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Comparative Analysis of Deflective Capability and Breaking Points of Wood Composites.

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----------ABSTRACT----------
Ever since the beginning, wood and its composite has been tremendously used for so many purposes in construction industry, such as beams, columns, piers or wall partitions in building. Therefore, it is imperative to research into the strength, resistance, breakpoint and deflection characteristics of wood composite materials in order to recommend its appropriate usage.
KEYWORDS;-*Composite boards, Deflective Capability, Breaking Points, Structural Members*

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I. INTRODUCTION

Research into the strength improvement of materials has given composite materials an increase in demand for the construction industry. Composite materials are engineered, man-made or manufactured materials made with improved physical and mechanical properties to produce a different synthetic material characteristics more accomplished than the sum of the initial parent materials. Most wood composites such as plywood, chipboard, particle board, block board, laminated board, medium-density fiberboard (MDF) and high-density fiber boards (HDF) are ordinarily manufactured using synthetic adhesives with waterproof and strength characteristics. Composite materials are manufactured boards made by processing solid timber into sheets of stable materials glued together by various means. Corbett (2012) expressed that parts of the tree that otherwise would be pulped can be reformed to produce an economic building material. Manufactured wood as described by Albert & Day (2005) are the building work materials which can be roughly divided into three basic types, each with its own subdivisions: laminated (plywood), particle boards, and fiberboards. This gives the advantage of producing large sheets that are also easy to work with and low cost materials that are most suitable for either interior and exterior wall sheeting or claddings, freer from defects and having smooth surfaces which are easily machined [11].

Every structural element exhibits resistance when loaded during its lifespan. A structural member must be able to withstand the design load that it is being designed for during its usage. Most structural members are designed using the maximum moment associated with the design load. In Engineering, the degree to which a structural element is displaced under loading is termed deflection. Deflection is a change of direction as a reaction at the point of an imposed load which cannot occur without little or pronounced displacement. Maximum deflection denoted by $\Delta_{max} = Pl^3/48EI$ at point load. Booth (2019) emphasized that the effects of load distribution, support conditions and span may be separated from the effects of the material and geometrical properties of the cross section [2].

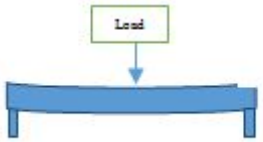

Figure 1: Composite materials subjected to loading

Wood materials as structural members, are often used as beams, columns, piers, wall claddings or wall partitions in building. Good structural panels are often used with structural components such as trusses to provide the structural decking for the floors and roofs. Various wood materials exhibit different deflection characteristics when loaded with constant load. Factors affecting deflection includes the load, length of the member, modulus of elasticity and moment of inertia. The percentage moisture content equally affects the mechanical properties when it changes below the fiber saturation point (FSP).

The engineered composite boards used for this research work are: MDF, Plywood and Chipboard since they are among the common manufactured boards used in Nigeria. **Medium Density Fibreboard** is an example of fibreboard engineered wood product made by breaking down wood wastes, into wood fibres in a defibrator and mixed with synthetic adhesives. This is used, according to Spence (2005) to form panels by applying high temperature and pressure. MDF frames failed suddenly in brittle manner, which is not the typical behaviour of polymer material such as polyethylene [6]. MDF has poor moisture resistance and low integral strength [3]. **Chipboard** is a particle board material made from compressed wood chips, wood pulp, sawdust and resin-binded, often coated or veneered for use in furniture and building works [11]. **Plywood** is a laminated wood material manufactured from thin piles of wood veneer glued as cross bands at 90 degrees to one another [9]. However, Wagner &Kicklighter (2006) established that plywood is manufactured in accordance with U.S PRODUCTS STANDARD PS 1-74/ANSIA 199.1 which provides a system for designating the species, strengths, types of glue and appearance. Structural plywood is produced for applications where strength and durability are prime considerations [1].

Strength is the ability of structure to resist the influence of the external forces acting upon it (Markova, Madenski&Pentrova, 2014). Strength of timber, according to Kunchok (2018), is a function of species, density, size of members, moisture content and duration of the applied loading with strength-reducing characteristics such as slope of grain, knots, fissures, wane and other defects [7]. The material structure of wood is complex and comprises of vessels, fibres, ray, axial parenchyma and tracheids[8] which are strong orthotropic materials with unique properties in different directions when loaded parallel to grain and relatively weak when loaded perpendicular to grain. The factors that determine the strength of wood and wood members include the moisture content, density, temperature, duration of loading and defects[5].

Breaking Point is the exact point at which an elastic material breaks, having being stretched beyond the yield point. The breaking point of woody materials is the moment of greatest strain at which the woody material gives way and its endurance collapses. The maximum tensile stress is calculated through dividing the applied load by the cross sectional area. The relative creep for all board types increases with increasing stress level, increasing relative humidity and increasing temperature[4].

II. MATERIALS AND METHODOLOGY:

The materials used for this experiment are: Wood composite (plywood, MDF and chipboard) of dimension (18mm x 18mm) with a constant length of 500mm were subjected to varying mass of 200g, 400g, 600g,….,7000gconsecutively and their linear displacement measured with each load applied till the breaking point is reached for each composite material. The moisture content of each composite was measured using the moisture meter and their respective weight were measured before loading. The density is measured in the relationship between mass and volume with the unit in kg/m3. The equipment used are: moisture meter tester, measuring tape, weighing balance, crampand Beam apparatus SM104.

The percentage moisture content of the materials were the same and they were all tested at the same room temperature of 32ºC.

III. RESULTS AND DISCUSSIONS

Physical Characteristics of wood composites

PHYSICAL CHARACTERISTICS				
S/N	**Material Properties**	**Mass (g)**	**Density(kg/m3)**	**Moisture Content (%)**
1	Plywood	56.06	346	6
2	Chipboard	76.08	467.63	6
3	MDF	97.08	597.26	6

Table 1 (Physical Characteristics of Selected Wood Composite)

From Table 1 above, it was deduced that plywood is lighter than chipboard which is equally of a low density compared to MDF even at same moisture content rating.

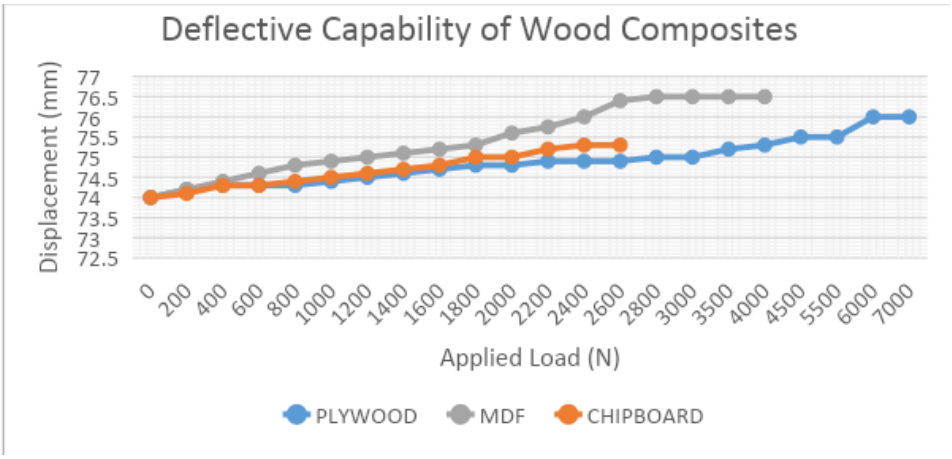

Figure 2: Performance of wood composite under loading

The materials were subjected to incremental loads of 200g (1.961N) intermittently. It was observed from Figure 2 that there is an initial creeping followed by the creaking sound before the breaking point of the engineered boards tested except the MDF that breaks suddenly. The sound is an initial warning before the collapse of the material being tested. The creeping sound of chipboard was attained at 2000N before the breaking point at 2600N. However, the time frame might be too short to make any amendment before the collapse if the MDF is actually used as a structural material for heavy loads. The creeping sound of plywood was attained at 5500N before the breaking point at 7000N.Plywood has better strength and resistance to loading compared to other wood composites used in construction within the building industry. It was observed that the chipboard cannot resist force that is more than 19.6N and MDF could not support more than 25.4N before failing unlike the plywood that is able to withstand a force of 53N before failure.

RECOMMENDATION:

Plywood has better load resistance than other engineered boards and it is therefore most recommended when strength is of paramount necessity. Again, the face veneer used in the making of a plywood can be made very colourful and attractive if desired. Chipboard can only be recommended for use as formwork in work points or areas that are not subjected to loading or when the loading is minor at less than 19N.When beauty and aesthetics is of utmost importance and when the load to be supported is less than 25N, MDF remains the best option because of the plastic craft material used in the final finishing, which also makes it more resistant to water absorption from the face or back veneer. Mechanically, plywood is tested to be more resistant to the effects of water than as obtained with materials such as chipboard or medium density fiber boards having lower resistance to the hydro effect. Conclusively, the price of individual materials can also determine which of them to be selected for various purposes after the loading capacity of individual material is first considered.

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