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Nigerian Market Medium-Density Fibreboard (MDF) Force-at-Yield Assessment for Sustainable Economic Development

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Abstract

This study assessed the Force-At-Yield properties of three commercially available and ubiquitous samples of medium-density fibreboard (MDF) brands in Nigerian commercial sector to provide technical guidance for material selection in support of sustainable economic development to forestall the prevailing gratuitous financial loss arising from failures resulting from the use of inappropriate Medium-Density FibreBoard (MDF) brands. Four replica tests for Force-At-Yield per brand took place according to testometric testing machine requirement while conforming to ASTM D1037 standard and the average of aggregate also presented. Chats on the characteristics of the Force-At-Yield of the brands resulted through computer program using the generated data. One-Way ANOVA on the results revealed significant differences in force-at-yield among the three MDF brands ($F(2, 9) = 3,518,673.77$, $p < 0.001$). Tukey's HSD test at ($p < 0.001$) revealed a significant difference for each pairwise comparison. SGK Nordic exhibited the highest mean force-at-yield (296.58N), followed by Richard Russel (291.73N) and then MDF Hokusan with the mean value (27.53N). The coefficients of variation ranged from 0.051% to 0.620%, indicating excellent measurement precision. Cohen's d values ranged from 30.18 to 1643.78, demonstrating extremely large differences between the MDF brands. These findings indicate that the force-at-yield performance of commercial MDF brands in Nigerian economy varies substantially, SGK Nordic exhibiting highest resistance to yielding under the test conditions. Biomedical, Mechanical, Civil, Materials, Production, Metallurgical, Mechatronics, Chemical engineers and construction companies as baseline should value this innovative technical knowledge for sustainable applications in developments of their designs especially in medically non-invasive supportive devices and in construction applications. Force-at-Yield characteristics of other engineered wood products types that have not been investigated warrant further research to provide a more comprehensive understanding of their performance characteristics.

Keywords: *Engineered Wood, Force-at-Yield, Mechanical Properties, Medium-density fibreboard (MDF), Plastic Deformation, Tukey's HSD.*

I. Introduction

Background of the Study

Engineered wood products are designed to provide enhanced dimensional stability, superior mechanical performance, and improved durability, making them suitable for energy-efficient construction and the fabrication of large, complex structural components (Fasasi, Baba, & Ogunmilua, 2024). Among these products, fiberboards and particleboards are commonly manufactured from agricultural residues such as rye straw, wheat straw, sugarcane bagasse, and hemp stalks. Their environmentally sustainable nature has led to widespread application in the construction sector as alternatives to conventional wood. These materials are increasingly utilized in the production of furniture, ceiling panels, partition walls, and thermal insulation systems because they combine desirable chemical, mechanical, thermal, and acoustic properties with costeffectiveness (Garcia-Garcia, Quiles-Carrillo, Montanes, Fombuena, & Balart, 2018). Engineered wood products are manufactured by bonding wood fibers, particles, strands, or veneers into composite materials with enhanced performance characteristics. In Nigeria, wood composites constitute an important category of engineered wood products and are extensively used in the packaging, furniture, manufacturing, and construction sectors. Despite the country's abundant supply of raw materials and expanding domestic demand, Nigeria continues to rely heavily on imported engineered wood products, highlighting the need to strengthen local production capacity. The global engineered wood market is projected to attain a value of approximately USD 282.73 billion by the end of 2025, with an estimated compound annual growth rate (CAGR) of 5.45%. Sustained market expansion is expected to increase its value to about USD 432.19 billion by 2033 (Shirsath, 2025). Similarly, the Nigerian engineered wood market was valued at USD 8.81 billion in 2023 and is forecast to reach approximately USD 11.05 billion by 2030, representing a CAGR of 3.3% (FMRL, 2025). Engineered wood products (EWPs), including laminated veneer lumber (LVL), high-density fibreboard (HDF), and cross-laminated timber (CLT), are finding increasing application in the manufacture of non-invasive assistive and supportive devices (Bayat, 2023). This is because they are eco-friendly have lightweight and high-strength alternatives to traditional solid woods, metals and plastics in rehabilitation and orthotics equipment. In thermal comfort and suitability, compared to plastics, wood-composites are generally breathable and do not trap heat thereby reducing the likelihood of skin irritations.Timber harvesting, processing, and trade for both domestic use and export made substantial contributions to Nigeria's economy from the late eighteenth century through the 1960s, a period widely recognized as the golden era of the country's forestry sector, with its influence extending into the early 1970s (Olorunnisola, 2023). During the 1950s, 1960s, and 1970s, Nigeria was a major exporter of wood-based industrial products, reflecting the significant role of the forestry industry in the nation's economic development (Ogunwusi, 2012). The availability and cost of building materials have a significant influence on residential housing development. A study conducted in Owerri, Imo State, Nigeria, established a strong relationship between building material costs and the rate of residential development, demonstrating that fluctuations in material prices directly affect housing delivery (Igboekulie, Monye, & Joseph, 2022). Nigeria's economy, particularly the building materials market, has been adversely affected by persistent inflation, which has eroded the purchasing power of the national currency, the Naira (Barguma et al., 2022). This macroeconomic trend has contributed to sustained increases in the prices of construction materials. Supporting this observation, a correlation analysis conducted in Benin City identified inflation as the most significant factor driving the rising cost of building materials, revealing a direct relationship between inflation rates and material prices (Obaedo, 2024). Despite their numerous advantages, engineered wood products are associated with several inherent limitations. Fiber-based and particle-based engineered wood products are particularly susceptible to moisture absorption, which can result in humidity-induced swelling, warping, and dimensional instability—effects that are generally less pronounced in solid wood. In addition, some engineered wood products present greater fire-related risks because of their chemical composition and the thermal behaviour of the adhesives and other constituents used during manufacture. Another important concern is the potential emission of formaldehyde from products bonded with urea-formaldehyde resins, which remain among the most widely used and economical adhesives in engineered wood manufacturing. The release of formaldehyde from these finished products has raised environmental and public health concerns, making it a key issue in the production and application of engineered wood products. Enhanced mechanical performance has been reported for environmentally sustainable engineered fibreboards produced from *Posidonia oceanica* waste using a partially bio-based epoxy resin as the binder. In particular, the combination of alkali treatment and subsequent silanization significantly improved the mechanical properties of the resulting fibreboards manufactured through hot-press moulding (Garcia-Garcia et al., 2018). Similarly, engineered wood products can be produced from a variety of plant-based fibres by incorporating lignin-containing materials and suitable chemical additives that promote effective bonding between wood flour and polymer matrices, thereby improving processing efficiency and overall material performance. Furthermore, the increasing utilization of wood residues and other lignocellulosic waste materials in engineered wood production has contributed to more sustainable resource utilization by reducing dependence on timber harvested from old-growth forests. Despite the limitations associated with engineered wood products, continuous improvements in their mechanical performance and aesthetic qualities have sustained their growing acceptance in both global and Nigerian markets. Market projections based on historical trends indicate that demand for these products will continue to increase, further emphasizing their importance within the construction and manufacturing industries. In view of this increasing demand, it is essential to evaluate the force-at-yield characteristics of Medium Density Fibreboard (MDF) products available in Nigeria. Such investigations provide critical engineering data for material selection and structural design, thereby minimizing the economic and performance consequences associated with the use of products that do not satisfy the quality requirements of specific applications.

Force-at-Yield

In engineering design, yield force is an important parameter used to establish the safe operating limits of materials and components. It represents the magnitude of applied force at which a material reaches its yield point, transitioning from elastic behaviour to plastic deformation. Below this threshold, the material can recover its original form after the removal of the applied load; however, once the yield force is exceeded, irreversible deformation occurs. Maintaining design loads below the yield force is therefore essential to prevent permanent changes in shape and preserve structural integrity. This property is particularly significant in material selection, quality assessment, and component design because its safety, performance, and service life, yield force serves as a fundamental and indicates the maximum load a material can withstand without experiencing permanent deformation. Materials with higher yield force values are preferred for load-bearing applications where dimensional stability and resistance to deformation are critical requirements. A universal testing machine (UTM) is commonly employed to determine the yield force and other mechanical characteristics of materials through controlled loading tests. Since exceeding the yield threshold can compromise safety, performance, and service life, yield force serves as a fundamental mechanical property for defining the acceptable working limits of engineered materials.

II. Literature Review

Courard et al. (2012), in their investigation of the development of concrete surface characteristics using measured lightness and absorption parameters, reported that marine plywood formwork exhibited noticeable alterations in surface quality after approximately 80 cycles of reuse. In contrast, comparable surface changes occurred after about 50 reuse cycles when oriented strand board (OSB) panels were employed as formwork. In a separate investigation of MDF wood composites available in the Nigerian market, Ilo, Nwanjoku, and Olayeye (2025) reported substantial differences in ultimate flexural strength among the products evaluated. SGK Nordic exhibited the highest value at 13.568 N/mm², followed by Richard Russel at 12.986 N/mm², whereas MDF Hokusan recorded a considerably lower value of 1.24 N/mm². Okoye, Ilo, and Obuka (2026) evaluated the bending modulus of three widely used MDF products in Nigeria—MDF Hokusan, SGK Nordic, and Richard Russel. The statistical analysis revealed a highly significant difference among the three products ($p < 0.0001$), while Tukey's post-hoc multiple-comparison test confirmed statistically significant differences for every pairwise comparison ($p < 0.001$). Richard Russel recorded the highest mean bending modulus, at 8,697 MPa, reflecting its greater resistance to bending deformation and comparatively higher stiffness. SGK Nordic ranked second, with a mean value of 7,398 MPa, whereas MDF Hokusan recorded the lowest value of 1,296 MPa, indicating comparatively lower stiffness and greater susceptibility to bending under load. Ilo, Onyia, and Onyejaka (2026) conducted a comparative investigation of the force-at-yield characteristics of veneered engineered wood (plywood) products available in the Nigerian market, with emphasis on their potential contribution to sustainable economic development. The one-way ANOVA identified a highly significant difference among the tested products, $F(2, 9) = 4.32 \times 10^6$, $p < 0.0001$. The mean force-at-yield values were 111.43 ± 0.13 N for Viewpoint, 210.78 ± 0.13 N for Plywood EQ, and 381.63 ± 0.13 N for Caledonian. Subsequent Tukey HSD multiple-comparison analysis confirmed statistically significant differences between every pair of products ($p < 0.0001$). Furthermore, the Cohen's *d* results indicated very large effect sizes, demonstrating that the observed differences were not only statistically significant but also substantial in practical terms. Ojo and Idieunmah (2021) reported a positive linear association, indicating that the compressive and shear strength of timber increase with age, with a corresponding, although comparatively moderate, improvement in bending strength. Similarly, Ilo, Emenike, and Oshim (2025), in their evaluation of the load–strain behaviour of marine-board engineered wood in the Nigerian economy, found that Super-Plex exhibited elongation-at-break values 61.37% and 117.96% greater than those recorded for Marine Plex and Nplex, respectively. Marine Plex also demonstrated a 35.07% higher elongation-at-break capacity than Nplex. Similarly, in a study evaluating the load–strain behaviour of veneered engineered wood (plywood) available in the Nigerian market, Ilo, Alumona, and Nwanjoku (2025) reported, based on statistical analysis, that Viewpoint exhibited a 119.51% greater elongation-at-break capacity than Caledonian and a 289.49% greater capacity than Plywood EQ. In comparison, the elongation-at-break performance of Caledonian exceeded that of Plywood EQ by 78.32%. In a more recent investigation of the flexural strength of marine board plywood within the Nigerian economy, Ilo, Ajibo, and Dim (2025a) found that

Marine Plex, Nplex, and Super Plex attained ultimate bending strengths of 17.96 N/mm², 21.502 N/mm², and 65.84 N/mm², respectively, with Super Plex demonstrating the highest peak flexural strength among the tested marine board plywood products. In their 2026 assessment of the energy-to-break performance of medium-density fibreboard (MDF) products marketed in Nigeria, Ilo, Ezirim, and Onwe reported a statistically significant difference in performance among the tested brands, $F(2,9) = 362,970$, $p < 0.0001$. The mean energy-to-break values were 0.5975 Nm for SGK NORDIC, 0.5795 Nm for RICHARD RUSSEL, and 0.1705 Nm for MDF HOKUSAN. Subsequent Tukey HSD analysis established that the differences between every pair of brands were statistically significant. The magnitude of the observed differences was also substantial, as Cohen's d exceeded 13 in all pairwise comparisons, demonstrating both statistical and practical importance. Furthermore, the coefficient of variation was below 1% for each brand, indicating very low variability within the individual groups. Ekundayo, Arum, and Owoyemi (2022) reported that glued laminated beams manufactured from locally sourced wood species and bonded with phenol–resorcinol–formaldehyde, urea–formaldehyde, and polyurethane adhesives exhibited significantly greater flexural strength than the control material (custom wood). This superiority was particularly pronounced when the beams were tested in the edgewise orientation. In a separate evaluation of the bending modulus of veneered engineered wood (plywood) products available in the Nigerian economy, Okoye, Ilo, and Chikelu (2025) established statistically significant differences among the tested products. Caledonian demonstrated a bending modulus 132.79% higher than Plywood EQ and 2155.50% higher than Viewpoint, whereas Plywood EQ exceeded Viewpoint by 868.89% in bending modulus performance. In an experimental study examining the flexural performance of plywood products within the Nigerian commercial sector, Ilo, Ajibo, and Dim (2025b) reported distinct maximum stress capacities among the tested materials. Viewpoint plywood exhibited a modulus of rupture (MOR) of 4.956 N/mm², whereas Plywood EQ and Caledonian achieved values of 9.467 N/mm² and 16.973 N/mm², respectively. These values represent the maximum bending stresses that each plywood product could sustain before structural failure or rupture, with Caledonian demonstrating the greatest resistance to bending-induced failure. Agina, Ilo, and Ezirim (2026) evaluated the energy-to-break characteristics of three commonly used high-density fibreboard (HDF) engineered wood products available in the Nigerian market. Their findings showed that Sinoply recorded the highest energy-to-break value at 10.88725 N·m, indicating the greatest toughness, impact resistance, and durability among the tested products. Dabar exhibited an intermediate value of 0.67175 N·m, suggesting a comparatively balanced behaviour between toughness and brittleness. Joubert recorded the lowest energy-to-break value, 0.588 N·m, implying that it may be more appropriate for applications in which high toughness is not a primary performance requirement. Iloabachie, Obiorah, and Anene (2018), in examining the influence of carbonized coconut shell (CS) volume fraction on the mechanical behaviour of unsaturated polyester resin (UPR) composites, observed that both flexural strength and elongation at break increased progressively with increasing coconut shell content. In a separate hardness assessment of veneered engineered wood (plywood) products available in the Nigerian market, Ilo, Uro, and Edeh (2025) reported differences in hardness among the tested products. Plywood EQ recorded the highest aggregate mean hardness value of 459.25 HLD, followed by View Point at 456.5 HLD, while Caledonian had the lowest value of 407.5 HLD on the Leeb Hardness Test scale. In a statistical evaluation of the load–strain behaviour of high-density fibreboard (HDF) engineered wood products marketed in Nigeria, Ilo, Nwachi, and Chukwunyere (2025) reported substantial differences in elongation-at-break performance among the tested products. Sinoply demonstrated an elongation capacity 544.89% greater than that of Dabar and 507.44% higher than that of Joubert, giving it a clear performance advantage. By comparison, Joubert exceeded Dabar in elongation-at-break capacity by only 6.16%. Similarly, Iloabachie et al. (2017), while investigating the influence of particle size on the ultimate tensile strength, flexural strength, density, and water absorption of uncarbonized coconut shell/unsaturated polyester composites, found that the 425 µm particle-size composite achieved its maximum flexural and ultimate tensile strengths at a 20 wt% composition. In an investigation of the force-at-yield performance of marine board engineered wood products available in Nigeria, Ilo, Ezirim, and Obiokoye (2026) reported that Super-Plex demonstrated substantially superior performance, exceeding Marine Plex and Nplex by factors of 3.6 and 8.4, respectively. The one-way ANOVA revealed a highly significant difference among the tested products, $F(2,9) = 51,989,700$, $p < 0.0001$. Consistent with this finding, Tukey's HSD post-hoc analysis showed that all pairwise comparisons were statistically significant at $p < 0.0001$. Furthermore, Cohen's d analysis indicated extremely large effect sizes, confirming that the observed differences were not only statistically significant but also practically substantial. Ihueze, Achike, and Okafor (2016), in their investigation of the performance characteristics of coconut-fibre-reinforced high-density polyethylene (HDPE) polymer composites, reported an optimum flexural strength of 28.6 MPa. This value was obtained under the optimum combination of coconut-fibre filler volume fraction and particle size, demonstrating the mechanical performance achievable through the appropriate reinforcement of HDPE with coconut fibre. In a comparative assessment of the bending modulus of three widely used high-density fibreboard (HDF) engineered wood products in the Nigerian market, Okoye, Ilo, and Ozono (2026) examined their mechanical performance to provide technical information for informed material selection and contribute to sustainable economic development. Dabar exhibited the greatest bending modulus, approximately 14,282 MPa, indicating the highest stiffness and making it particularly suitable for applications requiring substantial strength and rigidity, including certain structural applications. Joubert recorded the lowest value, approximately 9,862 MPa, reflecting greater flexibility and potential suitability for applications involving curved or more adaptable designs. Sinoply occupied an intermediate position, with a bending modulus of approximately 10,674 MPa, representing a balance between stiffness and flexibility. Ilo, Ezirim, and Ozono (2026) evaluated the energy-to-break performance of marine board engineered wood products available in Nigeria and observed a clear ranking among the tested materials. Super-Plex recorded the highest mean energy-to-break value ($M = 3.32$, $SD = 0.005$ N·m), followed by Marine-Plex ($M = 1.48$, $SD = 0.004$ N·m) and Nplex ($M = 1.24$, $SD = 0.029$ N·m). Similarly, in a statistical investigation of the load–strain behaviour of medium-density fibreboard (MDF) engineered wood products in Nigeria, Ilo, Okoye, and Ugama (2025) reported that MDF Hokusan exhibited a 35.9526% greater elongation-at-break capacity than Richard Russel and a 57.8750% greater capacity than SKG Nordic. Richard Russel, in turn, exceeded SKG Nordic by 16.1250% in elongation-at-break performance, indicating a comparatively lower advantage over the latter than that demonstrated by MDF Hokusan. Aziz et al. (2015), in examining the effect of activated-carbon filler on the mechanical performance of wood-based composites, reported that the MDF composite specimens exhibited greater strength than the corresponding plywood specimens. This enhanced performance was attributed to the increased thickness of the activated-carbon filler incorporated into the composite material. In a hardness assessment of medium-density fibreboard (MDF) products available in the Nigerian economy, Eze, Ilo, and Dim (2025a) reported variations in Leeb hardness among the tested brands. SGK Nordic recorded the highest aggregate mean hardness value of 558.50 HLD, followed by Richard Russel at 545.75 HLD and Hokusan at 535.75 HLD. Similarly, Ilo, Nweke, and Nebo (2025), in their evaluation of the hardness characteristics of marine board products in Nigeria, found that Nplex achieved the highest aggregate mean hardness of 392.25 HLD. Super-Plex and Marine Plex recorded lower mean values of 370.75 HLD and 364.50 HLD, respectively. In their appraisal of marine board engineered wood products available in the Nigerian market, Okoye, Ilo, and Kanu (2025) reported statistically significant differences in bending modulus among the tested materials. Marine Plex exhibited a bending modulus 19.60% higher than that of Super-Plex and 163.66% higher than that of Nplex, indicating superior stiffness relative to both products. Super-Plex also demonstrated a 120.45% advantage in bending modulus over Nplex, placing it above Nplex in terms of bending performance. Akinyemi, Afolayan, and Oluwatobi (2016) investigated composite particleboards produced from corn cob (CC) and sawdust (SD), incorporating 0%, 25%, 50%, 75%, and 100% proportions of each agricultural residue while maintaining a constant board volume and using formaldehyde as the binder. Their findings indicated that the formulation containing 50% CC produced the most favourable overall performance in terms of both physical and mechanical properties. Similarly, in a hardness assessment of high-density fibreboards within the Nigerian economic sector, Eze, Ilo, and Dim (2025b) reported mean Leeb hardness values of 526.50 HLD for Dabar, 547.50 HLD for Sinoply, and 548.50 HLD for Joubert. In an investigation of the flexural strength of high-density fibreboard (HDF) engineered wood products in the Nigerian economy, Ilo, Nneji, and Igede (2025) reported peak flexural strength values of 15.604 N/mm² for Joubert HDF, 32.604 N/mm² for Dabar HDF, and 39.248 N/mm² for Sinoply HDF. Descriptive analysis of energy-to-break data obtained from veneered engineered wood (plywood) products in the Nigerian commercial sector revealed statistically significant differences among the tested groups. The results of the analysis of variance (ANOVA) showed a significant difference, $F = 7938.6$, $p < 0.001$, which was further supported by the Kruskal–Wallis test, $H = 10.26$, $p = 0.0059$. Caledonian recorded the highest mean energy-to-break value (2.836 ± 0.042 N·m; CV = 1.49%), followed by View Point (2.234 ± 0.003 N·m; CV = 0.12%), whereas Plywood EQ exhibited the lowest value (0.484 ± 0.006 N·m; CV = 1.29%). Post-hoc analysis further established that Plywood EQ differed significantly from both Caledonian and View Point (Ozono, Ilo, and Onyejaka, 2026). Therefore, the force-at-yield performance of Medium-Density Fibreboard (MDF) products in the Nigerian economy remains relatively under-investigated. The need to provide technical insight into the force-at-yield characteristics of MDF products available in the Nigerian market is consequently significant. Accordingly, this study contributes to addressing the identified gap in the literature.

III. Materials and Method

Materials

Three prevalent MDF brands were examined to determine their respective force-at-yield performances. The brands are MDF Hokusan, SGK Nordic and Richard Russel as detailed in table 1.

TABLE 1: Tested Brands of Medium-Density Fibreboards (MDF)

SAMPLE	X	Y	Z
MAKE	SGK Nordic	MDF Hokusan	Richard Russel

Equipment

In conformity with the requirements of ASTM D1037, the test specimens were prepared and tested using a Testometric universal testing machine. Quasi-static three-point bending tests were conducted using a centre-point loading configuration at a crosshead speed of approximately 5 mm/min (±50%). The tests were performed under controlled laboratory conditions at a relative humidity of 65% ± 5% and a temperature of 27 ± 1°C, with minimal vibration. The specimens were confirmed to have comparable density and moisture content prior to testing. Moisture content was determined using the oven-dry method in accordance with ASTM D4442, which provides a direct measurement of the moisture content of wood and wood-based materials. The specimens were conditioned to an approximate moisture content (MC) of 8–10% in accordance with ASTM D1037. The quasi-static tests were conducted using the Testometric testing machine shown in Figure 1. During testing, the machine's downward-moving jaw applied load to each specimen, and the resulting resistance of the material was recorded to generate the Force-at-Yield data. Following careful specimen preparation, all samples were tested sequentially using the Testometric machine in accordance with the specified testing procedure. Four replicate tests were conducted for each sample, and the resulting Force-at-Yield values were aggregated to obtain the average statistical values. In addition, computer-based analysis of the digital data generated during testing was used to produce the Force-at-Yield plots, illustrating the force-response behaviour of the specimens throughout the test. The resulting plots, which reflect the compositional characteristics and inherent properties of the samples, provide a clear indication of the force required to initiate plastic deformation in the materials. A one-way analysis of variance (ANOVA) was conducted at a significance level of $\alpha = 0.05$ to determine whether statistically significant differences existed among the samples. Following the ANOVA, Tukey's post-hoc test was performed for pairwise comparisons, while Cohen's *d* was used to quantify the effect sizes of the observed differences. The statistical analyses and the generated Force-at-Yield plots are presented and discussed in the Results and Analysis section.

Fig. 1: *The Testometric Universal Testing Machine*

IV. Result and Analysis

Force-at-yield performance characteristics are indicated in figures 2, 3 and 4 respectively for SGK Nordic, MDF Hokusan and Richard Russel brands. Figure 5 uncovers the average of their aggregate. One way ANOVA test, Tukey's Honestly Significant Difference (HSD) post-hoc analysis and Effect Size-Cohen's *d* are respectively analyzed in tables 2, 3 and 4.

Figures

Data for four study conducted on SGK Nordic presented in figure 2 shows a low of variation implying brand homogeneity. This is evident in the average of the aggregate.

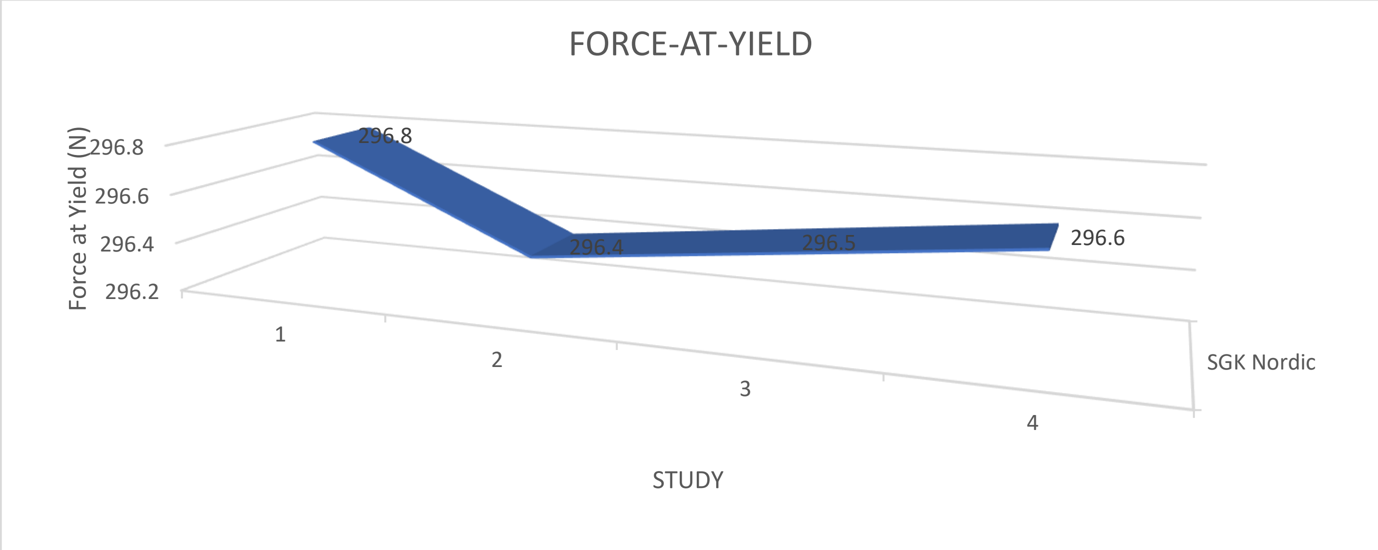

Figure 2: *SGK Nordic Force-at-Yield Results*

Data for four study conducted on MDF Hokusan presented in figure 3 shows that there is no wide spread of results indicating brand's obvious force-at-yield pattern. This is evident in the average of the aggregate.

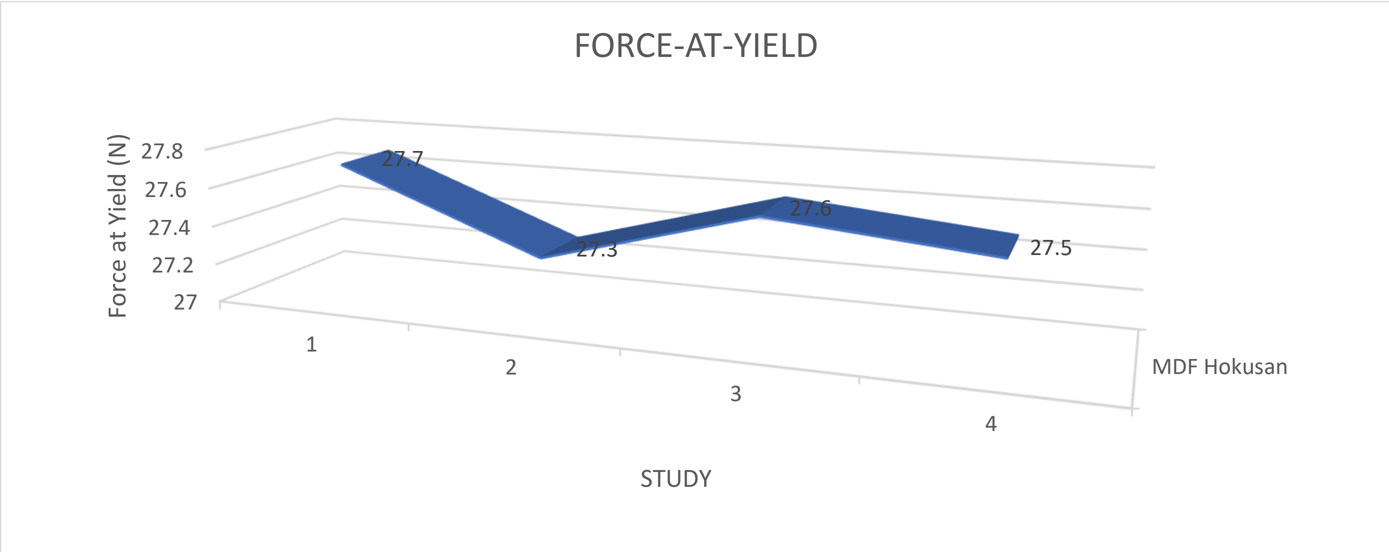

Figure 3: *MDF Hokusan Force-at-Yield Results*

Data for four study conducted on Richard Russel presented in figure 4 shows that there is no wide spread of results indicating brand's apparent force-at-yield pattern. This is evident in the average of the aggregate.

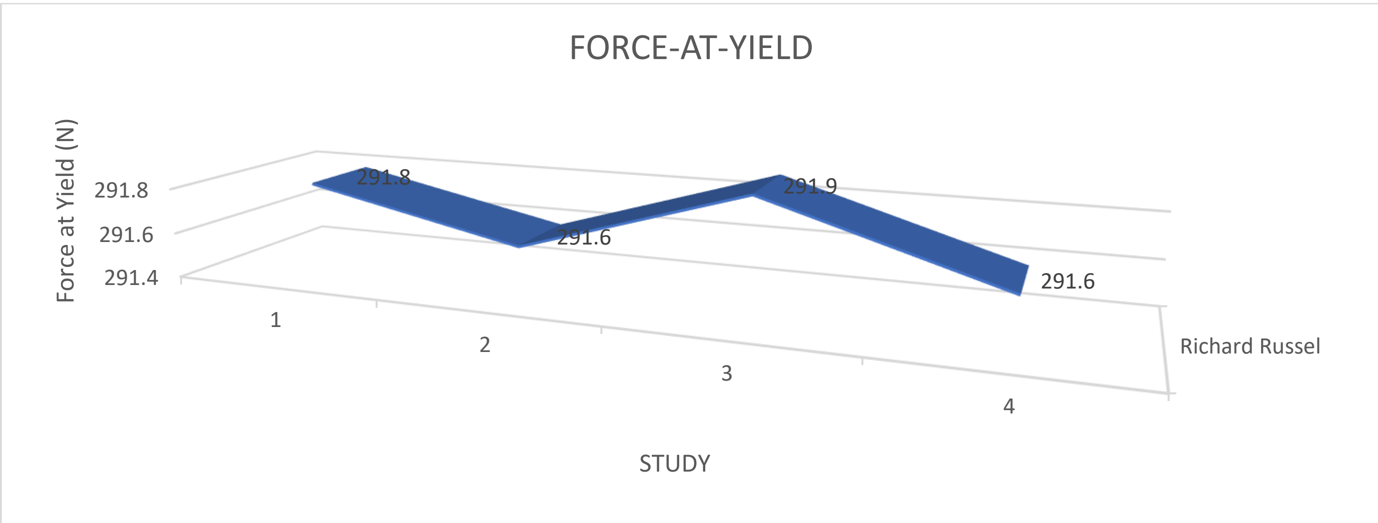

Figure 4: *Richard Russel Force-at-Yield Results*

Study on SGK Nordic, Richard Russel and MDF Hokusan is shown in figure 5 below indicating average of the aggregate reported. This shows the much-needed force for plastic deformation to be attained. By substantial margin, the highest force-at-yield was recorded by SGK Nordic having about 1.0166 times that of Richard Russel and about 10.7747 that of MDF Hokusan making SGK Nordic have superior load-bearing potentials without irreversible droop or ding.

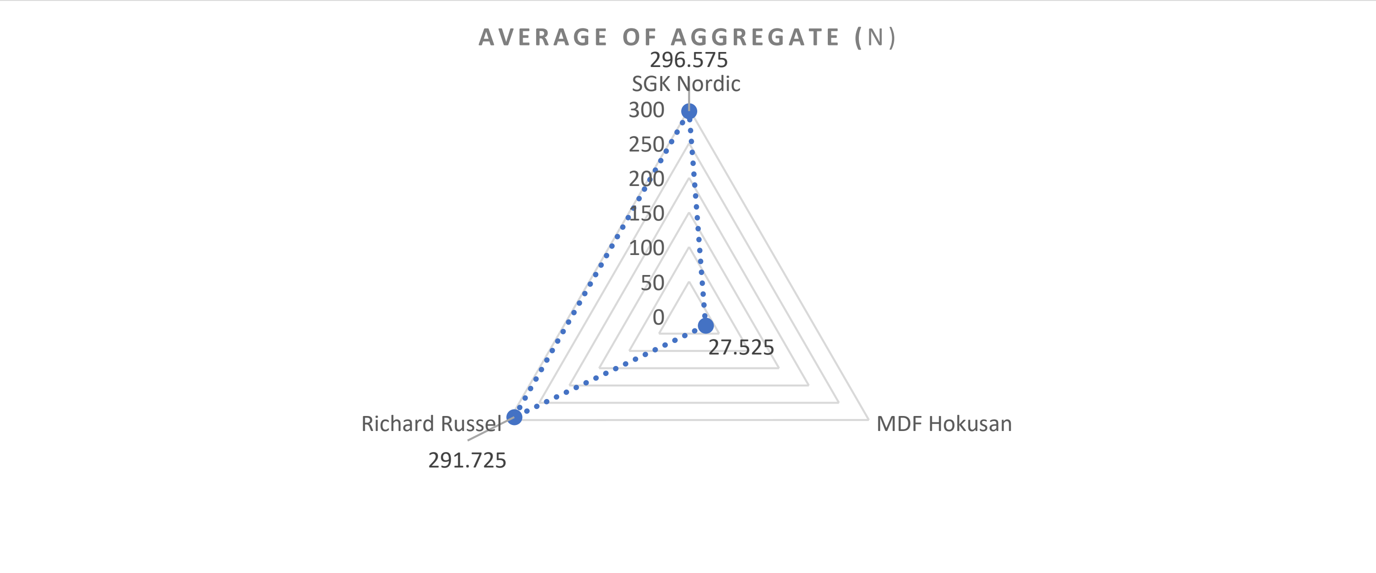

Figure 5: *SGK Nordic, MDF Hokusan and Richard Russel Force-at-Yield Average of Aggregate*

TABLE 2: *Medium-Density Fibreboard (MDF) One-Way ANOVA for Force-at-Yield*

Source of Variation	Sum of Squares (SS)	Df	Mean Square (MS)	F	p-value
Between Groups	**177,936.17**	**2**	**88,968.08**	**3,518,673.77**	**$3.03*10^{-27}$(<0.001)**
Within Groups (Error)	**0.2275**	**9**	**0.02528**	**-**	**-**
Total	**177,936.40**	**11**	**-**	**-**	**-**

A statistically significant difference at α=0.05 significance level is observed in table 2 for the mean force-at-yield among the three brands. One way analysis on variance ANOVA reveals F statistic 3,518,673.77, p<0.001. The huge F-value and near-zero p-value is an indication difference between samples is massively larger than the variation within each sample. It is evident with MDF Hokusan being approximately 10 times lower than SGK Nordic and Richard Russel, while the within-group variation is tiny.

TABLE 3: *Tukey HSD Test Result for Post Hoc Analysis*

SAMPLES COMPARED	Mean Difference (N)	p-value	Significant?
MDF Hokusan vs Richard Russel	**264.20**	**<0.001**	**Yes**
MDF Hokusan vs SGK Nordic	**269.05**	**<0.001**	**Yes**
Richard Russel vs SGK Nordic	**4.85**	**<0.001**	**Yes**

Tukey Honestly Significant Difference (HSD) Post-hoc analysis in table 3 shows that the differences are clearly statistically significant and that at p <0.001, all pairwise comparisons were statistically significant. Honestly Significant Difference (HSD) Value at α=0.05 is approximately ≈ 0.31N. All three differences are far above this, so all pairs are significantly different. Ranked by force-at-yield, SGK Nordic is greater than Richard Russel and far greater than MDF Hokusan and each difference is statistically significant. The gap between SGK Nordic and Richard Russel is small at 4.85N, but it is real and consistent given the low within-group variance.

TABLE 4: Effect Size-Cohen's d

SAMPLES COMPARED	Cohen's *d*	Interpretation
SGK Nordic vs MDF Hokusan	**1575.40**	**Extremely large**
SGK Nordic vs Richard Russel	**30.18**	**Extremely large**
MDF Hokusanvs Richard Russel	**1643.78**	**Extremely large**

Cohen's *d* values evident in table 4 ranged from 30.18 to 1643.78 far exceeding the benchmark value of 0.8 for large effect demonstrating extremely large effect sizes between compared groups. The tiny within-group variance makes the effect sizes huge, even for the 4.85N gap between SGK Nordic and Richard Russel.

V. Conclusion and Recommendation

Among the evaluated products, SGK Nordic recorded the highest mean force-at-yield, followed by Richard Russel, then MDF Hokusan. The coefficients of variation for all brands were below 1%, demonstrating excellent repeatability and reliability of the experimental measurements. In addition, the extremely large Cohen's *d* values indicate the observed differences among the MDF brands were beyond mere statistical significance but also practically substantial. The calculated F statistic (3,518,673.77) exceeded the critical F value (4.26) at $\alpha=0.05$. Overall, the findings demonstrate that commercially available MDF products in the Nigerian market differ markedly in their resistance to yielding. These results provide valuable information for manufacturers, engineers, builders, furniture producers, and consumers when selecting MDF for applications where mechanical performance and structural reliability are important, especially in the medically non-invasive supportive devices. Engineers, furniture manufacturers, builders, and consumers should consider the mechanical performance of MDF when selecting materials for structural and load-bearing applications and especially in medically non-invasive supportive devices. Based on the force-at-yield results, SGK Nordic should be most preferred for applications requiring higher resistance to yielding. Further studies should focus on evaluating the force-at-yield performance of other engineered wood products widely used in Nigerian commercial sector insufficiently investigated.

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