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**Research Paper**

# Influence of Adhesive Density on Thatch Grass Particleboard Characteristics

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***Abstract***
*The response of resin concentration on some properties of thatch grass particleboard was obtained. In this study, the different concentrations of resin used were 10%, 15%, 20%, 25% and 30% for oven dry weight of thatch grass. The European Standard (EN standard) was used as a base for the tests carried out. It was observed that an increase in resin concentration resulted in an improvement in both mechanical and physical properties of the particleboard. These results were recorded for Modulus of Rupture (MOR), Internal Bond Strength (IB), Modulus of Elasticity (MOE), Thickness Swelling (TS) and Water Absorption (WA) in these ranges: 11.20 to 13.78N/mm$^2$, 0.25 to 0.48N/mm$^2$, 1185 to 1969N/mm$^2$, 8.02 to 13.60% and 27.84 to 57.98% respectively. This reveals that the particleboards as obtained are in conformity to the EN standard.*

***Keywords:*** *Thatch Grass, Hyparrhenia, Particleboard, Resin Concentration, Physical and Mechanical Properties.*

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## I. INTRODUCTION

Thatch grass is species of various grass that are usually tall and coarse which are most times suitable for thatching in building. Thatch grass is usually referred to as those grasses of the family of **Hyparrhenia,** Barany, et al, (2003). Africa is regarded as the region where Thatch grass is native to. In some areas in the tropics, thatch grass is often grown as a pasture grass. This practice has given rise to this materials to naturalised and spread beyond the areas where it was originally planted because of it characteristics nature to withstand the harsh conditions of the tropics, Barany, et al, (2003). This material has been abandoned, from the use of it for roofing, for more advanced roofing sheets. Because of the effect of over utilization of timber and its resource which has caused devastating consequences on the global environment; there is a need to source for alternate material for our day to day needs. Hence, the need to utilize thatch grass for particleboard production comes to mind.

According to Osarenmwinda and Nwachukwu (2007), the production of particleboard in Nigeria started at African Timber and plywood (AT and P) Company Limited in Sapele, Delta State. Then in 1976, the Piedmont Wood Industry located at Ologbo town in Ikpoba Okha Local Government Area of Edo State started operation. These industries were set up in these areas to utilize the abundant wood residues generated from the numerous saw mills and plywood mill activities in those areas. While these productions were going on, it was discovered that Atapex particleboard, the product of African Timber and Plywood Sapele, A division of UAC Nigeria Limited was of a high quality standard which compared even better than the same particleboard of same thickness because they were manufactured from timber waste of hardwood species chips. The Atapex particleboard raw materials are from timber wastes such as veneer peeler cores, off cuts, edge ripping, chipping and under-sized wood (Islam, et al 2006).

Particleboard could be described as a panel material that is manufactured by subjecting the particle materials, which is essentially from particles of either wood or other lingo-cellulosic fibrous materials in form of wood chips, sawdust and flax shives, under pressure with the introduction of a binder (Nemli, et al 2007).

The construction industry in Nigeria utilizes large quantity of materials, (Osarenmwinda and Nwachukwu, 2007). They further stated that 30,000 elements of different specifications and properties is estimated to be used in residential building is estimated in Nigeria. The performance of the entire building

structure is a function of the quality of each material that constitutes the building. Despite abundant material resources in Nigeria, over 80% of materials used in the construction industry are imported; including particleboards (Adedayo, 2015). Particleboard requirements in Nigeria are estimated at 108,000$m^3$ in 1990 and are expected to reach 199,000$m^3$ in 2000. If this figure is extrapolated to a 20 year period assuming constant growth rate per annum over the years, the particle board requirement may have grown to 201,900$m^3$ in 2020. Therefore, in 2030 it must have grown to 1111900$m^3$. According to the World Bank report 2019, Nigeria needs to provide over 700,000 housing units annually from 2020 to 2030 to accommodate the rising population in order to achieve the Goal 11 of the Sustainable Development Goal. This goal aims to Achieve Sustainable Cities and Communities in the year 2030, (World Bank, 2019). The implication is that Nigeria need to spend additional ₦728M at 8000 per cubic meter of particleboard annually and in the 10 year period it will amount to ₦7.28B to sustain the annual incremental demand and ₦8.8952B for 2030 total alone. This sum as quoted does will affect Nigerian foreign exchange negatively.

With the economic challenges facing the Nigerian nation without any evidence of this trend changing any time soon, finding solution to this severe housing problem will remain very slim unless something drastic is done to change this. Part of the drastic measures needed to be taken is to make efforts directed at utilization of locally available materials in the production of materials that are comparable to the imported one in terms of quality and price and make it a continuous action plan to advance the Local Content law by changing Nigeria from consumer nation to producer nation, (Punch News, 2021).

Before now, properties of boards made from Thatch Grass have not been reported but there are reports of other material which had been used for particleboard manufacture. Furthermore, so many manufacturing factors may affect the expected properties of the particleboard. Some of these factors may include the particleboard raw materials, the particle size of the raw materials and the particle shape. Also part of the factors is the type of resin used as binder and its concentration. More factors that may also affect the properties of the particleboard still include the particle-resin mix water content during the manufacturing process, introduction of some additives, orientation of particles, specific gravity level of the particleboard, the extent of compression during manufacture, the temperature of cure and the length of time for conditioning. To achieve a specific property, these factors listed can be married in numerous ways to arrive at different end products as may be desired by the manufacturer, (Osarenmwinda and Nwachukwu, 2007).

Consequently, the mechanical and physical properties of boards can be varied during production process to possess range of boards' qualities which may influence the final consumer value of the board. Therefore, there is a need to have a clear understanding of the way the process variable affect the board properties if one must have a good control of the board specific properties. This work anchors its objective on the effort to unravel the response of resin concentration on the physical properties and mechanical properties of thatch grass particleboards.

## II. METHODOLOGY

Thatch Grass is the primary material used in this study. The thatch grass was sourced from selected grass lands of the five states of the south east region of Nigeria. The sourcing was eventually narrowed down due to similarity of quality of the thatch grass sourced from these localities. The crushing of the thatch grass was done with a ball miller machine. The crushed material was screened with an induction vibrator machine with set of mounted sieves with different mesh sizes. This study used the material collected under the mesh of 0.05mm. The particles used were taken to an oven to achieve a moisture content of 4.02%. Then urea formaldehyde, which is the binder used, was digested with the dried particles at these concentrations 10%, 15%, 20%, 25% and 30%. Hydraulic pressing machine was used to press the manually formed mat in the hot chamber mould to form board of these dimensions 300mm x 275mm x 20mm. using the. The force used on the hydraulic press was force of 100KN. The finally board obtained was placed under a temperature of 100°C for 30 minutes in the laboratory oven to allow the board dry.

At room temperature (25±3°C) and relative humidity of 65±5%, the particleboards produced were placed on shelves for conditioning for a period of 24hrs before the test pieces were cut out. For each resin concentration, three panels were made. An average density of 730Kg/$m^3$ was targeted for each of the boards. The test piece for Thickness Swelling (TA) was immersed in water for 24hr and the thickness swelling recorded accordingly. Also recorded were the 24hrs immersion results of Water Absorption (WA) of the test pieces. The EN standard for testing of particleboard; EN 317, EN 310, EN 319 (1993) were used to determined the mechanical properties of the particleboard which include Modulus of Rupture (MOR), Modulus of Elasticity (MOE) and Internal Bond Strength (IB).

## III. RESULTS AND DISCUSSION

**Table 1:** Properties of Thatch Grass Particleboard

| Name of Panel | Resin Concentration (%) | MOR ($N/mm^2$) | IB ($N/mm^2$) | MOE ($N/mm^2$) | TS (%) | WA (%) |
|---|---|---|---|---|---|---|
| $A_1$ | 10.00 | 11.20 | 0.25 | 1185.00 | 13.60 | 56.98 |
| $A_2$ | 15.00 | 11.89 | 0.30 | 1457.00 | 12.92 | 49.76 |
| $A_3$ | 20.00 | 12.41 | 0.37 | 1692.00 | 10.72 | 43.59 |
| $A_4$ | 25.00 | 13.02 | 0.41 | 1813.00 | 9.25 | 35.40 |
| $A_5$ | 30.00 | 13.78 | 0.48 | 1969.4 | 8.02 | 27.84 |

The table 1 above shows the results obtained for the experiment carried out.

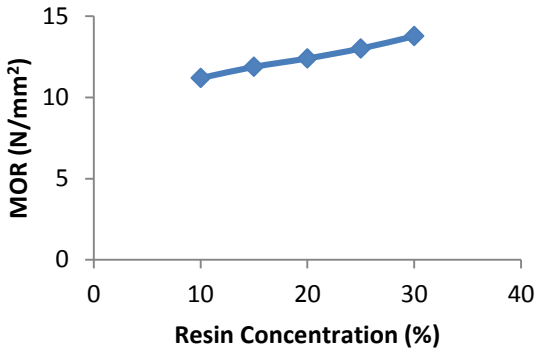


**Figure 1:** Resin Concentration against MOR

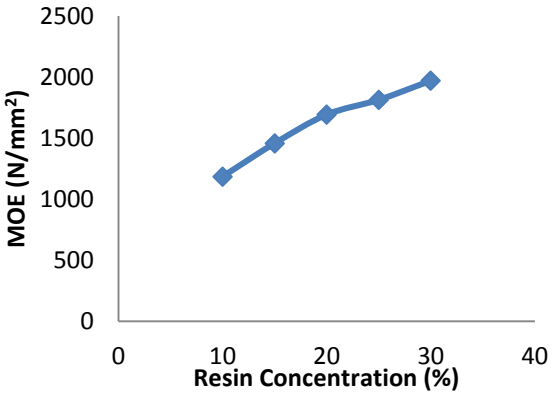


**Figure 2:** Resin Concentration against MOE

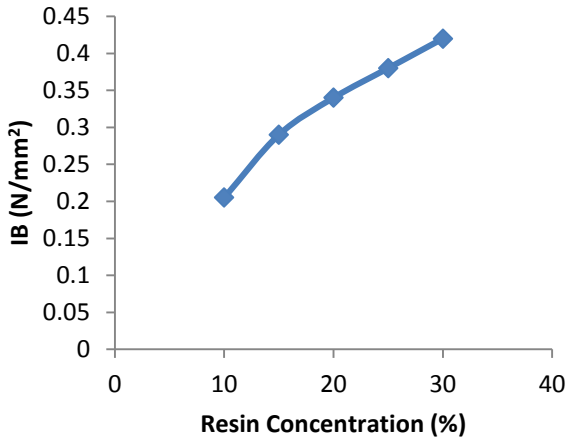


**Figure 3:** Resin Concentration against Internal Bonding

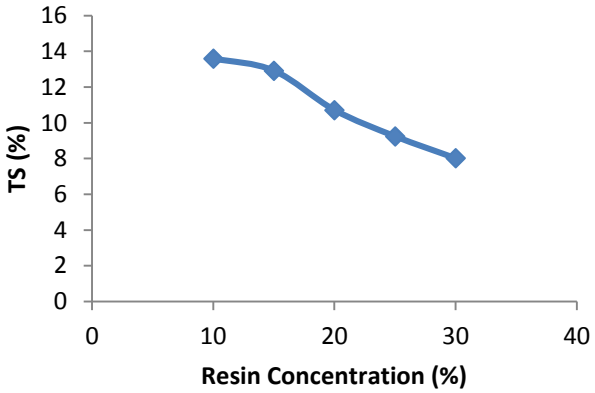


**Figure 4:** Resin Concentration against Thickness Swelling

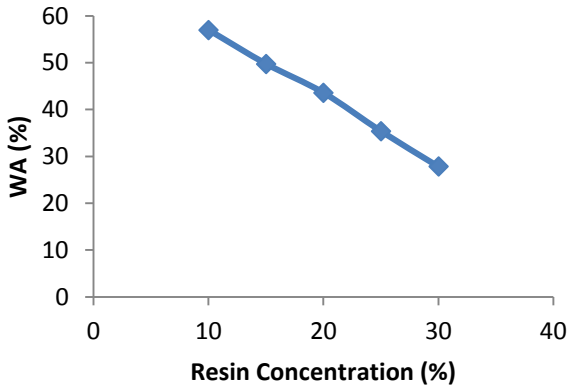


**Figure 5:** Resin Concentration V Water Absorption

Table 1 above shows the tabular presentation of the Mean values of Modulus of elasticity, modulus of rupture, internal bond strength, thickness swelling and water absorption. The mechanical properties (modulus of rupture, internal bond strength, modulus of elasticity) were observed to increase as resin concentration increased. For instance, in **table 1 and fig. 1**, the MOR for particleboard of resin 10%, 15%, 20%, 25% and 30% was 11.20N/mm² 11.89N/mm², 12.41N/mm 13.02N/mm² and 13.78N/mm² respectively, for IB, in **table 1 and fig. 2,** it was 0.25N/mm², 0.30N/mm², 0.37N/mm², 0.41N/mm² and 0.48N/mm² respectively; while for MOE, **table 1 and fig. 3**, it was 1185N/mm², 1457N/mm², 1692N/mm², 1813N/mm² and 1969.4N/mm² respectively. It was also observed that increased in resin concentration brought about improved physical properties in the Thatch Grass particleboard. For instance, in **table 1 and fig 4**, the TS for particleboard of resin concentration

10%, 15%, 20%, 25% and 30% was 13.60% 12.92%, 10.72%, 9.25% and 8.02% respectively while, in **table 1 and fig 5,** the WA was 56.98%, 49.76%, 43.59%, 35.40%, 27.84% respectively.

From EN Standards, the minimum requirement for particleboards MOR is 11.5N/mm² for general use and MOE is 1600N/mm² for furniture manufacturing (EN SI2-2 1996). From the table 1, panel types $A_3$, $A_4$ and $A_5$ satisfied the MOR and MOE requirements for general uses and furniture manufacturing. The IB strength requirements are 0.24N/mm² and >24N/mm² for general purposes board and indoor fitments respectively (EN312-2. 1996). All panel types comply with IB strength values for general uses and also for IB requirement for indoor fitment.

Using EN Standards still, it states that particleboard should have a maximum thickness swelling value of 9% for 24 hours immersion (EN 317, 1993). The average thickness swelling of the samples ranged from 8.02% to 13.60% while the water absorption values ranged from 27.84% to 56.98%. Therefore, it is observed from table 1 that it is only panel type $A_1$ met the EN standard minimum requirement for thickness swelling. The other panels did not meet the minimum requirement. This may have been due to the tact that no wax or hydrophobic substances were used during particleboard manufacture (Nemli, 2007).

## IV. CONCLUSION

The determination of the response of resin concentration on the physical and mechanical properties of Thatch Grass particleboards has been achieved. Results shows that an increased in resin concentration brought about improved mechanical and physical properties. Particleboard from Thatch Grass met EN Standard. It is recommended that the use of other agricultural waste for particleboard be explored to increase local content. Also, effect of other manufacturing factors on particleboard properties should be investigated. It is expected that this will help reduce over dependency on wood based particleboards, reduce importation of the particleboard, increase country's GDP, reduce building material cost in the country and create employment.

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