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EFFECT OF HOT WATER PRE-TREATMENT ON MECHANICAL AND PHYSICAL PROPERTIES OF WOOD-CEMENT BONDED PARTICLES BOARD

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ABSTRACT: Wood- cement bonded particle boards were manufactured by exposing the particles (Sawdusts and wood shavings) to water temperature treatments of 50°C, 60°C,70°C,80°C and 90°C respectively. The dried particles were mixed together at ratio 5: 1 by the inclusion of cement at ratio 2: 3. 3% aluminium Chloride was later added to the mixture. The set up was airdried and filled into moulds while pressure was applied manually to the formed mat. The results of the physical and mechanical properties of the produced boards showed the following range of values; water absorption (22.20-27.00%), thickness/swelling (11.00-16.07%), Linear expansivity(10.90-15.20%) and modulus of rupture (3.78-5.20)N/mm$^{2.}$ Stronger and stiffer boards with good dimensional stability were obtained at temperature between 50°C -80°C, while at temperature 80°C, the bonded particle boards were observed to be weaker. Sawdusts and Shavings are strong contenders for Wood –Cement bonded particle board production.

Keynote: Properties, Pre-treatment, Board properties, Wood-cement.

INTRODUCTION

The development and understanding building materials have generally recovered less attention in the last few decades (Swamy, 1990). One of the solutions to the inadequacy of affordable housing in Nigeria has been largely due to in ability to develop low cost building materials capable of satisfying the culture, architectural construction safety and health requirements of the populace (Olorunnisola and Adefisan, 2005).

Wood cement composite panels, light weight concrete products in which wood particle serve as aggregate in cement water mixtures may appear to have the potential to satisfy these requirement (Briston and Eiton, 1990), since materials used (sawdust and wood shaving) are very cheap. The behaviour and properties of cement based materials may be better understood, designed and predicted using a modern approach than was on the basis of traditional concrete technology (Brandt, 1995). Research has shown that hardwoods tend to inhibit cement hydration due to their relatively high sugar, hemicellulose and phenolic extractive contents (Alberto *et al*, 2000).

The inhibitory effect can however be minimized by various means, including application of particles board preservatives, prolonged storage with or without cold water extraction of the soluble sugar etc.

Therefore, the aim of this work was to manufacture and assess the effect of water pre-treatment temperature on physical and mechanical properties of wood cement- bonded particle boards.

MATERIALS AND METHODS

SOURCE OF MATERIALS

The materials: sawdusts, wood shavings, wooden rectangular moulds, water, cellophane sheets and cement were all sourced locally at Owo.

PRODUCTION OF PARTICLE BOARDS

A 10kg portion of each of the saw dusts and wood shavings was sieved using 4mm wire mesh to obtain an extraneous matter free and homogeneous particle respectively.

The particles (sawdusts and wood shavings) were soaked respectively as varying water temperature (50^{0}C, 60^{0}C,70^{0}C,80^{0}C and 90^{0}C) for two hours (Simatupang, 1979). The water was then decanted and the particles spread out to air dry. The air dried particles were then kept at room temperature for seven days to obtain a moisture content of 12% (Simatupang, 1979). The dried particles(sawdust and wood shaving) were mixed together in 5:1 respectively. The mixture was again mixed with cementin ratio 2:3, and 3% aluminium chloride was then added to it.

The 200g portion of the mixture was soaked in water at varying temperatures (50^0C to 90^0C) for two hours and later spread out to dry. A 30mm by 350mm portion of the air dried mixture was spread on plywood cauls plate already underlined with polythene nylon while the grey cement was spread slightly on it. A wooden mould of 23mm by 320mm dimension was placed on the placed on the plate and the mixture was hand filled manually into uniform mat inside the mould and covered immediately using polythene nylon. This was again covered with another plywood cauls plate.

A pressure of 1.23N/mm^2 was applied manually on the formed mat for 24 hours and later de- moulded and kept inside a properly closed polythene bag for progressive setting and curing of cements to occur for another period of 24% hours. Thereafter, the board was spread out in the laboratory and air-dried for 7 days. The board obtained is shown in plate 1.0.

MECHANICAL AND PHYSICAL PROPERTIES

(a) Modulus of rupture (MOR) test

Modulus of rupture(MOR) is the maximum bending strength of panels. It is a parameter for measuring the bending strength of wood-cement bonded particle boards. It is also the magnitude of load required to cause failure in bending strength. This test was done using Hands Field Tensometer. MOR then calculated using the formula;

$$MOR = \frac{(3PL)}{2BD^2}$$

Where:
P= maximum load (force) in Newton
B=the width of the test specimen (mm)
D=thickness of the test specimen (mm)
L=Length of the test specimen (mm) (Rudolf, *et al*, 1998)

(b) WATER ABSORPTION (WA) TEST

A sample of the board was horizontally immersed in water at room temperature. The initial and final weights of the sample were recorded after 24hours of soaking. Water absorption of the board was calculated using the formula;

$$W.A\ (\%) = \frac{(---W_2 - W_1)}{W_1}$$

Where:
W.A= Water absorption
W_1 = Initial weight before soaking.
W_2 = Final weight after soaking. (Terra, 2008)

(c) THICKNESS SWELLING

The same procedure for water absorption was used for thickness swelling. The rate of thickness swelling was expressed as the percentage of the increase of the board over the original thickness (Terra, 2008)

$$T.S(\%) = \frac{(T2 - T1)}{T1}$$

Where:
$T.S$ =Thickness Swelling.
$T_1 =$ Initial thickness before soaking
$T_2 =$ Final thickness before soaking (Terra, 2008)

(d) LINEAR EXPANSIVITY

The same procedure used for water absorption was also followed. The initial and final length of the board when immersed in the water for 24 hours was taken. Linear expansivity was then calculated using this formula;

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

Where:
$\boldsymbol{L.E}$ **= Linear Expansivity**
$\boldsymbol{L_1}$ **= Initial thichness before soaking**.

L_2 = **Final thickness after soaking**. (Hugh and Rager, 2008)

RESULT AND DISCUSSION

The results revealed the following mean value ranges: Water absorption (22.2% - 27.50%), Thickness Swelling (11.00% - 16.67%) Linear Expansivity (10.95 – 1398%) and modulus of rupture (3.78N/mm^2) respectively. The decrease in the value of water absorption as the water temperature increased from 50^{0}C to 80^{0}C could be attributed to the amount of inhibiting substances that can withhold water in the board which reduced gradually as the temperature increases. This is in line with similar work of Huarg and Copper (2000). However, as the temperature reached 90^{0}Ca lot of substances that ought not to be extracted were being extracted which made the board to be more porous. This could have resulted in the sudden increase in water absorption, thickness swelling and linear expansivity as shown in table 1.0 which could be as a result of the mechanical property of the board.

The decrease in water absorption, thickness swelling and linear expansivity and increase in modulus of rupture as the temperature of pre-treated water increased from 50^{0}C to 80^{0}C resulted to an increase in firmness, hardness and the good quality of the boards. However, at 90^{0}C of pre water treatment, the product resulted in poor quality which was in agreement with the work of Badejo and Owonubi, (2000) in terms of all the quality attributes evaluateds.

CONCLUSION

The research work showed that pre-water treatment at the temperatures of 50^{0}C and 80^{0}C resulted in the production of stronger and stiffer particle boards While, inferior product were obtained when the temperature was increased from 80^{0}C to 90^{0}C.It has established the excellent suitability andpossibility of using sawdust and woodshavings for wood Cement bounded particle boards.

TABLE 1.0 Physical and mechanical properties of locally produced wood cement bounded particle board at varying temperature.

TEMP. TREATMENT	W.A (%)	T.S (%)	L.E (%)	MOR (M/mm^2)
50°C	26.20	15.56	13.98	4.20
60°C	25.65	13.56	12.48	4.46
70°C	24.89	12.22	11.35	4.78
80°C	22.20	11.00	10.90	5.20
90°C	27.50	16.67	15.20	3.78

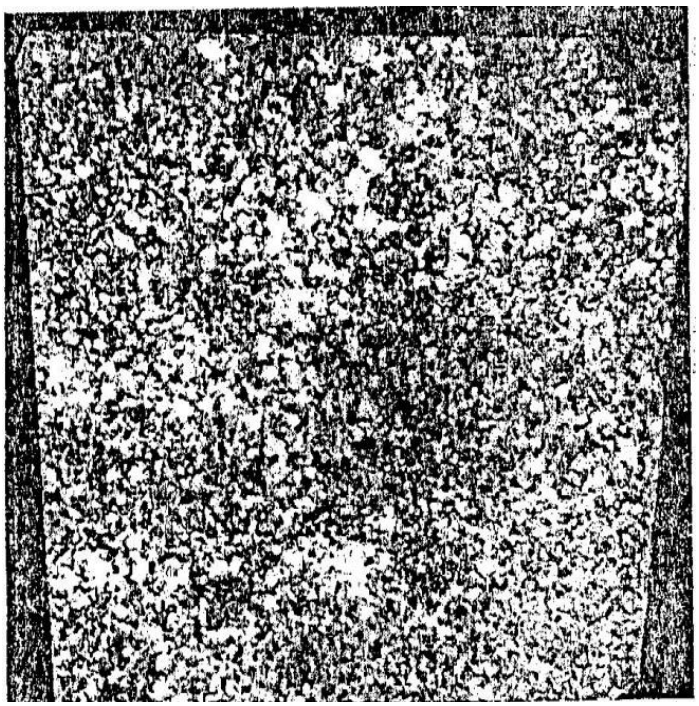

Plate 1.0; Locally produced wood cement bounded board.

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