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DEPARTMENT OF CIVIL ENGINEERING AND FORESTRY TECHNIQUES

VALORIZATION OF LOCAL WASTE MATERIALS: UTILIZING WOOD DUST AND WOOD CHIPS IN PARTICLE BOARD PROIDUCTION.

Dissertation Submitted in the department of civil engineering and forestry techniques in Partial Fulfilment of the Requirements for the Award of a Higher Technical School Teacher Post Graduate Diploma (DIPET II) in Wood Work Technology

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ABSTRACT

Sawdust, a by-product of wood processing, poses disposal challenges and environmental concerns. This study investigates the valorization of sawdust in construction applications in Cameroon, particularly in the production of particle boards. Following ASTM (D143-09) standards, sawdust from local workshops was analyzed for its physio-mechanical properties. Key findings include variations in apparent density, thickness swelling, water absorption, and flexural properties, indicating that sawdust particle boards meet industry standards. The research highlights the potential for sawdust to reduce deforestation and promote sustainable practices in the wood industry.

Keywords: Sawdust, Wood processing, Particle board, Sustainable practices, Cameroon

1. INTRODUCTION

Wood is a vital renewable resource, often generating significant waste during processing. This research aims to valorize wood waste, particularly sawdust and wood chips, to improve sustainability in the wood industry.

1.1. Background and Context of the Study

Wood processing generates large quantities of sawdust, leading to environmental pollution and waste management challenges. Historically, wood waste has been managed through various methods, but many remain inefficient. This study explores the economic and ecological benefits of utilizing sawdust in the production of particle boards.

According to Skog and Rosen (1997) and Kiss et al. (2016), wood-based industries generate a large volume of wood waste in primary and secondary wood processing factories. For example, plain shavings, sawdust, and wood off-cuts are all wastes generated during wood processing in sawmills. On the other hand, sander dust, wood shavings and wood chips are generated in the furniture and particleboard industries while the plywood industries generate wood waste from bark, peeler cores, veneer wastes, and panel trims (Owoyemi et al.,2016).

Wood waste can be a potential resource for the production of different materials by re-forming or creating new products (Lykidis and Grigoriou, 2008). The intended use of this waste can be categorized in to energy and non-energy applications. The use of wood waste for energy generation include in the form of combustion, cogeneration, pellet and briquette while non-energyuses include the production of composite boards, pulp and paper, land reclamation, animal bedding, and agricultural mulches (Murphy et al.,2007).

Taylor et al. (2005) also categorized the wood waste re-utilization options in to direct and indirect reuses. Direct recycling is the manufacturing of new wood products such as finger joint and lamination, MediumDensity Fiberboard (MDF) and particle board (chipboard), and wood-plastic composite material while indirect aids include animal bedding, landscape mulch, surfacing products, composting, and cement board. Apart from international experience, wood waste is not effectively utilized in Ethiopia, mainly because of the low level of skills, knowledge, and backward technologies used for both production and processing activities. Poor coordination of wood waste generating factories and concerned bodies that ultimately utilized it is another

1.2. Problem Statement

Despite technological advancements, many wood waste materials remain unrecycled. This study investigates how local wood waste can be transformed into valuable construction materials, particularly in Cameroon, where traditional disposal methods are prevalent.

1.3. Research Objectives

- To produce particle boards from sawdust obtained from sawmills.
- To analyze the mechanical properties of the produced particle boards.
- To evaluate the economic benefits of using local materials in construction.

2. LITERATURE REVIEW

2.1. Introduction to Wood and Wood Processing

Wood waste is the remainder part after any operation done in any wood-based industry (Barua et al.,2014). It generates from primary and secondary wood processing industries that are normally discarded as useless or unwanted product in former times, but it has many other uses now a day.

Wood waste management can be defined as the discipline associated with the control of generation, storage, collection, transportation, processing, and disposal of wood wastes in a consideration of public health, economic feasibility, conservation, and public response. Wood waste management enables to obtain economic benefit from material that has regarded as waste. It can be achieved through reusing, recycling, conversion, and energy recovery methods (Tadesse, 2004). The majority of wood waste in different wood-based industries will go to landfill or energy (Sommerhuber et al., 2015). Appropriate policies and incentives need to be in place to encourage wood waste utilization and prevention from its indiscriminate disposal (Akhator et al.,2017). For example, a number of UK Government policies have a great role in the recovery of wood waste. These include waste management policy, the renewable heat incentive and the renewable transport fuels obligation.

Since wood is among the most recyclable, and reusable materials now a day, there is a growing concern about wood waste recycling and utilizing practice in the world (Barua et al.,2014). It has been reported that wood waste reprocessing for the production of new products is an economically viable plan (Carpio et al., 2013). Wood recycling is one of the basic steps towards a circular economy regenerative system that can able to minimize resource depletion and energy consumption (Keskisaari and Kärki, 2018; Castaldo et al., 2019). It also guaranteed the sustainability of the forest conservation in the emerging economies (Bergeron, 2014). When wood recycled, it increases the economic, environmental, and social benefits. For example, recycling of wood waste in Nigeria reduced pressure on forest, it also reduced environmental pollution, and it created wealth and employment the performance of wood composites.

2.2. Need for Valorization of Wood Waste

Cameroon currently has no specific bidding rules and regulations in the management and utilization of wood waste, although the country has clearly defined environmental laws. Wood industries of the country are found at a lower level in all aspects including technology and skilled manpower, which are considered as the major causes for the current generation of the huge amounts of waste by wood industries. Due to these and related factors, wood industries irresponsibly generate and dispose of such materials everywhere in the city. For instance, wood waste can be found on roadsides, in rivers crossing the areas, between residential houses, and many other places of Bambili.

Bambili, which is not different from other big towns, where wood-based enterprises are available As institutional issues there is no good policy in the country that tries to improve effective and efficient wood waste management, there is also no functional structure set up at the grassroots level communities and institutions.

There is no linkage between the waste generating industries and concerned wood waste utilizer stakeholders. Therefore, the waste from wood industries to-date is not only potentially polluting the environment as told above, but also negatively influences the productivity of the enterprises themselves; as such waste materials normally occupy large areas of spaces that would have been used for other production purposes.

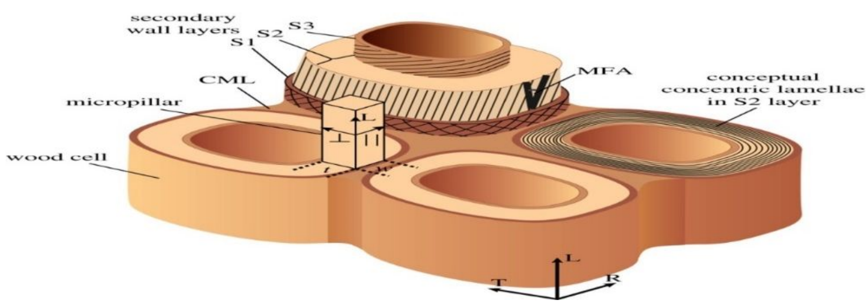

Figure 1: Simplified structure of a woody cell (Source: Côté 1967).

2.4.2. Chemical composition of wood trees fibers

It generally consists of the following properties.

	Hard wood	**Soft wood**
Cellulose	40- 50%	35-45%
Lignin	20-30%	25-35%

Lowering the costs would increase their market share.

WOOD ADHESIVE

CLASS	**RESIN TYPE**	**TYPICAL ADHESION SYSTEM**

Synthetic	Amino	-Urea-formaldehyde (UF)
• *Thermosetting*		-Melamine-formaldehyde (MF)
		-Melamine-urea-formaldehyde (MUF)
		-phenol-formaldehyde (PF)
	Phenolic	-Resorcinol-formaldehyde (RF)
		-Phenol-resorcinol-formaldehyde(PRF)
	Isocyanate	- Diphenylmethane-4,4'-discocyanate
	Epoxy	(MDI)
	Elastomeric	-Bisphenol A-based epoxy resins
		- Styrene butadiene rubber (SBR)
• *Thermoplastic*	Vinyl	-Polyvinyl acetate (PVAc)
		-Polyvinyl alcohol (PVA)
	Hot-melts	- Ethylene vinyl acetate (EVA)

Table 1: Synthetic classification ***(Source: Sellers 1998.)***

3. RESEARCH METHODOLOGY

3.1. Scope and Area of Study

This research was conducted in Bamenda, the headquarters of the Northwest Region of Cameroon, which has a population of approximately 500,000 inhabitants and is situated about 1,500 meters above sea level. Bamenda is predominantly English-speaking and is composed of seven divisions, each further divided into sub-divisions. The region experiences two main seasons: the rainy season and the dry season. However, due to its altitude, Bamenda enjoys a pleasant climate (World Atlas, 2016).

The ethnic and cultural diversity, along with geographical factors, make this region one of the most attractive tourist destinations in Cameroon. Some of its notable tourist sites include lakes, waterfalls, game reserves, hilly landscapes, plains, forests, caves, and mountains. The creative local inhabitants, with their traditional crafts and arts, museums, and Fondoms (kingdoms ruled by chiefs known as Fons), contribute significantly to the tourism potential of Bamenda and its surroundings. Specifically, the locality of Bambili hosts laboratory tests conducted in the geo-technical lab at GTHS Bamenda.

Bambili is located in the Northwest Region of Cameroon, within the Tubah sub-division of the Mezam division. It lies between latitudes 5°60' and 6°05' North of the equator, and between longitudes 10°-22' East of the Greenwich Meridian. Covering a surface area of approximately [insert surface area], Bambili is bordered to the North and Northwest by Kedjum-Ketingoh and Sabga, to the West by Bambui, to the East by Banja, to the Southeast by Nkwen, and to the South by the Bamenda sub-division. The population of Bambili was approximately 14,863 in 2005

(BUCREP, 2005), but has since increased to about 22,000 inhabitants as of 2012 (www.google.com, 2012). Like many communities worldwide, the population is predominantly female, accounting for 51%, compared to 49% for males.

Figures 2 and 3 below provide a brief description of Bamenda's location on the Cameroon map and the specific location of Bambili, respectively (Microsoft Encarta, 2009).

Figure 2: location of Bamenda on the map.
Source: (Microsoft Encarta @ 2009)

Figure 3; location of Bambili in the Map of the Northwest region of Cameroon

3.2.Research Design

This research adheres to standard practices, employing the ASTM D143-09 method established by the American Society for Testing and Materials. This approach ensures that the choice of materials, particle size, type of mesh used for sizing particles, and construction methods align with industry standards for producing a high-quality particle board.

3.3. Description of Method

3.3.1. Collection of Saw Dust

The wood dust utilized in this research was collected from the Alanta Woodwork Shop, located near the Catholic Church in the northwest region of Cameroon. The sawdust primarily consists of Iroko tree material sourced from the southwest region of Cameroon, as illustrated in Figure 4.

Figure 3: Collection of Wood Dust from a dimension saw (Alanta wood workshop).

Source: Field work 2018.

3.3.2. Drying of Particle and Preparation

The drying process is a critical step in the production of composite materials. Raw materials often arrive at the plant with high moisture content, which is not suitable for immediate use. Wood dust can have moisture content ranging from 10% to 200%. In this research, the particles were dried to reduce the moisture content to approximately 20%. This reduction is essential to ensure effective resin mixing, resulting in particle boards with optimal strength and smooth surfaces. It is important to use a homogeneous material with a high degree of slenderness, avoiding oversized particles depending on the available manufacturing equipment.**3.3.3. Determination of Particle Size and Quantity of Wood Dust**

The wood dust used in this research was sieved using 3mm, 6mm, and 8mm mesh sizes. The following colanders were employed to obtain the desired particle sizes.

3.3.4. Construction of Frames for Molding

The frames constructed for molding the particle boards measured 40mm x 40mm x 160mm. These frames were built according to ASTM D143-09 standards for particle board production. The three frames will be used as follows:

- The first frame for the finest particles obtained from a sanding machine (3mm).
- The second frame for medium-sized particles obtained from a dimension saw (6mm).
- The third frame for the largest particles obtained from a planning machine, known as wood chips.

Once molded, the particle boards were placed in a kiln or an oven for drying. The drying process took approximately 48 hours, conducted in both the kiln and naturally.

Final sample pieces obtain below.

Figure 6: specimens for test

Source: Field work 2018

3.4. Finishing of the Particle Board

3.4.1 Painting the Particle Board

Applying a primer coat is essential for most painting projects, including particle boards. A primer prepares the surface for paint adhesion. Before applying the primer, ensure the surface is clean and free of dust from sanding; otherwise, the primer may not adhere properly. Allow the primer to dry completely before painting. For best results, sand the primed surface with 200-220 grit paper to remove imperfections, then apply paint using spray, dipping, or a brush.

3.4.2 Finishing the Particle Board With Vanish

Given that these boards are made from wood dust, they will absorb varnish. Therefore, three coats of sealer should be applied, followed by sanding before applying the varnish. The best method for applying varnish is by spraying.

3.4.3 Finishing the Particle Board with Formica

Formica is currently one of the most suitable materials for finishing particle boards, as it protects against water damage while enhancing the board's aesthetic appeal compared to other finishing materials.

3.4.4 Procedure to Install a Formica on a Particle Board

- Prepare the surface by removing all imperfections.
- Cut the Formica to the required dimensions.
- Apply contact adhesive to the surface and then place the Formica on the particle board.
- Apply pressure on the flat surfaces to avoid voids beneath the Formica.

3.5. Description of Research Instrument's

3.5.1 The Compressive Test Machine

The compressive test machine is designed to evaluate the compressive strength of construction materials such as bricks, concrete, and wood. It can test rectangular, cylindrical, and cube-shaped samples. The apparatus is graduated in kilo-Newtons (kN), measuring from 0 kN to 500 kN. The readings obtained are analyzed manually, as shown in Figure 10.

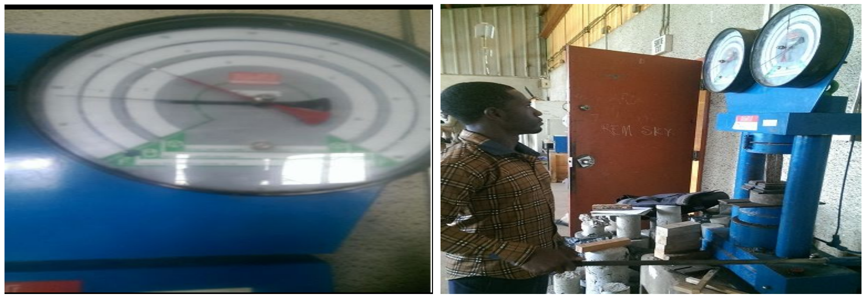

Figure 4: compressive test machine

Source: Field work 2018

The formula for calculating compressive strength is: compressive strength (CS) $= \frac{\text{Load}}{\text{Surface Area}}$

Implying CS $= \frac{\text{Load}}{\text{Surface Area}}$

Procedure for testing the compressive strength

1. Open the compressor press using the hydraulic button.
2. Insert the sample into the press and lower the press using the hydraulic lever until it stops.
3. Ensure the manometer reads zero; if not, adjust it back to zero.
4. Observe the needle on the manometer and record the value where it stops. The scale is graduated in kilo-Newtons.
5. Stop the press and take the reading from the manometer.
6. Open the compressor to introduce the next sample for testing.
7. Clean any debris from the press before introducing the next sample
8. The average resistance to compression is given by: $\frac{\text{Sum of Load}}{\text{Number of samples}}$

3.5.2 The Flexural Test Machine

This apparatus tests the tensile strength (modulus of elasticity) of construction materials. It can handle rectangular and cylindrical samples up to 160mm x 50mm x 50mm. The apparatus is graduated in deca-Newtons (daN), measuring from 0 daN to 1000 daN. The readings are calculated and analyzed manually, as shown in Figure 10.

The formula for calculating bending is B$= \frac{\text{Load}}{\text{Surface Area}}$

Procedure for testing the bending strength

To effectively use the tensile strength test machine the following steps were recommended;

1. Open the tensile press using the hand wheel.
2. Insert a sample into the press.
3. Tighten the press onto the sample using the hand wheel.
4. Ensure the tensile strength reader is set to zero; if not, reset it.
5. Turn on the electrical switch.

6. Allow the strength test reader to operate and then stop.
7. Record the reading from the scale, graduated in daN.
8. Turn off the electrical switch and prepare the strength press for the next sample The average resistance to bending is given by: $\frac{\text{Sum of Load}}{\text{Number of samples}}$

3.6. Description of Data Analysis Plan

For this analysis each board will be cut according to ASTM D143-09 standards, as outlined in Table 4 below

Table 2: A brief description of data analysis plan.

TEST	DIAMENSION OF PIECES	NUMBER OF PIECES	STANDARD
PARTICLE BOARD DENSITY	160mm×40mm×40mm	02	D143-09
MODULUS OF RUPTURE (MOR)	160mm×40mm×40mm	02	D143-09
MODULUS OF ELASTICITY (MOE)	160mm×40mm×40mm	02	D143-09
THICKNESS SWELLING	160mm×40mm×40mm	02	D143-09

For this study, urea-bonded particle boards made from sawdust and wood chips mixed with resin at standard levels will be evaluated in the laboratory. Tests will be conducted for modulus of rupture, modulus of elasticity, relative humidity, thickness swelling, and internal bonding strength.

3.7. Description of Progress of Data Collection

Specimens were produced and cut according to ASTM D143-09 standards, as shown in Figure 11.

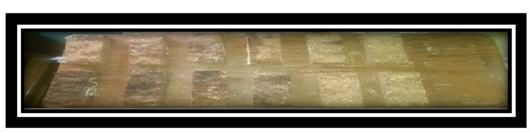

Figure 5: Specimens for the tests.

The apparent density and relative humidity will be recorded from the samples starting from day one of the process. The modulus of rupture (MOR) and modulus of elasticity (MOE) will also be evaluated on the first day. For thickness swelling or water absorption, dimensions will be measured before submerging the pieces in water, and measurements will be taken after 2 hours and 24 hours of immersion.

4. Presentation of Results

In this chapter, we will present the results of the experimental work. The results will include the apparent density, thickness swelling, and flexural bending strength tests (MOR, MOE) of the particle boards.

4.1 Apparent Density

The apparent density obtained is to explain the behavior of the particles to the mechanical resistance of this proportion. The result obtained are consigned in the table 2 below

I took 12 samples for the test.

The apparent density obtained will explain the behavior of the particles concerning the mechanical resistance of the material. The results are summarized in Table 5 below.

$$d = m/v \text{.................formula 1}$$

Table 3: Description of samples

Sample number	Description
S1	Sample of 3mm grid size
S2	Sample of 3mm grid size
S3	Sample of 3mm grid size
S4	Sample of 3mm grid size
S5	Sample of 6mm grid size
S6	Sample of 6mm grid size
S7	Sample of 6mm grid size
S8	Sample of 6mm grid size
S9	Sample of 8mm grid size
S10	Sample of 8mm grid size
S11	Sample of 8mm grid size
S12	Sample of 8mm grid size

Table 4: Apparent density of the samples

Samples	*Mass (kg)*	*L (m)*	*W(m)*	*T(m)*	*Volume(m^3)*	*Density (kg/m^3)*
S1	**0.22**	0.16	0.04	0.04	0.000256	**859.4**
S2	**0.23**	0.16	0.04	0.04	0.000256	**898.4**
S3	**0.22**	0.16	0.04	0.04	0.000256	**859.4**
S4	**0.21**	0.16	0.04	0.04	0.000256	**820.3**
S5	**0.19**	0.16	0.04	0.04	0.000256	**742.2**
S6	**0.20**	0.16	0.04	0.04	0.000256	**781.3**
S7	**0.19**	0.16	0.04	0.04	0.000256	**742.2**
S8	**0.19**	0.16	0.04	0.04	0.000256	**742.2**
S9	**0.12**	0.16	0.04	0.04	0.000256	**468.8**
S10	**0.14**	0.16	0.04	0.04	0.000256	**546.9**
S11	**0.13**	0.16	0.04	0.04	0.000256	**507.8**

S12	**0.13**	0.16	0.04	0.04	0.000256	**507.8**
Total d.	**2.17**					**24296.7**

4.2 Thickness Swelling or Water Absorption

The apparent density obtained will explain the behavior of the particles concerning the mechanical resistance of the material. The results are summarized in Table 7 below.

Figure 6: samples in water (S2, S6 and S10)

The rate of thickness swelling of each piece is determine following the formulae:

$$IT = \frac{t2-t1}{t1} * 100.$$

Where IT= immersion time

t1 = the thickness of the piece before immersion

t2 = the thickness of the piece after immersion

Table 5: Determination of the thickness swelling

Samples	Initial	After 2hours of immersion	After 24 hours of immersion
S2 (3mm grid size)	40	40.2	40.5
S6 (6mm grid size)	40	40.3	41
S10 (8mm grid size)	40	41	41.5

4.2.1 Calculating the thickness swelling for S2 (3mm grid size)

To obtain the immersion time (IT) after 2hours for sample attributed as S10 we used the formula

Given that: $IT=\frac{t2-t1}{t1} * 100.$

Where t1=40 and t2 =40.2

Therefore 2hrs= $IT=\frac{40.2-40}{40} * 100 = 0.5\%.$

The immersion time(IT) after 24hrs for sample attributed as S10 we used the formula

$$IT=\frac{t2-t1}{t1} * 100.$$

Where t1=40 and t2 =40.5

$$IT=\frac{40.5-40}{40}*100 = 1.25\%.$$

4.2.2 Calculating the thickness swelling for S6 (6mm grid size)

To obtain the immersion time (IT) after 2hours for sample attributed as S10 we used the formula

Given that: $IT=\frac{t2-t1}{t1}*100.$

Where t1=40 and t2 =40.3

Therefore 2hrs= $IT=\frac{40.3-40}{40}*100 = 0.75\%.$

The immersion time(IT) after 24hrs for sample attributed as S10 we used the formula

$$IT=\frac{t2-t1}{t1}*100.$$

Where t1=40 and t2 =41

$$IT=\frac{41-40}{40}*100 = 2.5\%.$$

4.2.3 Calculating the thickness swelling for S10 (8mm grid size)

To obtain the immersion time (IT) after 2hours for sample attributed as S10 we used the formula

Given that: $IT=\frac{t2-t1}{t1}*100.$

Where t1=40 and t2 =41

Therefore 2hrs= $IT=\frac{41-40}{40}*100 = 2.5\%.$

The immersion time (IT) after 24hrs for sample attributed as S10 we used the formula

$$IT=\frac{t2-t1}{t1}*100.$$

Where t1=41 and t2 =41.5

$$IT=\frac{41.5-40}{40}*100 = 3.75\%.$$

4.4 Flexural (Bending) Strength Test

Table 6: samples from bending

DIMENSIONS (MM)			GRID SIZE	QUANTITY	FORCE **(DAN/ cm^2)**
L	**W**	**TH**			
160	40	40	3mm	1	**60**
			6mm	1	**51**
			8MM	**1**	**46**

COMPRESSION PARALLEL TO SAMPLE PIECE

Table 7: samples from compression

DIMENSIONS (MM)			GRID SIZE	QUATITY	FORCE (DAN/ cm^2)
L	**W**	**TH**			

160	40	40	3mm	1	**7**
			6mm	1	**5**
			8MM	**1**	**4**

COMPRESSION PERPENDICULAR TO SAMPLE PIECE

Table 8: samples from compression

DIMENSIONS (MM)			GRID SIZE	QUANTITY	FORCE (DAN/ cm^2)
L	**W**	**TH**			
160	40	40	3mm	1	**45**
			6mm	1	**92**
			8MM	**1**	**50**

4.7 Calculations

Calculating of the surface areas of the samples with reference to the surface involved

Dimension of sample: {160*40*40}.

Surface area for the bending strength test: A= L $* \ W = 16 * 4 = 64cm^2$

Surface area for the compression strength test: A= W $* \ TH = 4 * 4 = 16cm^2$

Description

3mm grid size is refer to (FG) first grid size particle board

6mm grid size is refer to (SG) second grid size particle board

8mm grid size is refer to (TG) third grid size particle board

4.8 Calculating the Stress per Samples

1. Flexural (Bending) Force Per Sample

First grid size particle board

FG= $\frac{F}{A} = \frac{60}{64}$ =1.06daN/cm^2

Second grid particle board

SG= $\frac{F}{A} = \frac{51}{64}$ = 0.79daN/cm^2

Third grid particle board.

TG= $\frac{F}{A} = \frac{46}{64}$ = 0.71daN/cm^2

2. Compression Parallel to Sample Stress Per Sample

Frist grid size particle board

FG= $\frac{F}{A} = \frac{7}{16}$ =0.44KN/cm^2

Second grid size particle board

SG= $\frac{F}{A} = \frac{5}{16}$ = 0.31 KN/cm^2

Third grid size particle board.

TG= $\frac{F}{A} = \frac{4}{16}$ = 0.25 KN/cm^2

3. Compression Perpendicular to Sample Stress Per Sample
First grid size particle board

FG= $\frac{F}{A} = \frac{45}{64}$ = 0.70 KN/cm^2

Second grid size particle board

SG= $\frac{F}{A} = \frac{92}{64}$ = 1.44 KN/cm^2

Third grid size particle board.

TG= $\frac{F}{A} = \frac{50}{64}$ = 0.782 KN/cm^2

4.9. Summaries of the Final Stress of the Conducted Test Samples.
Table 9: The final flexural strength resistance.

SAMPLE GRID SIZE	*FIRST GRID SIZE; 3mm*	*SECOND GRID SIZE; 6mm*	*THIRD GRID SIZE; 8mm*
STRESS	1.06 daN/cm^2	0.79 daN/cm^2	0.71 daN/cm^2

Table 10: The final compression parallel strength resistance.

SAMPLE GRID SIZE	*FIRST GRID SIZE; 3mm*	*SECOND GRID SIZE; 6mm*	*THIRD GRID SIZE; 8mm*
STRESS	0.44KN/ cm^2	0.13KN/ cm^2	0.25KN/ cm^2

Table 11: The final compression perpendicular strength resistance.

SAMPLE GRID SIZE	*FIRST GRID SIZE; 3mm*	*SECOND GRID SIZE; 6mm*	*THIRD GRID SIZE; 8mm*
STRESS	0.70KN/ cm^2	1.44KN/ cm^2	0.78KN/ cm^2

The data collected from the flexural test, compression strength test, and the calculated results presented in this chapter will be interpreted in the next chapter.

5.Discussion of Result

This chapter interprets the results presented in Chapter Four, focusing on the mechanical properties of particle boards produced from different grid sizes. The analysis compares the flexural strength, compression parallel to the grain, and compression perpendicular to the grain for the three grid sizes. The primary aim is to identify which sample exhibits the best mechanical properties based on the forces applied during testing.

The results indicate that the higher the force applied before the point of rupture (failure), the better the sample's mechanical properties. Conversely, samples that fail with lower force exhibit weaker mechanical properties.

5.1 Summary of Findings

5.1.1 Flexural strength analysis for sampling chart

The table below present the calculated result of the flexural strength for the samples from the three different grid size

Table 12: flexural strength

SAMPLE GRID SIZE	*FIRST GRID SIZE; 3mm*	*SECOND GRID SIZE; 6mm*	*THIRD GRID SIZE; 8mm*
STRESS	1.06 daN/cm^2	0.79 daN/cm^2	0.71 daN/cm^2

From Figure 13, we can conclude that the first grid size (3mm) shows the highest resistance at 1.06 daN/c, followed by the second grid size (6mm) at 0.79 daN/c, and the third grid size (8mm) at 0.71 daN/c.

Therefore, the first grid size produces the best results, making it suitable for applications such as tabletops or flat surfaces.

5.1.2 Compression strength analysis for sampling chart

The table below presents the calculated results for compression strength parallel to the grain for the samples from the three different grid sizes.

Table 13: Compression parallel to sample piece

SAMPLE GRID SIZE	*FIRST GRID SIZE; 3mm*	*SECOND GRID SIZE; 6mm*	*THIRD GRID SIZE; 8mm*
STRESS	0.44KN/ cm^2	0.13KN/ cm^2	0.25KN/ cm^2

The analysis shows that the first grid size can withstand the highest force of 0.44 KN/c, followed by the third grid size at 0.25 KN/c, and lastly, the second grid size at 0.13 KN/c. The results indicate that the particle boards may perform poorly under structural loads, making them unsuitable for load-bearing applications.

5.1.3 Compression strength analysis for sampling chart

The table below presents the calculated results for compression strength perpendicular to the grain for the samples from the three different grid sizes.

Table 14: Compression perpendicular to sample piece

SAMPLE GRID SIZE	*FIRST GRID SIZE; 3mm*	*SECOND GRID SIZE; 6mm*	*THIRD GRID SIZE; 8mm*
STRESS	0.70KN/ cm^2	1.44KN/ cm^2	0.78KN/ cm^2

From this analysis, the second grid size (6mm) exhibits the highest resistance at 1.44 KN/c, followed by the third grid size at 0.78 KN/c, and the first grid size at 0.70 KN/c. Thus, the second grid size is deemed appropriate for applications in cabinetry.

5.2 Density Analysis of the Samples

Table 15: Representation of the density obtained

Samples	***Density kg/ m^3***
S1	859.4
S2	898.4
S3	859.4
S4	820.3
S5	742.2
S6	781.3
S7	742.2
S8	742.2
S9	468.8
S10	546.9
S11	507.8
S12	507.8

From the density analysis, samples S1 to S4 represent the first grid size (3mm), indicating that thinner particles yield denser MDF. The average density for the first grid size is 859.4 kg/m³, followed by the second grid size (average density of 751.9 kg/m³), and lastly, the third grid size (average density of 507.8 kg/m³).

5.3. Thickness Swelling Analysis

Table 16: samples immersion after 2 and 24 hours.

Samples	*After 2 hours in %*	*After 24 hours in %*
S2	0.5	1.25
S6	0.75	2.5
S10	2.5	3.75

The results indicate the moisture absorption rates of different grid sizes. The first grid size (3mm) absorbed the least moisture, showing a dimensional change of 0.5% after 2 hours and 1.25% after 24 hours. The second grid size experienced more significant changes in dimensions, suggesting that larger grid sizes lead to greater moisture absorption and swelling.

5.4 Conclusion

The valorization of sawdust into construction materials is not only feasible but also beneficial for the environment and local economies. This research supports the idea that sawdust should be regarded as a resource rather than waste.

5.5 Recommendations

Sawdust, often considered a waste product in Cameroon, has the potential for better utilization. Based on the findings of this research, I recommend the following:

- Future research should explore the thermal and acoustic properties of particle boards made from sawdust and investigate the potential for blending with other materials.

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