV	__	100

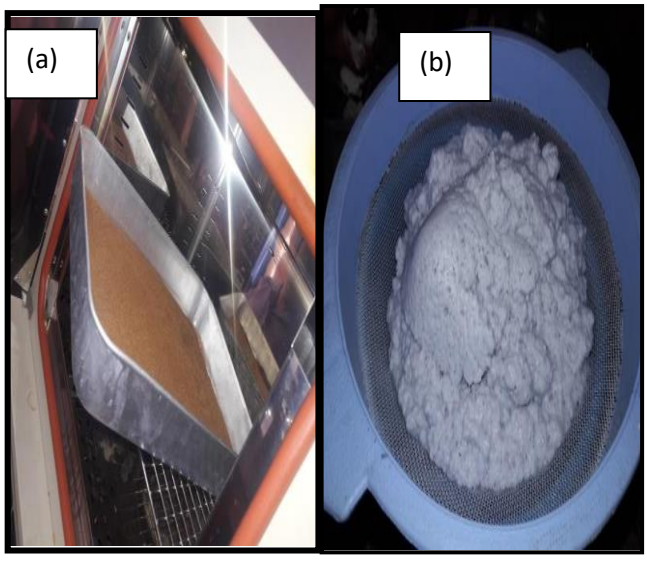

Figure 01:– (a) Oven drying of saw dust, (b) Draining the pounded paper

Figure 02:– Sun drying the sample

ANALYSIS

Density test

The density of each sample was calculated by following equation. To determine the average densities, mass, length, width and the height of the partition board was measured using mechanical balance and Venire caliper of sensitivity 0.1 g and 0.01 mm respectively

$$Density = \frac{Mass}{Volume}$$

Electrical Conductivity

Electrical conductivity is the ratio of the current density to the electric field strength and which measures of a material's capability to allow the transference of an electric charge. Its SI unit is the Siemens per meter, Sm^{-1} (Ωm^{-1}). Electrical conductivity is the converse of electrical resistivity (ρ)

So, electrical conductivity (σ) is,

$$\sigma = {}^{l}/_{RA}$$

R is the electrical resistance of a uniform specimen of the material

l is the length of the specimen

A is the cross-sectional area of the specimen

Thermal Conductivity

Thermal conductivity of the partition board was analyzed using Lee's Disc method. Thermal conductivity is the capacity to transfer heat through the material. Using the below equation the thermal conductivity was determined.

$$k = \frac{t_1}{(T_0 - T_1)}\left[\frac{V^2}{SR} - \frac{k_1}{t_2}(T_0 - T_2)\right]$$

Where k and$k_1$are thermal conductivity of the brick and the insulating disc respectively, *V* is the voltage, *R* is the resistance of the coil, *S* is the surface area of the brick, ρ is the density of the board, *E* is the thermal effusivity, $t_1$andt_2 are the thickness of the board.

Figure 03:– Experimental setup of thermal conductivity test

Compressive Strength (CS) analysis

Compressive strength analyses were performed using Universal Testing Machine. This analysis was done according to the Sri Lankan Standards [8], which is similar to ASTM C67-05 [9]. The compressive strengths of boards were measured with the support of a pressure gauge of sensitivity 2 $kg.cm^{-2}$ attached to the Universal Testing Machine. Then the width and length of the board were measured. When the maximum force applied the board starts to break up at that time force is measured. The compressive strength was determined using the equation.

$$\mathrm{CS} = \frac{\text{Force at failure}}{\text{Width of the brick} \times \text{Length of the brick}}$$

Flexural Strength (*FS*) analysis

Then the board pieces were placed in the three point bending test apparatus as shown is the Figure 5. After that the pressure was increased continuously until the crack was observed on the board surface. At that time value of the maximum pressure was recorded. This procedure was done for the board pieces of all ratios and the readings were recorded. The following equation was used to calculated the flexural strength.

$$FS = FL / wh^2 = 3Fa /2wh^2$$

Where *FS* is flexural strength, (kPa), *L* is length, (mm), *w* and *h* are width and height of the block, (mm) respectively, *a* is distance between line of fracture and the nearest support, (mm), and *F* is maximum applied load (kN).

Figure 04- Arrangement of sample for compressive strength analysis

Tensile Strength (*TS*) analysis

First the board strips were wiped with a sand paper to get smooth surfaces and placed in order. Then the hook and the pin were attached at the center of the strip. Then the board strips were loaded placed on the knife edges and the cathetometer was focused to the sharp edge of the pin (Figure 05). Deflection was measured at midpoint of the strip under loads. Then the tensile strength was calculated for each sample.

Figure 05- Arrangement of sample for Tensile strength analysis

III. RESULTS AND DISSCUSSION

In this study, various types of particle board were prepared and mechanical and physical analyses were done. To investigate the properties of manufactured particleboard samples for the physical properties density, thermal conductivity and electrical conductivity were performed. It was examined the mechanical properties such as flexural strength compressive strength and tensile stress.

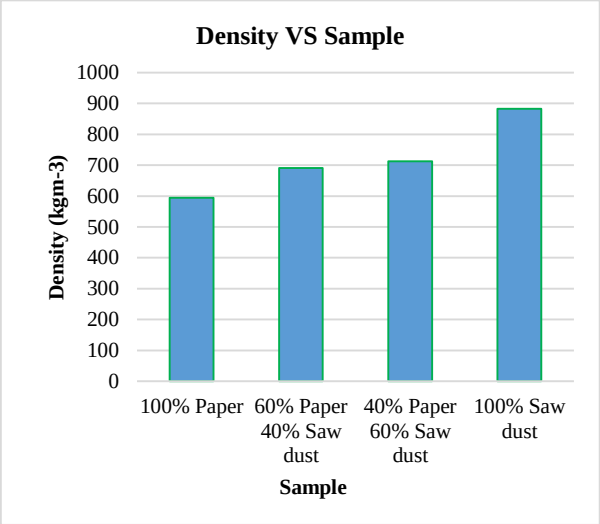

Figure 06:– Graph of Density variation with Sample

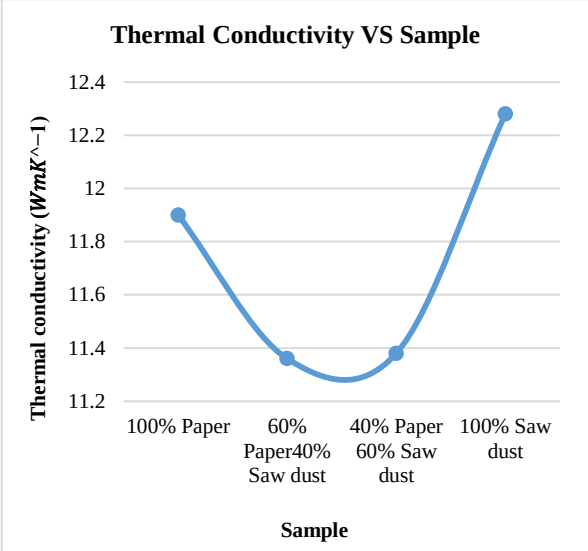

Figure 07:– The Variation of Thermal Conductivity with Samples

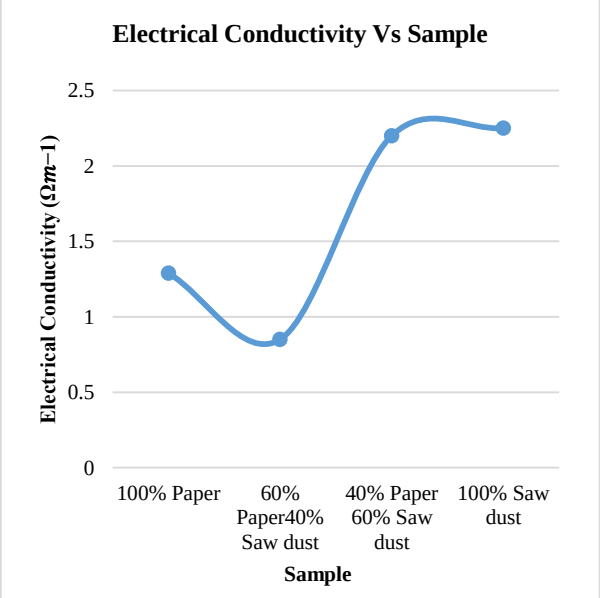

Figure 08:– The Variation of Electrical Conductivity with Samples

Table 02:- Results of Flexural Strength analysis

Sample	Composition	Flexural Strength ($FSx10^6$) Nm^{-2}
I	100% Paper	-
II	60% Paper 40% Saw dust	11.35
III	40% Paper 60% Saw dust	11.02
IV	100% Saw dust	7.53

Table 03:- Results of Compressive Strength analysis

Sample	Composition	Compressive Strength ($CSx10^{-4}$) Nm^{-2}
I	100% Paper	-
II	60% Paper 40% Saw dust	98.43
III	40% Paper 60% Saw dust	75.24
IV	100% Saw dust	65.75

Table 04:- Results of Tensile Strength analysis

Sample	Composition	Tensile Strength ($TSx10^7$) Nm^{-2}
I	100% Paper	5.24
II	60% Paper 40% Saw dust	2.91
III	40% Paper 60% Saw dust	1.01
IV	100% Saw dust	-

Figure 06 indicates that how the density is varied with samples. It is noticed that the density of the board is linearly increasing with the percentage of the saw dust increases. The density of purely (100 %) made of paper pulp shows very law value (594.17 kgm^{-3}) while of purely made of saw dust has got 882.74 kgm^{-3}. This exhibits that wood sawdust is denser than paper.

The results of the flexural strength is tabulated in Table 02. It is clearly observed that the sample II (60% Paper 40% Saw dust) has got highest value than other. While increasing the paper pulp the flexural strength is decreased. The Flexural strength of sample IV which is made by 100% saw dust is exhibited the lowest value 7.53

$x10^6$ Nm^{-2}. Furthermore it couldn't measure the flexural strength of the partition board of the purely made with paper pulp. The compressive strength is examined and exhibits in Table 03.It revels the pattern of the flexural strength. The sample which is made purely saw dust has got lowest value of compressive strength. Similar to flexural strength it is difficult to measure the compressive strength for the virtuously made by paper pulp. This is owing by highest water holding capacity and presence of stomata which makes the partition board easily crushed. However the sample II (60% paper 40% saw dust) is the maximum suitable percentage to form a good bonding to increase the strength of the partition board. The percentage of saw dust increases the open pores and decreases the compressive strength and flexural strength.

The results of tensile stress analysis exhibits the contradictory approach from flexural strength and compressive strength analysis. It is organized in Table 04 and which is obviously showed that the sample I (100% Paper) has highest value of 5.24 $x10^7$ Nm^{-2}. This is decreased while cumulative the percentage of saw dust resulting by its brittleness. The partition board which is made by purely the saw dust could not be loaded due to very brittle. So the compressive strength didn't measure for the sample I.

Thermal conductivity increases with decrease of the percentage of paper is shown in Figure 07. This is due to diminution of paper decreases the porosity of the mixture. Thus these pores support to increase the thermal conductivity. Even though the sample II (60% paper 40% saw dust) exhibits the least value of thermal conductivity by its good composition. It confirms that the sample II evidently favourable to the improvement of the thermal conductivity in the partition board.

Figure 08 shows that the how electrical conductivity varies with samples and it is revealed the same configuration of the thermal conductivity. The sample II 60% paper 40% saw dust) has lowest value 0.85 is attained which is further support to the results. While snowballing the percentage of saw dust the electrical conductivity is smoothly increased. A maximum electrical conductivity 2.25 Ωm^{-1} is obtained for 100% saw dust sample.

IV. CONCLUSION

This research was scrutinized the effect of particle board with partial addition of paper pulp on the efficiency of the board. The particle board has been made using waste paper and saw dust with different combination. From various studies of physical properties performed by adding different percentage of saw dust and paper pulp, it could be concluded that partial addition of saw dust develops the physical properties of particle board. The higher value of density was reported for purely made by saw dust particle. However particleboard exhibits desired characteristics with peak value of Flexural strength and compressive strength that is 11.35 $x10^6$ Nm^{-2} and 98.43 $x10^{-4}$ Nm^{-2} respectively. While it illustrates that the low value of tensile stress 2.91 $x10^7$ Nm^{-2}. Furthermore, thermal conductivity and electrical conductivity also supported to this sample II (60% paper 40% saw dust) possibly. The thermal conductivities lay in the range 11.36 to 12.18 $WmK^{-1}$and sample II parades lower than other values while the electrical conductivity, 0.85 Ωm^{-1} of sample II reveals the lowest value.

Therefore, 60% paper 40% saw dust particle board has the best properties among all the others and it could be recommended for the external construction; as well as for interior wall partitions and decorations. Furthermore, this can be manufactured on low cost, semi labour skills and indigenous economy will flourish. By presenting the use of locally accessible waste materials which directed to reduce the environmental pollution.

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