

ACHIEVING SUSTAINABLE DEVELOPMENT THROUGH NIGERIAN ECONOMY MARINE BOARD ENGINEERED WOOD LOAD STRAIN EVALUATION

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DOI: <https://doi.org/10.5281/zenodo.18092920>

Published Date: 30-December-2025

Abstract: Owing to uncommonness of information to avert the usual resources loss due to failure associated with using unfit marine board engineered wood products in Nigerian economy with respect to their strain and deformation for various needs, technical insights relevant to prevent such loss was investigated. Prepared and subjected to test as required by a universal testing machine (UTM), the testometric testing machine were the three most sought after following their identification. From the generated data, charts on Strain at Break (%) and Deformation at Break (mm) of the samples were ensued by computer program. From statistical analysis, Super-Plex ability to elongate at break is 61.37% and 117.96% higher than that of Marine Plex and Nplex respectively while Marine Plex elongation at break potential over Nplex is 35.07%. Again, in an ascending order of deformation at break for the samples, Nplex attained 7.771mm, Marine Plex attained 10.495mm while Super-Plex attained of 16.935mm. Empirically also, dynamics of the deformation at break exhibited analogous pattern to strain, where Super-Plex ability to resist deformation at break is 61.36% and 117.93% better than that of Marine Plex and Nplex respectively. Marine Plex deformation resistance at break potential over Nplex is just 35.05%. This sustainable avant-garde technical data forms a good tool by stakeholders like contractors and biomedical, mechanical and civil engineers. Strain at break and deformation at break research works of other engineered wood products not yet available should form future research works.

Keyword: Durability, Elasticity, Elongation, Extension, Flexure Strength, Mechanical Test, Resilience.

I. INTRODUCTION

BACKGROUND OF THE STUDY

[1] Asserted that forestry products industrial goods exports were relished by Nigeria in the 1950's, 1960's and 1970's. Engineered wood products, a derivative of wood product are typically obtained through the processes of binding fibers, particles, the strands, or boards of wood together. It has been noted that engineered wood products offer enhanced mechanical properties, dimensional stability as well as durability that streamline improved energy performance and larger complex structural elements, [2]. [3] Asserted that global engineered wood market will reach USD 282.728 billion by the

end of 2025 growing at a compound annual growth rate (CAGR) estimate of as much as 5.448% during 2025 with projection to reach USD 432.191 billion by the year 2033. In Nigeria, [4] noted that Nigerian engineered wood market was valued at USD 8.81 billion in 2023 is actually expected to reach USD 11.05 billion by 2030 growing at a CAGR of 3.3%. Used comprehensively across packaging industries, furniture, and construction, wood composite in Nigeria remains a vital engineered wood product. Sadly, Nigeria as at present despite abundant raw materials and a fast-growing domestic market, mostly remain heavily dependent on engineered wood imports. [5] Noted that particle and fiberboards that are usually made of materials like rye and wheat straw, sugar cane residue, hemp stalks e.t.c, are widely used in the building industry as eco-friendly solutions to wood with increasing uses in ceiling boards, wall partitions and thermal insulators e.t.c, due to an excellent combination of mechanical, thermal and acoustic properties together with a competitive price. [5] Again observed that mechanical properties improvements are usually remarkably observed with combination of the alkali treatment followed by silanization at the production of highly environmentally-friendly engineered fiberboards by a partially biobased epoxy resin as binder and hot-press molding using *Posidonia oceanica* wastes. Towards facilitating optimal processing conditions, comparable engineered wood products are made from vegetable fibers using lignin-containing materials as well as chemical additives to enable the integration of polymer and wood flour. Production of engineered wood products, peak points the reduction in the need to fell old-growth forests as they are commonly made by the use of wood waste materials.

It is evident that there are some challenges with the use of engineered wood products. When exposed to moisture, humidity-induced warping which is not common in solid woods is a common experience in engineered wood product that are fiber-based and particle-based. Toxic formaldehyde from the finished products, a strong apprehension with engineered wood product is formed and is usually released when cheap and commonly used resins in the engineered wood product are usually made with urea-formaldehyde bonded products. Higher fire hazard is a possibility when a comparison is made between engineered wood product and solid wood products as a result of higher chemical heat content and melting properties. [6] Revealed that the economy, especially building materials market was badly hit by the inflation with the purchasing power of the Nigerian currency, Naira seen to be decreasing from the critical study of inflation trend pattern and its impact on Nigeria's economy. [7] From a correlation analysis of the inflation rate and the prices of building materials in Benin city observed that inflation rate in Nigeria has a direct relationship with prices of building materials as inflation was the most influential factor responsible for increase in cost of building materials. [8] Established that a very strong link exists between rate of residential development and building materials prices while studying the effect of building materials cost on housing development in Owerri, Imo state, eastern region of Nigeria. Demand for engineered wood product within Nigeria and across the globe as projected by earlier statistics is on the increase despite all these hurdles due to remarkable improvement on the esthetic and mechanical properties. Prudent use of the resources becomes a must have. Aimed towards sustainable economic development, it becomes essential to study load strain and deformation of marine board engineered wood products in Nigeria as the technical insight provided will notably go a long way to prevent heavy loss of revenue due to use of unsuitable quality for various needs.

Materials Behaviour, Strain and Deformation

Strain is the deformation or displacement of a material under stress, usually expressed as a ratio of the change in length to the original length in mm/mm expressed as a percentage (%) in materials science. Characteristics that define a material's behaviour under various conditions are their material properties. It is worthy of note that materials response to strain in a number of ways. Reversible deformation is experienced within elastic behaviour (elastic strain) where materials can return to their original shapes after stress or force is removed. Examples of such materials are steel and rubber. Under plastic behaviour (plastic strain), clay and copper deform permanently. This is because their original shapes are lost even with the removal of the force. Fracture is a common experience on materials like ceramics and glass under brittle behaviour. Strain gauges detect changes in electrical capacitance or resistance which comes as result of deformation. Changes in length or displacement are measured by instruments like extensometers. Some key concepts describe materials behaviour. The linear relationship between stress and strain in elastic materials is described by Hooke's. As a crucial concept, data and understanding of materials strain help in choice of materials in materials selection. Secondly under various loads, strain analysis predicts material behaviour in structural analysis. Lastly, excessive strain can lead to material failure. These showcase their ductility potentials.

II. REVIEW OF RELATED LITERATURE

Recently, [9] found that quantitatively, the bending modulus for Marine Plex is just 19.60% and as much as 163.66% better suited than that of Super-Plex and Nplex respectively while for Super-Plex, it is as much as 120.45% favorable than that of Nplex in examination of marine board engineered wood products in Nigeria market. Again, [10] found that Joubert (HDF) recorded 15.604 N/mm², Dabar (HDF) recorded 32.604 N/mm² while Sinoply (HDF) recorded 39.248 N/mm² of their flexural strength at peak in a study of the flexural strength of high density fibreboard (HDF) engineered wood in Nigerian market. Flexural strength and elongation at break increased as coconut shell proportion got increased in the study of the effects of carbonized coconut shell (CS) volume fraction on mechanical properties of unsaturated polyester resin (UPR) composite and the mechanical properties by [11]. [12] In a hardness test analysis of marine board in Nigerian economy observed that Marine Plex attained aggregate average hardness of 364.5 Leeb Hardness Test (HLD), Nplex attained aggregate average hardness of 392.25 HLD while Super-Plex attained aggregate average hardness of 370.75 HLD. A modification of surface quality was noticed after 80 reuses with marine plywood formworks while such changes were observed after 50 reuses with oriented strand board (OSB) panels formworks in the study of the evolution of surface properties of concrete through measured lightness and absorption by [13]. [14] Showed that Richard Russel attained aggregate average hardness of 545.75 HLD, Hokusan attained aggregate average hardness of 535.75 Leeb Hardness Test (HLD), while SGK Nordiac attained aggregate average hardness of 558.50 HLD in hardness test analysis of medium density fibreboards MDF in Nigerian economy. Panels with 50% CC had the most preferred performances for both physical and mechanical properties in a study of the properties of developed composite corn cob (CC) and sawdust (SD) particle boards using 0%, 25%, 50%, 75% and 100% variations for both agricultural wastes using formaldehyde as binder at constant volume by [15]. An experimental analysis of flexural strength of veneered engineered wood (Plywood) in Nigerian commercial sector showed that Viewpoint plywood recorded 4.956 N/mm², Plywood EQ recorded 9.467 N/mm² while Caledonian recorded 16.973 N/mm² as the maximum stress, modulus of rupture (MOR) each of them can withstand while being bent before failing or rupturing, [16]. Maximum flexural and ultimate tensile strength were attained at 20wt% for the 425 microns when the effect of particle size on the ultimate tensile strength, flexural strength, density and water absorption characteristics of uncarbonized coconut shell/unsaturated polyester composites of particle size 425 microns sample and 170 microns sample were investigated, [17]. Sinoply ability to elongate at break being 544.89% and 507.44.89% more than that of Dabar and Joubert respectively thereby placing Sinoply at an advantage position while Joubert elongation at break potential over Dabar being just 6.16% higher were all revealed in the statistical analysis of wood load strain of high density fibre engineered wood product in Nigeria, [18]. Plywood EQ attained aggregate average hardness of 459.25 HLD, View Point attained aggregate average hardness of 456.5 HLD while Caledonian attained aggregate average hardness of 407.5 Leeb Hardness Test (HLD) in a hardness test analysis of veneered engineered wood (Plywood) in Nigerian market, [19]. Coconut fibre reinforced HDPE had 28.6 mega pascal as optimum value for flexural strength in a study of the performance characteristics and reinforcement combinations of coconut fibre reinforced high density polyethylene (HDPE) polymer matrixes at optimum condition of volume fractions and particle sizes of coconut fibre-filler, [20]. Flexural strength values in glulam beams were found significantly higher than the control (custom wood) especially in edgewise direction in the assessment of glued laminated beams made from local wood species bonded with phenol resorcinol formaldehyde, urea-formaldehyde adhesives and polyurethane, [21]. Dabar attained aggregate average hardness of 526.50 Leeb Hardness Test (HLD), Sinoply attained aggregate average hardness of 547.50 HLD while Joubert attained aggregate average hardness of 548.50 HLD in the hardness test conducted on high density fibreboards in Nigerian economy, [22]. A linear relationship between age and strength properties of timber, increasing both the compression and shear strengths and even to a reasonable extent the bending strength was established in an attempt to find the relationship between age and properties of timber, [23]. [24] Assessed the Medium Density Fibreboard (MDF) engineered wood load strain in Nigerian and found that statistically, MDF Hokusan ability to elongate at break is 35.9526% and 57.8750% higher than that of Richard Russel and SKG Nordic respectively, placing MDF Hokusan favoured while Richard Russel elongation potential over SKG Nordic is just 16.1250%. SGK Nordic had the best ultimate flexural strength of 13.568 N/mm², MDF Hokusan (MDF) recorded 1.24 N/mm², while Richard Russel had ultimate flexural strength of 12.986 N/mm² when [25] studied flexural strength of medium density fibreboard (MDF) wood composite in Nigerian market. Recently, [26] found that Marine Plex marine board plywood had ultimate bending strength of 17.96 N/mm², Nplex marine board plywood recorded 21.502 N/mm² while Super Plex marine board plywood had the best flexural strength at peak of 65.84 N/mm² in Nigerian economy marine board assessment. [27], while assessing the veneered engineered wood (Plywood) product in Nigerian economy bending modulus found that statistically, the bending modulus for Caledonian is 132.79% and to the extent of 2155.50% more superior than that of

Plywood EQ and Viewpoint respectively while bending modulus for Plywood EQ is 868.89% more suitable than that of Viewpoint. It is crystal clear from above, in summary that research has not been directed towards providing technical information on marine board engineered wood in Nigerian economy with regards to their load strain and deformation, hence the obvious need for this research paper.

III. METHODOLOGY

MATERIAL

Research was made in Nigerian market on commonly used and major marine board engineered wood products samples in Nigeria to value their strain at break potentials. Most common and three major marine board engineered wood products in Nigeria in top demands were identified from the survey made. They were selected as samples for test and subsequent analysis. The marine board engineered wood product samples were Marine Plex, Super-Plex and Nplex. They are represented accordingly in table 1.

In table 1, the samples are marked “a”, “b” and “c” representing Marine Plex, Super-Plex and Nplex. They are all prepared according to the requirement by the machine and tested on the machine one after the other.

TABLE 1: Marine Board Engineered Wood product samples tested

Sample	a	b	c
Make	Marine Plex	Super-Plex	Nplex

EQUIPMENT

The machine shown in figure 1 a universal testing machine (UTM) the testometric testing machine was use in the test. It works by clamping down on a sample of marine board engineered wood product appropriately conditioned as required by the machine and mounted on it for test. Data on the properties of the material including Strain at Break (%) and Deformation at Break (mm) were generated, as the jaw moves down, by the resistive potentials of each sample.

The samples, (a) representing **Marine Plex**, (b) representing **Super-Plex** and (c) representing **Nplex** were all tested on the machine one after the other after being prepared diligently according to the requirement by the testometric machine shown in figure 1. The samples were prepared by cutting to the dimensions of 30 mm x 200 mm so as to fit in with the testing machine as required. Operated by moving the jaw of the TESTOMETRIC TESTING MACHINE down to clamp on the workpiece as earlier stated that is the conditioned marine board engineered wood product samples, Strain at Break (%) and Deformation at Break (mm) data of the marine board engineered wood wood product samples are evaluated during the process. With computer program the dynamics of the Strain at Break (%) and Deformation at Break (mm) plots for the test are generated from data obtained. The plot being a function of the samples compositions resulting from their nature is obviously a clear indication of the change in length to the original length in a material under load. In this case, the material being the marine board engineered wood product samples. The data generated is analysed under results and analysis below.



Fig. 1: Testometric machine (A universal testing machine)

IV. RESULTS AND ANALYSIS

For each of the samples Marine Plex, Super-Plex and Nplex, the charts for strain at break (%), deformation at break (mm) and combined dynamics of the strain and deformation are shown as charts in figures 2, 3 and 4 respectively.

Plots

The figure 2 below is a chart for Strain at Break (%) for the samples Marine Plex, Super-Plex and Nplex. Super-Plex attained 3.81% strain at break, Marine Plex attained 2.361% strain at break while Nplex attained 1.748% strain at break.

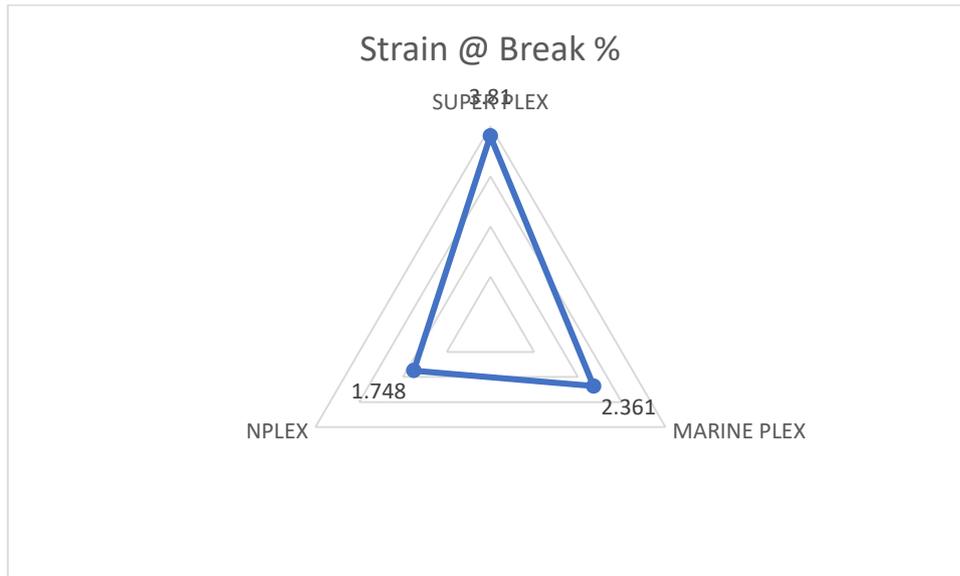


Fig 2: Chart of Strain at Break (%) for Marine Plex, Super-Plex and Nplex.

The figure 3 below is a chart for Deformation at Break (mm) for the samples Marine Plex, Super-Plex and Nplex. Super-Plex recorded 16.935mm deformation at break, Marine Plex recorded 10.495mm deformation at break while Nplex recorded 7.771mm deformation at break.

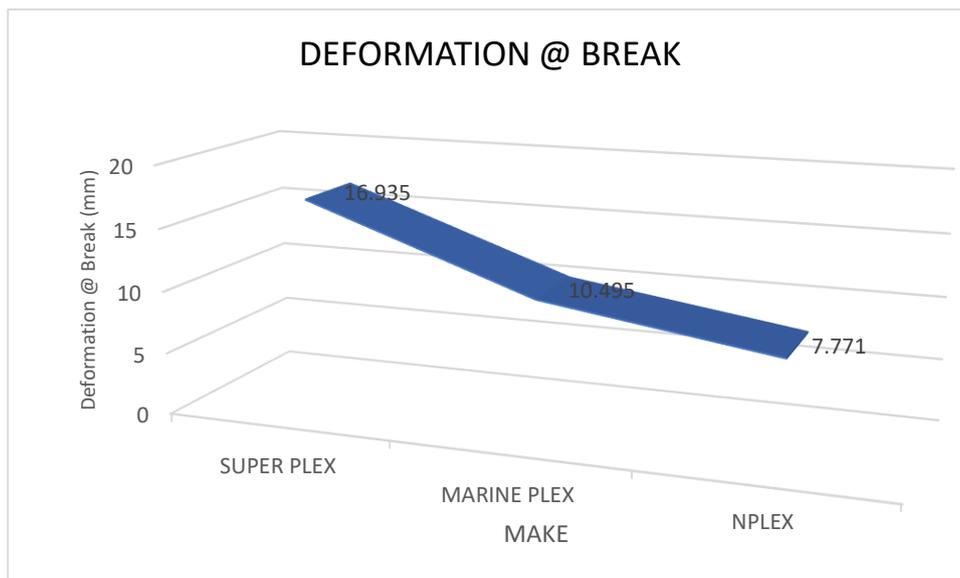


Fig. 3: Chart of Deformation at Break (mm) for Marine Plex, Super-Plex and Nplex.

The figure 4 below is a chart for relationship between Strain at Break (%) and Deformation at Break (mm) for the samples Marine Plex, Super-Plex and Nplex. A direct relationship is established between the strain and deformation for the samples Marine Plex, Super-Plex and Nplex with series 1 being strain while series 2 being the deformation.

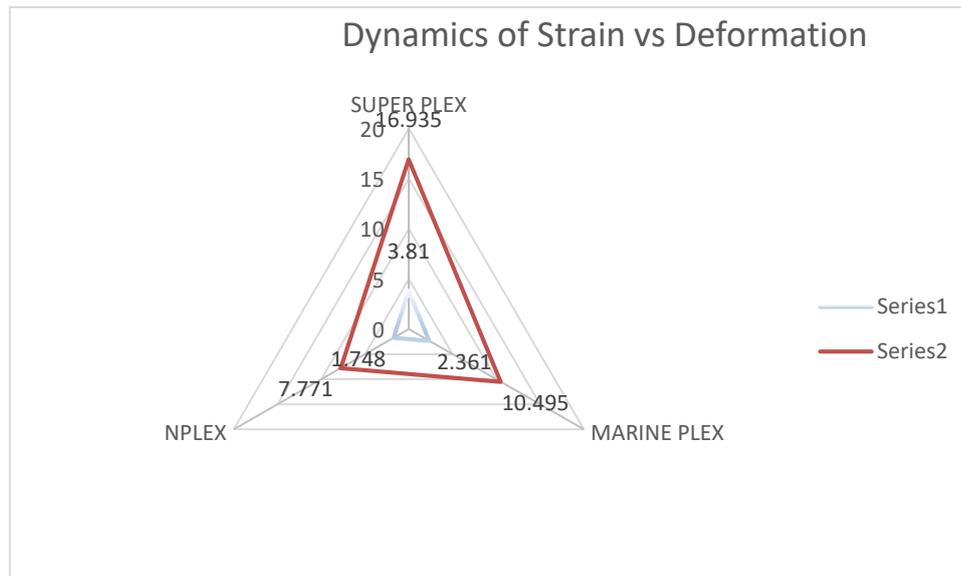


Fig. 4: Chart of Strain at Break (%) and Deformation at Break (mm) for Marine Plex, Super-Plex and Nplex.

V. CONCLUSION AND RECOMMENDATIONS

X-raying the results, arranging them in an ascending order of their Strain at Break (%) for the samples, Nplex achieved strain at break of 1.748%, Marine Plex achieved strain at break of 2.361% while Super-Plex achieved strain at break of 3.81%. From statistical analysis, Super-Plex ability to elongate at break is 61.37% and 117.96% better than that of Marine Plex and Nplex respectively. Marine Plex elongation at break potential over Nplex is 35.07%. Again, in an ascending order of their Deformation at Break (%) for the samples, Nplex attained deformation at break of 7.771mm, Marine Plex attained deformation at break of 10.495mm while Super-Plex attained deformation at break of 16.935mm. Empirically also, dynamics of the deformation at break exhibited analogous pattern to strain, where Super-Plex ability to resist deformation at break is 61.36% and 117.93% better than that of Marine Plex and Nplex respectively. Marine Plex deformation resistance at break potential over Nplex is just 35.05%. This innovative technical understanding on strain and deformation resistance potentials of marine board engineered wood product should be valued by architects, building contractors, engineers, individuals, construction companies as well as furniture makers. Engineers in the Biomedical areas as well as mechatronics equipment developers and Engineers in general can as well utilise this knowledge. Strain at break and deformation at break research of other engineered wood products should form future research works.

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