THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE

Effect of Spear Grass (Imperata Cylindrica) Fibre Inclusion on the Physico-Mechanical Properties of Cement Bonded Particle Board

Owoyemi Jacob Mayowa
Senior Lecturer, Department of Forestry and Wood Technology,
Federal University of Technology, Akure, Nigeria

Abstract:
This study investigated the effect of spear grass fibre inclusion on the physical and mechanical properties of cement-bonded particle boards. Cement-bonded particle boards of 8 mm in thickness were manufactured using spear grass (Imperata cylidrica) and sawdust at different levels of cement mixing ratios of 2:1 and 3:1 and blending proportions of 100-0, 90-10, 80-20, 70-30 and 0-100% spear grass to sawdust respectively. The effect of the spear grass fibres inclusion was tested on Water Absorption, Thickness Swelling, Linear Expansion, and also on the mechanical properties such as Modulus of Elasticity and Modulus of Rupture of the cement bonded particle board produced. Value obtained for physical properties ranged from 16.83 to 80.42, 0.71 to 20.35 and 0.72 to 2.67% for Water Absorption, Thickness Swelling and Linear Expansion respectively. The value of mechanical properties ranged from 115.6935 to 541.8375 and 25908.26 to 160529.4N/mm^2 for mixing ratio 2:1. 10560.8 to 153969.8 and 67.75 to 456.64 N/mm^2 were recorded for mixing ratio 3:1 for Modulus of Elasticity and Modulus of Rupture respectively. The best materials mixture was found for 100:0, while 0:100 blending proportion constitute the weakest mixture. However, 90:10 proved spear grass inclusion was effective due to its close values with 100:0 blending proportion. The values for water absorption, thickness swelling and linear expansion showed that, after 24, 48, and 72 hours water immersion, there was increase in the physical properties as a result of decrease in both blending proportions and mixing ratios. The increase in physical properties was due to the reduction of the sawdust in the blending proportions and mixing ratios. MOE and MOR decreases with decreased in the blending proportion. The study has shown that spear grass can be utilized to produce cement bonded particle board but only at specified proportions.

Keywords: *Blending, bio-fibre, physical properties, mechanical properties, spear grass*

1. Introduction

Natural and plantation forest serve as sources of raw materials for the production of wood products. The forest industry in Nigeria has traversed a variety of circumstances. Prior to I976, round wood log over exploitation for export was rife, and this, coupled with high waste generation by the forest led to significant reduction in industrial round wood availability in the forest reserves. With an average recovery rate between 45 – 55%, the waste generated in the sawmill industry in form of bark, sawdust, trimming, split wood, planer shavings and sander dust in year 2010 alone was over 1,000,000m^3 (Ogunwusi, 2014). Varying waste disposal methods are adopted by these sawmills in disposing the huge wastes they generate. The methods of disposal adopted by sawmills depending on their knowledge of waste utilization, technology and facilities available amongst others. It has been observed that agricultural residues provide renewable and environmentally friendly alternative biomass resources for easing the high demand for woody materials (Sampathrajan et al., 1992, Kozlowski and Helwig, 1998).

In order to ensure a sustainable forest management, most countries have put in place several measures including utilization of lesser known timber species, reforestation, setting margins for annual allowable cuts, banning export of round logs, conservation of biological diversity and promotion of efficient wood-based industries. Alternatively, there is a growing research worldwide on the use of agricultural waste and other lignocellulosic materials for composite board production to supplement timber production in order to meet the global demand for wood products.

Spear grass [Imperata cylindrica (L.) Raueschel] is one of the most dominant, competitive, and difficult weeds to control in the humid and sub-humid tropics of Asia, West Africa, and Latin America (Garrity et al., 1997). In West Africa, it is a serious weed of intensive agriculture particularly in areas prone to coastal derived savanna [also called forest/savanna transition zone] (Chikoye et al., 1999). The negative impact of spear grass on agriculture includes severe crop yield losses and high investment in labor for weeding. Crop yield reduction attributable to competition from spear grass has been estimated at 76}80% in cassava, 78% in yam, and 50% in maize (Koch et al., 1990; Chikoye et al., 2000). Small-scale farmers, who undertake most of the agricultural activities in West Africa, are more affected by spear grass because they rely on manual weeding which consumes lots of labour and which is not effective on underground rhizomes. For example, weeding maize and cowpea "elds infested with spear grass twice has been reported to consume about 54% of the total labour budget (IITA, 1977). Akobundu et al. (2000) have however reported that at least four weeding line are required to prevent reduction in maize yields due to spear grass interference in the derived savanna of Nigeria. Field observation showed that undeveloped areas in schools and institutions are usually overgrown with spear grass requiring manual or mechanical method of clearing. Even after clearing the waste are raked and burnt causing environmental pollution. This research was aimed at finding suitable use for spear grass in producing value added product like ceiling panel using cement as a binder.

2. Materials and Method

2.1. Materials

The spear grass for this project (Figure 1) was collected from the football field of Faith Nursery and Primary School, Aule Akure. Other materials such as cement, additives, water, caul plates, press were obtained from the composites laboratory of the Department of Forestry and Wood Technology, Federal University of Technology Akure, Nigeria.

Figure 1: Spear Grass (Imperata Cylindrical)

2.2. Material Formation

The spear grass was sun dried for two weeks to remove moisture from the material after which it was cut to 20 mm. Hot water pre-treatment was carried out for 72hrs to remove extraneous materials or inhibitors from the materials. Further milling process of the materials was done to soften the fibres.

The sawdust of Astonial congensis wood was pretreated by boiling with hot water for 30mins at a temperature of 90^0C to further remove the inhibitory substances that may likely affect the setting of the cement used as binding agent (Ajayi, 2005) and was washed and air dried at room temperature for 7 days.

The quantity of materials (cement and spear grass) used for the production of each specimen having the size 220 × 220 × 8 mm and density was calculated and measured on a weighing balance and put into the mixing bowl according to the level of mixing ratio and additive concentration. The materials were mixed together thoroughly first by using hand then later poured in the mixing machine to enhance proper mixing.

The chemical additives of calcium chloride were calculated and weighed based on the quantity of the cement used in each specimen. The required quantity of additive used was dissolved in the required quantity of water added to the mixture while mixing it in the mixer.

2.3. Board Formation

The mixture was spread out on of 220 × 220 × 8 mm wooden mould covered with polythene sheets to enhance easy board removal, thereafter; the mixtures was pre-pressed to allow uniform mat formation after which it was transferred to the press under a pressing pressure to form the required thickness of 8 mm for a period of 24hours. The blend of materials was done at proportions of 100 – 0, 80 – 20, 70 – 30 and 0 – 100% for spear grass and sawdust respectively. Cement/material mixing ratios of 2:1 and 3:1 were adopted and run into a mould of 350 × 350 × 8 mm, covered with polythene sheets to enhance easy board removal after which it was transferred to the press under the pressure of $1.24n/m^3$ overnight to form the required thickness. The boards were removed from the mould and kept under a controlled laboratory condition for 21 days for curing.

2.4. Variables Tested

The board edges were trimmed with circular saw to avoid edge effect and was dimensioned into the required sizes of 50 × 50 × 8 mm and 195 × 50 × 8 mm for the physical and mechanical tests respectively according to the ASTM (2005). The following tests was carried out on all the board samples:

2.4.1. Water Absorption

The test samples were soaked in water for 24, 48, 72 hours and percentage water absorption for the test samples for three days was calculated using;

$$WA\ (\%) = \frac{W_2 - W_1}{W_1} \times 100 \quad (1)$$

Where;
WA = Water absorption (%)
W_1 = Initial weight (g)
W_2 = Final weight (g)

2.4.2. Thickness Swelling

This was carried out by taking the initial thickness (T_1) with the aid of a veneer caliper after which the test samples were soaked in water for 24, 48, 72 hours. Changes in thickness of the board samples were measured and percentage thickness swelling (TS %) were calculated;

$$TS\ (\%) = \frac{T_2 - T_1}{T_1} \times 100 \quad (2)$$

Where;
TS = thickness swelling (%)
T_1 = Initial thickness (mm)
T_2 = final thickness (mm)

2.4.3. Linear Expansion

This is the increase in the length of the material when subjected to water soaking test was calculated using:

$$L.E\ (\%) = \frac{L_2 - L_1}{L_1} \times 100 \quad (3)$$

Where,
L_1 = initial length of the material
L_2 = final length of the material

2.4.4. Modulus of Elasticity (MOE)

The modulus of elasticity (MOE) was calculated according to ASTM (2005) using;

$$MOE = \frac{PL^2}{4bd^3D} \quad (4)$$

Where;
L = span between center of support (mm)
b = width of the specimen (mm)
P = ultimate failure load (N)
d = thickness of specimen (mm)
D = Deflection

2.4.5. Modulus of Rupture

The specimen was mounted one by one on the universal testing machine in accordance with British Standard 373(1989). The load was applied at the center with the aid of an electro-mechanical motor till the point when failure occurs. The recording of the ultimate load (P) will be recorded and estimated using;

$$MOR = \frac{3PL}{2BH^2}\ (N/mm^2) \quad (5)$$

Where;
L = Span between center of support (mm)
B = width of the test specimen (mm)
H = thickness of the test specimen
P = ultimate Failure load (N)

2.5. Experimental Design

The experimental design for the study was 2 × 5 factorial experiment in a Completely Randomised Design (CRD) which consists of two mixing ratios (2:1 and 3:1) and fixed blending proportions of sawdust to spear grass: 100 – 0, 80 –

20, 70 – 30 and 0 – 100%. Data obtained were subjected to Analysis of Variance (ANOVA), while mean separation was carried out for significant difference by using Duncan Multiple Range Test (DMRT).

3. Results and Discussion

3.1. Results

3.1.1. Effect of Production Variables on Water Absorption Properties of Cement Bonded Particle Board

The result of water absorption (WA) ranged from 16.83 to 80.42 % from 24 to 72 hours of soaking. WA at mixing ratio 2:1 range between 28.14 and 71.55 %, 34.61 and 74.98%, 37.74 and 80.42% at 24, 48, and 72 hours respectively. WA at mixing ratio 3:1 range between 16.83 and 53.64 %, 17.78 and 57.89%, 20.72 and 65.63 for 24, 48, and 72 hours soaking respectively as shown in Table 1.

The Analysis of Variance carried out at 95% probability level (Table 2) shows that mixing ratio, blending proportion has significant effect on water absorption after 24, 48 and 72hours but the interaction between the various levels of mixing ratio and blending proportion shows there was no significant difference. The follow-up analysis using Duncan Multiple Ranged Test (DMRT) shows that there was significant difference in board produced between the blending proportions and the mixing ratios as shown in Table 8.

Mixing Ratio	Blending Proportion	Water Absorption 24hrs ± Std	Water Absorption 48hrs ± Std	Water Absorption 72hrs ± Std
2:1	100:0	28.14±6.52	34.61±5.61	37.74±4.80
	90:10	33.33±9.70	40.33±16.14	41.9±19.77
	80:20	42.67±4.31	47.03±2.75	51.18±4.41
	70:30	53.6±19.74	63.01±20.01	70.35±23.59
	0:100	71.55±5.17	74.98±7.44	80.42±9.96
3:1	100:0	16.83±20.15	17.78±11.59	20.72±18.35
	90:10	29.42±8.54	31.33±9.02	33.14±8.81
	80:20	36.12±4.71	39.27±15.21	42.29±22.59
	70:30	43.25±31.97	47.56±12.01	52.70±20.16
	0:100	53.64±8.21	57.89±9.12	65.63±25.34

Table 1: Effect of Blending Proportion and Mixing Ratio on Water Absorption after 24, 48 and 72hrs Water Soaking Test

Source of Variation	Df	Sum of Square	Mean Square	F-cal
Mixing ratio	1	5596.88	5596.88	25.24*
Blending Proportion	4	32053.18	8013.30	36.13*
Mixing ratio*Blending proportion	4	579.606	144.90	0.63^{ns}
Error	120	26613.93	221.78	
Total	149			

Table 2: Analysis of Variance for Water Absorption
**Significant (P<0.05)* ^{Ns} *Not Significant (P>0.05)*

3.1.2. Effect of Production Variables on Thickness Swelling Properties of Cement Bonded Particle Board

Thickness swelling (TS) ranged from 0.71 to 20.35. TS at mixing ratio 2:1 ranged between 1.56 and 16.64 %, 2.34 and 18.02%, 2.64 and 20.35% at 24, 48 and 72 hours respectively while TS for mixing ratio 3:1 range between 0.71 and 5.06 %, 1.30 and 7.52 %, 2.29 and 8.70 % at 24, 48 and 72 hours respectively as shown in Table 3.

The Analysis of Variance carried out at 95% probability level (Table 4) shows that mixing ratio, blending proportion and the interaction between mixing ratios and blending proportions has significant effect on water absorption after 24, 48 and 72hours. The follow-up test using Duncan Multiple Ranged Test (DMRT) shows mean separation between the blending proportions of 100:0 to 0:100, mixing ratios and the interaction between the mixing ratios and the blending proportions as shown in Table 7.

Mixing Ratio	Blending Proportion	Thickness Swelling 24hrs ± Std	Thickness Swelling 48hrs ± Std	Thickness Swelling 72hrs ± Std
2:1	100:0	1.56±0.86	2.34±1.24	2.64±1.16
	90:10	1.69±0.66	5.57±4.03	6.74±4.16
	80:20	7.02±3.95	8.41±4.55	10.37±4.70
	70:30	12.06±5.69	13.99±1.38	16.09±2.13
	0:100	16.64±7.58	18.02±7.43	20.35±6.48

Mixing Ratio	Blending Proportion	Thickness Swelling 24hrs ± Std	Thickness Swelling 48hrs ± Std	Thickness Swelling 72hrs ± Std
3:1	100:0	0.71±0.36	1.30±0.47	2.29±1.14
	90:10	2.24±1.37	2.87±1.12	3.53±1.16
	80:20	2.80±0.95	3.29±1.15	3.70±1.25
	70:30	3.66±4.89	4.32±4.76	4.89±5.20
	0:100	5.06±1.56	7.52±1.31	8.70±1.34

Table 3: Effect of Blending Proportion and Mixing Ratio on Thickness Swelling after 24, 48and 72hrs Water Soaking Test

Source of Variation	Df	Sum of Square	Mean Square	F-cal.
Mixing ratio	1	1249.82	1249.82	98.93*
Blending Proportion	4	2260.98	565.245	44.74*
Mixing ratio*Blending proportion	4	653.28	163.32	12.93*
Error	120	1515.99	12.633	
Total	149			

Table 4: Analysis of Variance for Thickness Swelling
**Significant (P<0.05) Ns Not Significant (P>0.05)*

3.1.3. Effect of Production Variable on Linear Expansion Properties of the Cement Bonded Particle Board

Linear Expansion (LE) ranged from 0.72 to 2.67 %. LE under-mixing ratio 2:1 range between 0.58 and 2.26 %, 0.67 and 2.34 %, 0.73 and 2.67 at 24, 48 and 72 hours respectively. LE at the mixing ratio 3:1 range between 0.18 and 1.35 %, 0.25 and 1.47 %, 0.51 and 1.64 % at 24, 48 and 72 hours respectively as shown in Table 5.

The Analysis of Variance carried out at 95% probability level (Table 6) shows that mixing ratio, blending proportion has significant effect on *water* absorption after 24, 48 and 72hours but the interaction between the two variables were not significantly different. The follow-up analysis using Duncan Multiple Ranged Test (DMRT) further separate the various means according to their level of difference as shown in Table 7.

Mixing Ratio	Blending Proportion	Linear Expansion 24hrs ± Std	Linear Expansion 48hrs ± Std	Linear Expansion 72hrs ± Std
2:1	100:0	0.58±0.96	0.67±1.01	0.73±1.00
	90:10	0.95±0.85	1.15±0.84	1.32±0.86
	80:20	1.42±0.91	1.53±0.85	1.65±0.85
	70:30	1.65±1.10	1.80±1.08	2.06±1.12
	0:100	2.26±0.18	2.34±0.17	2.67±0.12
3:1	100:0	0.18±0.03	0.25±0.06	0.51±0.22
	90:10	0.60±0.15	0.77±0.51	0.89±0.84
	80:20	0.72±0.79	0.92±0.80	1.02±0.80
	70:30	1.10±0.94	1.21±0.92	1.38±0.96
	0:100	1.35±1.65	1.47±1.63	1.64±1.65

Table 5: Effect of Blending Proportion and Mixing Ratio on Linear Expansion after 24, 48 and 72hrs Water Soaking Test

Source of Variation	Df	Sum of Square	Mean Square	F-cal.
Mixing ratio	1	12.89	12.89	16.23*
Blending Proportion	4	37.59	9.40	11.83*
Mixing ratio*Blending proportion	4	1.68	0.42	0.53ns
Error	120	95.32	0.79	
Total	149	150.07		

Table 6: Analysis of Variance for Linear Expansion
**Significant (P<0.05) Ns Not Significant (P>0.05)*

Blending Proportion	Linear Expansion	Water Absorption	Thickness Swelling
0:100	0.49[a]	25.97[a]	1.81[a]
70:30	0.95[b]	34.91[b]	3.78[b]
80:20	1.21[bc]	43.10[c]	5.93[c]
90:10	1.53[cd]	55.08[d]	9.17[d]
100:0	1.96[d]	67.35[e]	12.72[e]

Table 7: Duncan Multiple Range Test (Dmrt)

3.1.4. Effect of Production Variables on Modulus of Elasticity

The values for MOE ranged between 25908.26 to 160529.4N/mm^2 for mixing ratio 2:1 in relation to the different blending proportion levels while the values for MOE ranged between 10560.8 to 153969.8N/mm^2 for mixing ratio 3:1 and the blending proportion as shown in the Figure 2.

The Analysis of Variance carried out at 95% probability level shows that mixing ratio does not have significant effect on elasticity after 24,48 and 72hours (Table 8) but the bending proportion was significantly different. The Duncan Multiple Ranged Test (DMRT) shows significant difference in boards produced with blending proportion of 100:0, 90:10 and 100:0 and there was no significant difference in boards produced with blending proportion of 70:30 and 80:20 as shown in Table 9.

Source of Variation	Df	Sum of Square	Mean Square	F-cal
Mixing ratio	1	2350592830.99	2350592830.99	0.51[ns]
Blending Proportion	4	121367485019.060	30341871254.76	6.59*
Mixing ratio*Blending proportion	4	1202656770.59	300664192.65	0.07[ns]
Error	40	184211420056.35	4605285501.41	
Total	49	309132154676.98		

Table 8: Analysis Of Variance for Modulus of Elasticity
**Significant (P<0.05) [Ns] Not Significant (P>0.05)*

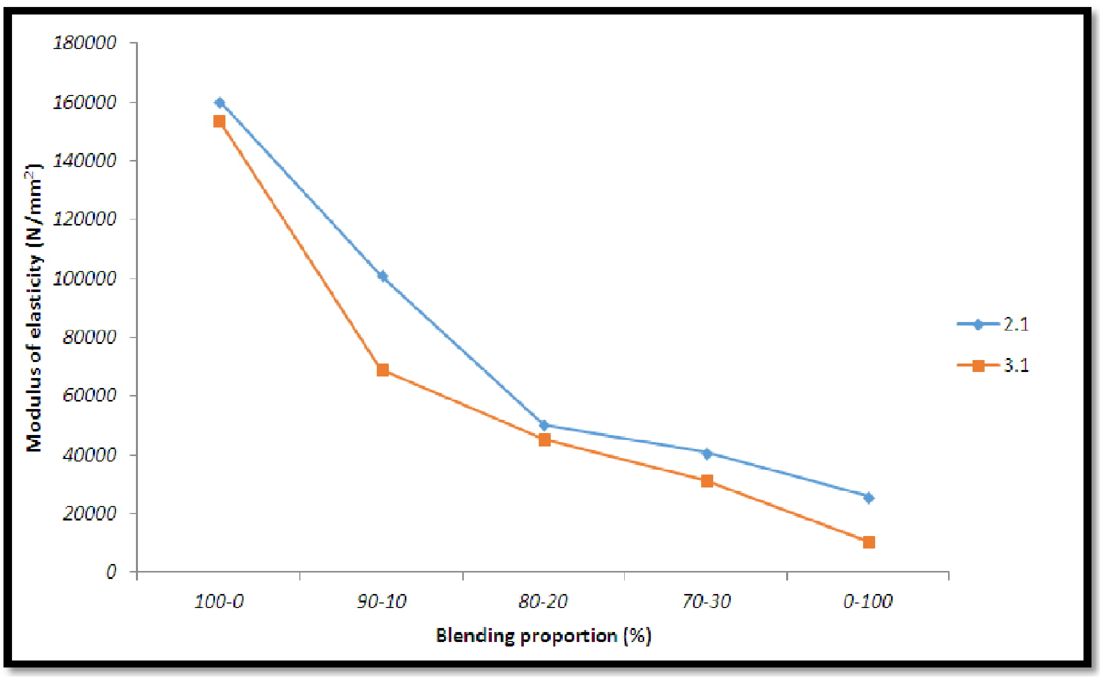

Figure 2: Effect of Blending Proportion and Mixing Ratio on MOE

Blending proportion	MOR	MOE
0:100	91.72[a]	18234.53[a]
70:30	123.80[ab]	36377.61[ab]
80:20	161.58[ab]	47976.14[ab]
90:10	302.36[b]	85291.11[b]
100:0	499.24[c]	157249.62[c]

Table 9: Duncan Multiple Range Test for Blending Proportion of Mor And Moe

3.1.5. Effect of Production Variables on Modulus of Rupture (MOR)

The value of modulus of rupture of cement bonded board produced ranged between 115.6935 to 541.8375N/mm^2 for mixing ratio 2:1 in relation to the different levels of the blending proportion while the values for MOR ranged between 67.75 to 456.64N/mm^2 for mixing ratio 3:1 as shown in Figure 3.

The Analysis of Variance carried out at 95% probability level shows that mixing ratio does not have significant effect on the bending strength of the board while blending proportion has significant effect on the boards MOR Table 10. However, the interaction between the mixing ratios and the blending proportions were not significantly different. The follow-up analysis using Duncan Multiple Ranged Test shows that there was significant difference on board produced with blending proportion of 100:0, 90:10 and 100:0 and there was no significant difference on board produced with blending proportion of 70:30 and 80:20 as shown in Table 9.

Source of Variation	Df	Sum of Square	Mean Square	F-cal
Mixing ratio	1	67205.23	67205.23	1.77^{ns}
Blending Proportion	4	1126436.62	281609.15	7.43*
Mixing ratio*Blending proportion	4	29181.10	7295.27	0.19^{ns}
Error	40	1515688.99	37892.23	
Total	49	2738511.93		

Table 10: Analysis of Variance for Modulus of Rupture
**Significant (P<0.05) ^{Ns}Not Significant (P>0.05)*

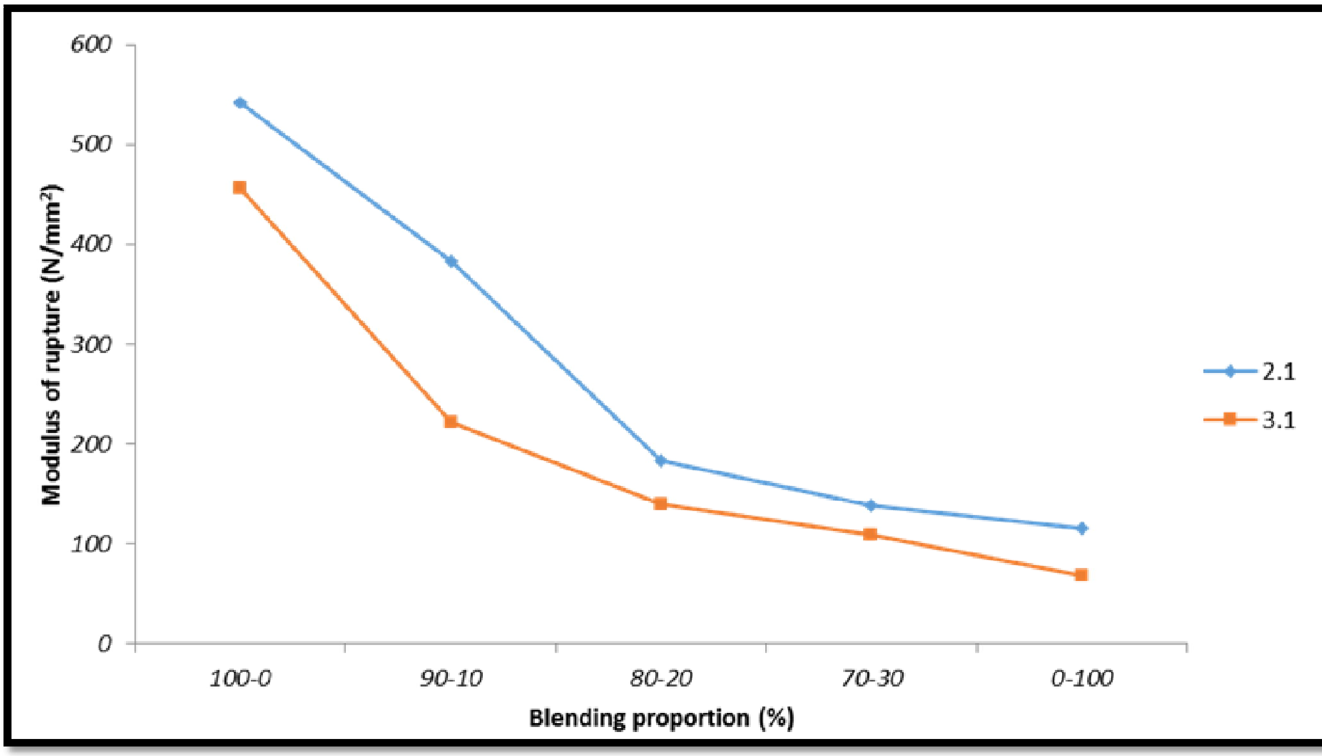

Figure 3: Effect of Blending Proportion and Mixing Ratio on Modulus of Rupture

3.2. Discussion

3.2.1. Water Absorption

The water absorption of the experimental board increases with increased quantity of spear grass addition in the composites mixture. The 0:100 blending proportion shown the highest water absorption and this reaction could be as a result of weak bonding ability of the spear grass fibre with cement. However, water absorption decreases with the addition of sawdust or increased in the quantity sawdust in the mixture. A phenomenon which could be best explained by reduction in the interfacial surfaces between the wood particles, thereby blocking all the pores where water could enter the experimental boards.

The observed high percentage of water absorption could also be attributed to difficulty in compression and presence of void spaces in the boards during production which increases the ability of the fibre to absorb water. These observations are similar to those observed by Ajayi (2005). He observed increase in void spaces of the cement bonded particles boards manufactured from Coffee Chaff which led to increase in the water absorption after board soaking.

The lowest water absorption was obtained from the mixing ratio 3:1 of cement to cellulosic materials and blending proportion 100:0 of sawdust to spear grass fibres which implies that increase in sawdust content of the board, resulted in decrease in water absorption. This observation agrees with the report of Fuwape, (1992), Oyagade, (1990) and Ajayi, (2000). They all reiterated in their findings that low water absorption by composites boards is as a result of finite nature of the wood particles used for the board production. The result of the Analysis of Variance further ascertains these occurrences due to the significant effect shown by the mixing ratio and blending proportion but the interaction between blending proportion and mixing ratio did not have significant effect on water absorption.

3.2.2. Thickness Swelling

Expansion in thickness of composites boards could be detrimental in a building construction where material accuracy and high precision is of greater importance. Regardless of the weather condition of any place, a good composites boards must remain stable after use. Therefore, board production variables that would ensure minimal or no increase in board thickness is of higher consideration in composites board selection.

The inclusion of spear grass led to increase in thickness swelling the boards produced. As the mixing ratio decrease or as the cellulosic materials increased in the production mixture, void spaces increase. The increase in the void spaces served as the point of weakness to the experimental boards due to its ability to absorb water easily, thereby causing swelling of the board bio-fibres which eventually led to increase in size of the board thickness. Experimental boards with the lowest thickness swelling was obtained from the mixing ratio 3:1 of cement to cellulosic materials and blending proportion 100:0 while the highest thickness swelling was obtained in mixing ratio 2:1 and blending proportion 0:100. This observation conforms to the findings of Olufemi, (2001). The reduction in thickness swelling with increase in sawdust in the production mixtures arises because of sufficient encapsulation of the bio-fibres at high cellulosic materials which also resulted to minimal swelling of the board particles. Aladejana and Oluyege (2016) also reported that by using low cement to bio-fibre ratio the wood particles are not encapsulated by cement which results in low bonding and increased thickness swelling. Sadiku, (2012) and Karade, et al., (2003) reported in their study that the interaction between the cement and bio-fibre is very important, at high cement, more cement (binder) is made available to thoroughly encapsulate the wood particles thereby limiting the availability and ability of bio-fibre to swell and increase in thickness.

3.2.3. Linear Expansion

Linear expansion is one of the criteria for determining the physical properties related to dimension stability of cement bonded particle boards. It is important to know the performance of cement board used for external purposes mostly especially in region with high humidity or severe prone environment. The relationship between composites board (CB) and water is the most significant feature of CB with a major influence on dimension stability.

The board linear expansion increased as the quantity of sawdust in the blending proportion increases and decreased as the mixing ratio increases. The board with the highest linear expansion (0:100 at 2:1) was caused by the ability of the spear grass in the mixture to absorb more water. This observation is similar to those reported by Owoyemi et al., (2017). They observed an increased in linear expansion in boards produced from Banana stem and pozzolan as the production variable reduces.

3.2.4. Modulus of Elasticity

Modulus of elasticity is the measure of stiffness of material. It is the stress applied to it divided by the resulting elastic strain. When loaded to stress levels above the proportional limit, plastic deformation or failure occurs. The measure of bending deflection, which is relative to the stiffness, was observed in this study. There are similarities in the result obtained for MOR and MOE. The MOE also increases with the increased in the addition of sawdust in the blending proportion. The lower MOE in the board can be attributed to the poor encapsulation of the mixture with cement at higher blending proportion of spear grass in the mixture, vice versa. These findings correlate with the research of Badejo et al., (2011) on cement bonded board. They observed that the blending proportion has greater influence on the strength properties. The board with the highest MOE is attributed to the sufficient encapsulation of the wood particles at high cement-fibre ratio (Frybort et al 2008). The high MOE of the cement bonded particle board could also be attributed to the uniform distribution of the sawdust in the composites mixture which eliminate the void spaces as much as possible (Olufemi et al., 2012)

3.2.5. Modulus of Rupture

Modulus of Rupture reflects the maximum load carrying capacity of a member and is proportional to maximum moment borne by the specimen. Modulus of rupture is an accepted measure of strength, although it is not a true stress because the formula by which it is computed is valid only to the elastic limit. The strength of the board increases with the increased in the quantity of sawdust to that of the spear grass in the blending proportion. The highest strength properties were obtained at 100-0 due to the good binding ability of the sawdust with cement. The good strength obtained in 100-0 could better be explained by ease of removing the extractive materials in the sawdust. Extractive materials, when not properly removed, could resist the binding of the fibres with cement. The ease of removing the extraneous materials might be as a result of the ability of wood to be broken down to smaller particles compared to spear grass with toughen fibres. The observed high percentage of strength (100:0) could also be attributed to the mixing ratio of sawdust with cement and the low percentage of strength (0:100) could also be attributed to the mixing ratio of spear grass with cement and which increased void spaces that served as point of weakness in the boards. Oyagade (1988) explained this phenomenon in his report that wood strand would be well oriented if its fibres are short and will accordingly increase bending strength and flexibility of the board produced. This could be concluded that homogeneous particle size tends to enhance bending strength of cement bonded particle board according to Olufemi et al., (2012). By using small particles more compact mat structure can be produced, which would eventually reduce void space and irregularities. Semple and Evans (2004) confirmed this assertion that using small strand, the structure will be more compacted, reduced void space and irregularities.

4. Conclusion

bservation from this research showed that the board produced with blending proportion of 100:0 has better physical and mechanical properties while board with the lowest physical and mechanical properties is as a result of nature of the spear grass fibre. The physical and mechanical properties of cement bonded particle board produced from spear grass can be improved when its fibres is grounded thoroughly to resemble the wood particles which was more uniform in the mixture. The board produced with blending proportion of 90:10 which is the second-best board has shown that cement bonded particle board can be engineered with spear grass inclusion to improve the physical and mechanical properties boards. Although, its inclusion must be minimal in the mixture if is not properly grounded to uniform size with other bio-fibres. This research work affirmed that spear grass which has been lying as waste in the farm and also constituting nuisance in our environment can be utilized to produce cement bonded particle board.

5. References

i. Ajayi B. (2000): The Strength and Dimensional Stability of Cement – Bonded Flake Board Produced From Gamelina arborea and Leucaena LeucocePhala.Unpublished PhD Thesis, Federal University of Technology, Akure, Nigeria. 176P.
ii. Ayayi, B.2005. Cement Bonded Particles Boards Manufactured from Coffee Chaff. Journal of Applied Tropical Agriculture.10 (2); 63-66
iii. Akobundu, I.O., Udensi, U.E., Chikoye, D., 2000. Velvetbean (Mucuna spp.)suppresses speargrass (Imperata cylindrica (L.) Raeuschel) and increases maize yield. Int. J. Pest Manage. 46, 103}108.
iv. Aladejana J. T. and Oluyege A. O. (2016): Assessment of selected physicomechanical properties of cement bonded board produced from Gliricidia sepium (Agunmaniye) PRO LIGNO Journal. Vol. 12 No 1. pp 3950. ISSN 2069-7430.
v. Aruofor, R. O. (2000): Review And Improvement of Data Related to Wood- Products In Nigeria. An output of the EC-FAO Partnership Programme (1998-2001) Project GCP/INT/679/EC Data collection and Analysis for sustainable forest managementin ACP Countries. ftp://ftp.fao.org/docrep/ fao/004/X6762E/X6762E00.pdf.
vi. ASTM. (2005). ASTM D 1037-93 - Standard methods for evaluating properties of wood based fiber and particle panel materials. American Society for Testing and Material, Philadelphia, PA
vii. British Standard 373. 1989. British Standard Institution Specification for Wood Chipboard and Methods of Test for Particle Board BS. 5669.
viii. British Standard 373. 1989. British Standard Institution Specification for Wood Chipboard and Methods of Test for Particle Board BS. 5669.
ix. Chikoye, D., Ekeleme, F., Udensi, U.E., 2000. Weed Flora and Soil Seedbank of Speargrass Imperata Cylindrical (L.) Raueschel) Dominated Fields in the Moist Savanna of West Africa. Weed Resistance, Accepted For Publication
x. Chikoye, D., Ekeleme, F., Ambe, J.T., 1999. Survey of distribution and farmer perceptions of speargrass (Imperata cylindrica) in cassava based cropping systems in west Africa. Int. J. Pest Manage. 45,
xi. 305}312.
xii. Frybort, S., Raimund, M., Alfred, T. and Muller, U. 2008. Cement Bonded Composites: A Mechanical Review, 3(2): 602-626.
xiii. Fuwape, j. A. (1992) Sorption Properties of Wood Cement Particle Board as in fluenced by cement/wood ratio. Junior industrial Academy Wood Science. 23(1): 1-9.
xiv. Garrity, D.P., Soekadi, M., Van Noordwijk, M., De La Cruz, R., Pathak, P.S., Gunasena, H.P.M., Van So, N., Huijun, G., Majid, N.M., 1997. The Imperata grasslands of tropical Asia: area, distribution, and typology. Agrofor. Syst. 36, 3}29
xv. IITA (International Institute of Tropical Agriculture), 1977. Annual Report of 1987. International Institute of Tropical Agriculture, Ibadan, 37pp
xvi. Karade, S.R. Irle, M. and Maher, K. (2003). Assessment of Wood-Cement Compatibility: A New Approach. Holzforschung (International Journal of the Biology, Chemistry, Physics, and Technology of wood), Vol 57(6), PP 672-680.
xvii. Koch, W., Grossmann, F., Weber, A., Lutzeyer, H.J., Akobundu, I.O.,1990. Weeds as components of maize/cassava cropping systems.In: Standortgemaesse landwirtschaft in West Africa. UniversitaetHohenheim, Stuttgart, Germany, pp. 283}298
xviii. Kozlowski R, Helwig M (1998). Lignocellulosic Polymer Composite. In: Prasad PN (ed.) Science and Technology of Polymer and Advanced Materials. Plenum Press, New York, pp. 79–698.
xix. Ogunwusi, A.A, (2014). Wood Waste Generation in the Forest Industry in Nigeria and Prospects for Its Industrial Utilization. Raw Materials Research and Development Council, Abuja, Nigeria wood in tackling climate change in Nigeria. Journal of Sciences Research 3(5): 106-115

xx. Olufemi, A. S., Abiodun, O. O., Omaojor, O., Paul, F. A., 2012. Evaluation of Cement Bonded Particle Board Produced From Afzelia Africana Wood Residues. Journal of Engineering Science and Technology. Vol. 7, No. 6: 732 - 743

xxi. Owoyemi, J.M., Akinbote, F. and Aladejana, J. T. (2017). Evaluation of The Physical and Mechanical Properties of Composite Boards made from Banana Stalk (Musa sapientum). Global Journal of Advance Engineering Technologies and Sciences. 4(4) 74 – 82

xxii. Oyagade, A.O. (1990). Thickness Swelling and Water Absorption of Cement-Bonded Particleboard as Influenced by Three Variables. The Nigeria Journal of Forestry. Volume 18. Page 1-2.

xxiii. Ronald W.W., Agron G., 1996. Cement Bonded Wood Composites as an Engineering Material. The Use of Recycled Wood and Paper in Building Applications. 7284: 84-90.

xxiv. Sadiku, N. (2012). Physico-Mechanical Characterization Of Wood Plastic Composite Produced From Some Tropical Wood Species, Mtech Project, Department of Forestry And Wood Technology, Akure.

xxv. Sampathrajan A, Vijayaraghavan NC, Swaminathan KR (1992). Mechanical and Thermal Properties of Particleboards made from Farm Residues. Bioresource Technology. 40: 249-251.

xxvi. Sellers, T., (2000): Growing markets for Engineered Products Spurs Research. Wood Technology. 127(3), 40–43.

xxvii. Semple K.E. and Evans P.D., Wood Cement Composites-Suitability of Western Australian Malleeeuclypt, Blue gum and Melaleucas, RIRDC/Land and Water Australia/FWPRDC/MDBC. 2004

xxviii. Wei, Y. M., Tomita, B., Hiramatsu, A., Fujii, T. and Yoshinaga, s. (2003) Study of hydration bahaviour of wood cement mixture: Compatibility of Cement Mixed with Wood Fibre Strand Obtained by the Water-Vapour Explosion Process. J. Wood Sci., 49: PP 317-326.

xxix. Youngquist J.A., (1999). Wood-Based Composites and Panel Products. In: Wood Handbook: woodas an Engineering Material. General Technology Report. FPL-GRT-113. USDA Forest Service, Forest Product Technology, Mandison, WI, pp. 1 – 31 (Chapter 10).