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Influential Parameters and Multi Objective Optimization of Bagasse and Palm Kernel Natural Fibre Plates Using Taguchi Assisted Topsis

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Abstract: *Composites that have a good to lower weight ratio can be used to replace conventionally used Engineering Materials. The properties of natural fibers are almost equal to that of artificial fibres. Natural fibers can be used in many applications and is also a cost-effective material. Bagasse fibre reinforced with dry palm kernel fibre powder is used to improve mechanical properties and fabricated in plate form. In this research work, the input constraints that have been used to fabricate the plate are 10, 20, 30 wt% of bagasse fibre, 10, 20, 30 wt% of palm kernel fibre, at 10, 15, 20 MPa compression pressure and 2, 4, 6 mm of speciemn thickness respectively. The optimization has been performed by Taguchi L27 orthogonal array and influence of output parameters viz. Tensile Strength (MPa), Flexural Strength (MPa) and Hardness (Hv) have been measured by using statistical analysis of variance. The multi-criteria decision making of the output parameters has been performed by Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). This research offers new insight into decision-making, particularly in the optimization part, to increase the strength and mechanical property of natural fiber composites.*

Keywords: *vinyl ester resin, bagasse fibre, palm kernel fibre, TOPSIS, Taguchi, ANOVA*

1. Introduction

A lot of research has recently been performed on natural fibres to predict mechanical and microscopic properties for engineering applications [1-3]. The primary use of composite involves replacing the metal in many applications and reducing the weight of costs. Compared to artificial fibres, these natural fibres are relatively reliable and can also be used for specific structural applications. The fibre quality also relies on the matrix medium for the use of epoxy or polyester resin. This paper assesses the mechanical characteristics of the hybrid natural Fibre of various particle sizes comprising an equal share of bagasse and palm kernel fibres [4, 5]. The particulate composites are categorized in which specific structural applications may be used. These natural fibres are derived from agro-waste and agro-residues. For particular applications, it is obtained at low-cost [6,7]. In both artificial and natural fibres, recent research on micro-components is becoming popular. Typically, in different technological applications, synthetic fibres like carbon and glass fibres are commonly used because their mechanical strength and thermal properties are substantial. These had a significant drawback and the storage of incinerators could lead to environmental issues. That is an environmentally friendly composite in the case of natural Fibre [8,9]. These shell fibres are used for the manufacture of natural hybrid composite in the bagasse and palm kernel. The Bagasse is a natural fibres that is produced by removing sugarcane from a palm kernel shell. Latest bagasse fiber research forecasts strong wear and low water absorption properties. The shell fiber Palm Kernel also has strong wear. The decrease in particle size gives the fibre a certain degree of strength to the mechanical characteristic [10 -13]. Also, the palm kernel shell has been considered as wastage and this was utilized sustainable and natural porous activated carbon in batteries [14-16]. Hence, both bagasse fibres and palm kernel shell are considered as a waste recycling fibre.

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So, this is the main outcome of this research work and study has been conducted on the properties of the processed natural hybrid composite in various particle sizes to microns.

2. Materials and methods

2.1. Materials

The materials used for fabrication of plate structure hybrid natural composites are Bagasse fibre and Palm Kernel Shell fibre in a powder form. Vinyl ester resin is used as a binder during the fabrication process. The proportions of Bagasse fibre consist of 46%-57% water, 43%-53% content of Fibre and 2%-6% Sugar. Here, Sugar which is rich in sucrose is also a binding component that has a molar mass of 330.29 g/mol and 1.6 g/cc density. It consists of mainly cellulose 1.25% of pentosans and lignin. The palm kernel is the natural edible content of the palm seed. In this research work, the shell of the palm seed is used to fabricate the plate. A fresh palm fruit bunch contains 30% palm oil, 8% palm kernel, 10% shell, 16% fibre, and rest of the fruit bunch material. The materials are powder in 150-micron size and it is binded using a Vinyl ester resin which is unsaturated type of thermoset matrix capable of being cured to a solid state when a proper proportionate of promoter and catalyst is added. Further, Di-Methyl Acetamide which has the density of 0.94 g/cc that act as a promoter and Cobalt Napthalate which has 0.98 g/ccdensity act as an accelerator are added to the mixture. Methyl Ethyl Ketone Peroxide which has density of 1.17 g/cc acts as a catalyst. Figure 1 Shows the pictorial representation of hybrid natural Bagasse and palm kernel fibre at 150-micron size. The powder of natural Fibre has been taken and mixed and fabricated as per the requirement of Design of experiments (DoE). The fabrication was performed by traditional Hand lay-up method. Figure 2 shows the mould box used for the fabrication of natural composite patterns [17]. The test coupon for material characterization is to be cut as per ASTM standard from the fabricated laminate.

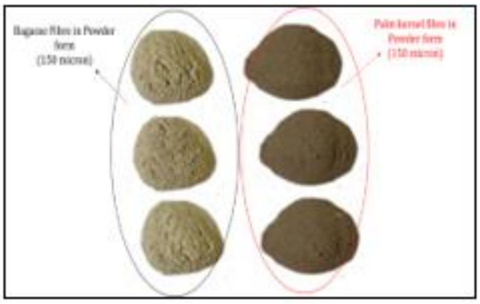

Figure 1. Bagasse Fibre powder and Palm Kernel shell powder at 150-micron size

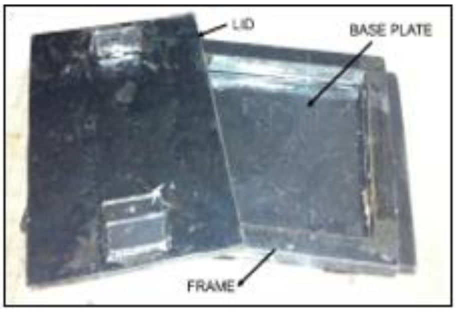

Figure 2. Conventional Mould box for fabricating natural composites

2.2. Optimization

From this research investigation, the optimization has been performed by Taguchi and parameters for tensile strength, flexural strength and Hardness had been performed by ANOVA. The tensile strength had been performed using a Universal Testing Machine with the ASTM D3039 standards. The flexural strength has been performed using a Flexural Testing Machine to ASTM D790 standards. The Hardness test was performed to ASTM E92 standard on Vickers hardness testing machine [18]. In this research work, twenty-seven samples have been designed to analyze the feasibility of Tensile strength (MPa), Flexural Strength (MPa) and Hardness (Hv). The factors and levels of input parameters have been shown in Table 1. The overall multi-criteria decision-making analysis has been performed by using technique for order preference by similarity to ideal solution.

Table 1. Desired factors and corresponding levels for DoE

Factors	Level 1	Level 2	Level 3
wt% of Bagasse	10	20	30

wt% of Palm Kernel	10	20	30
Compression Pressure (MPa)	10	15	20
Thickness (mm)	4	5	6

3. Results and discussions

In this research investigation, the weight percentage of Bagasse fibre, weight percentage of palm kernel, compression pressure (MPa) and the Thickness of the plate are taken as a input constraints and the tensile strength (MPa). Flexural Strength (MPa) and Hardness are the output parameters. The variation of input parameters strongly influences better output parameter values. Table 2 reveals that the experimental values of the input parameters and the output constraints.

Table 2. Input and output values of bagasse and Palm Kernel fibres

Ex. No	**wt% of Bagasse**	**wt% of Palm Kernel**	**Compression Pressure, (MPa)**	**Thickness (mm)**	**Tensile Strength, (MPa)**	**Flexural Strength, (MPa)**	**Hardness (Hv)**
1	10	10	10	4	73.59	94.13	79.77
2	10	10	15	5	74.34	95.59	80.20
3	10	10	20	6	75.10	97.04	80.74
4	10	20	10	5	76.77	98.68	82.35
5	10	20	15	6	77.52	100.14	82.84
6	10	20	20	4	74.54	96.19	80.25
7	10	30	10	6	79.95	103.30	85.05
8	10	30	15	4	76.97	99.28	82.49
9	10	30	20	5	77.72	100.73	83.03
10	20	10	10	4	76.12	97.69	82.05
11	20	10	15	5	76.88	99.14	82.49
12	20	10	20	6	77.63	100.60	82.98
13	20	20	10	5	79.30	102.24	84.64
14	20	20	15	6	80.06	103.69	85.13
15	20	20	20	4	77.08	99.74	82.50
16	20	30	10	6	82.48	106.79	87.33
17	20	30	15	4	79.50	102.84	84.78
18	20	30	20	5	80.26	104.29	85.20
19	30	10	10	4	78.66	101.24	84.34
20	30	10	15	5	79.41	102.70	84.78
21	30	10	20	6	80.16	104.15	85.18
22	30	20	10	5	81.84	105.79	86.93
23	30	20	15	6	82.59	107.25	87.42
24	30	20	20	4	79.61	103.23	84.83
25	**30**	**30**	**10**	**6**	**85.02**	**110.34**	**89.62**
26	30	30	15	4	82.04	106.39	86.98
27	30	30	20	5	82.79	107.84	87.47

From the above table, the optimum joint strength has been achieved using the input parameters viz. 30% of Bagasse fibre, 30% of palm kernel fibre, 10 MPa of compression pressure and 6 mm plate thickness. The consolidated tensile strength value is 85.02 MPa, Flexure strength of 110.34 MPa and the 89.62 Vickers Hardness value. The least amount has been occurred using 10% of Bagasse fibre and 10% palm kernel fibre. So, the most convincing parameter is the weight percentage of the fibres.

3.1. Influence of tensile strength

From the Signal to Noise ratio's main effects plot, the signal desires the valuable noise that the most convincing parameter is 30% of bagasse fibre. The mean value achieved in this rational value is 38.20 at the third level-the delta value of the wt% of bagasse fibre almost 0.56. Further, the weight percentage of kernel fibre achieves maximum strengths and Hardness when the fibre parameter is 30%. The mean value achieved in this rational sequence is about 38.14 at the third level. The sample's compression pressure should be minimum that reveals by 10 MPa and the mean value is achieved as 37.97 at the first level. The Thickness of the plate should be maximum and this indicates by 6 mm and the mean value is committed as 38.06 at the third level. Figure 3 shows that the graph plot of SN ratio calculated at larger is better criteria. The minimum compression pressure ratio and the overall plate thickness reach optimal tensile strength, flexural strength and stiffness if the maximum weight percentage of all fibers is obtained. Table 3 reveals the response values for the graph plot of the SN ratio [19-22].

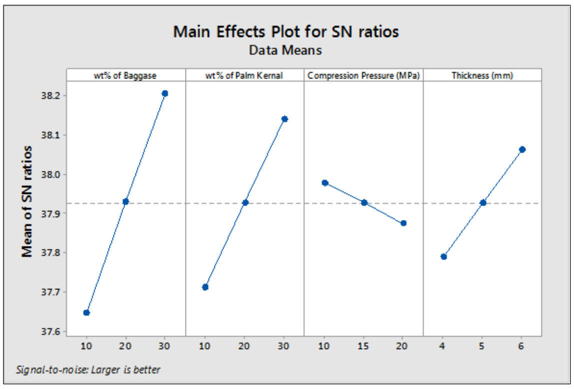

Figure 3. Graph plot of SN ratio in Larger is better criteria

Table 3. Response value of graph plot

Level	wt% of Bagasse	wt% of Palm Kernel	Compression Pressure, (MPa)	Thickness, (mm)
1	37.65	37.71	37.98	37.79
2	37.93	37.93	37.93	37.93
3	38.20	38.14	37.87	38.06
Delta	0.56	0.43	0.10	0.27
Rank	**1**	**2**	**4**	**3**

From Table 4, the variance of process parameters had been analyzed and the contribution of process parameters is calculated showing the main effect plots and ANAOVA. The most contributing parameter is the weight percentage of the bagasse fibres. Where the weight percentage of the bagasse Fibre contributes 53.7%, followed by the weight percentage of the palm kernel Fibre contributes 31.35%. The plate's thickness secures the third plate in contributing parameters, and the compression pressure is the least contributed. From the ANOVA table, it is proven that the contribution of weight percentages of Fibre contribute more compared with the other two factors.

Table 4. Analysis of variance of natural fibre composites

Source	DF	Adj SS	Adj MS	Percentage of contribution
wt% of Bagasse	2	115.581	57.7904	53.71
wt% of Palm Kernel	2	67.466	33.7329	31.35
Compression Pressure (MPa)	2	4.313	2.1565	2.00

Thickness (mm)	2	27.856	13.9278	12.94
Error	18	0.000	0.0000	0
Total	26	215.215		100

The R-sq value from Table 5 shows 100%, which means the mean effects value's statistical measure is close to the fitness function. The adjacent value and predicted values are also 100%, proving the value of mean effects and SN ratio closeness to the fitted regression function.

Table 5. Summary of main effects plot and ANOVA

S	R-sq	R-sq(adj)	R-sq(pred)
0	100.00%	100.00%	100.00%

Figure 5 reveals the interaction of the process parameters concerning the tensile strength values. The weight percentage of the bagasse fibre from the third level depends on the reaction of the weight percentage of the palm kernel fibre, compression pressure and Thickness of the plates.

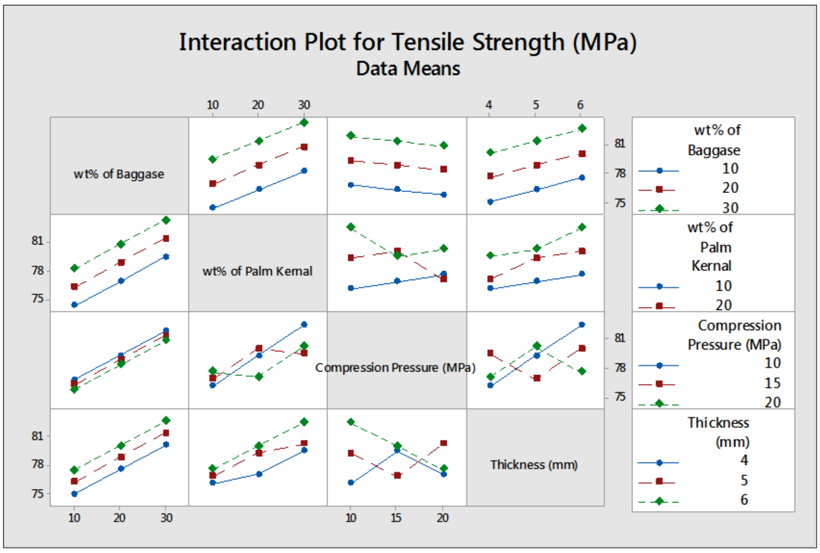

Figure 5. Interaction plot for the data means the value of tensile strength

3.2. Influence of flexural strength

The mean value achieved by the SN ratio chart in this rational value is 40.46 in 30 wt% of bagasse fibre. The deviation value between the parameters is 0.61 and this contributes to the most influencing parameters. At the same time, the palm kernel achieved the maximum level. The contact pressure reaches a minimum level, and the plate's Thickness should be leading to achieve optimum flexural strength. Figure 6 shows the graph plot of SN ratio and Table 6 displays the response table of the graph plot.

The variance of the parameters has been analyzed, the contribution of the process parameters is maximum at the wt% of the Bagasse (53.43%), followed by the wt% of the palm kernel (32.12%). This is followed by the Thickness of the plate (13.919%). In this research work, the error percentage is very minimum. Table 7 shows the ANOVA of natural fibre composites regarding flexural strength [23-25].

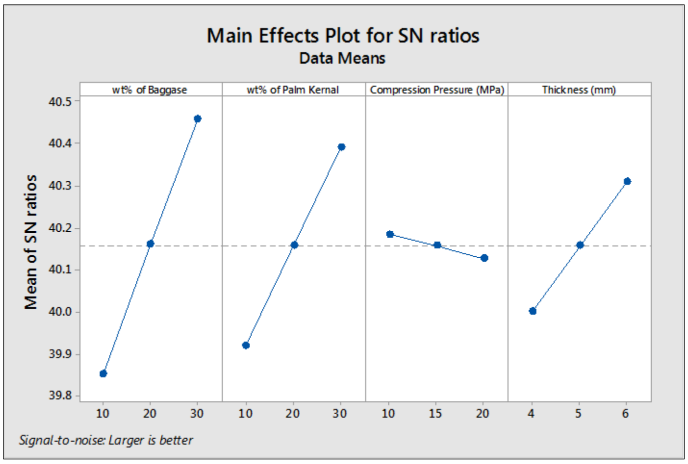

Figure 6. Graph plot of SN ratio in Larger is better criteria (Flexural strength)

Table 6. Response value of graph plot (flexural strength)

Level	wt% of Bagasse	wt% of Palm Kernel	Compression Pressure, (MPa)	Thickness (mm)
1	39.85	39.92	40.18	40.00
2	40.16	40.16	40.16	40.16
3	40.46	40.39	40.13	40.31
Delta	0.61	0.47	0.06	0.31
Rank	1	2	4	3

Table 7. Analysis of variance of natural fibre composites (flexural strength)

Source	DF	Adj SS	Adj MS	Percentage of Contribution
wt% of Bagasse	2	226.540	113.270	53.43
wt% of Palm Kernel	2	136.203	68.101	32.12
Compression Pressure (MPa)	2	2.273	1.137	0.53
Thickness (mm)	2	58.930	29.465	13.919
Error	18	0.005	0.000	0.001
Total	26	423.951		100

Table 8 shows the summary of the main effects plot with respective flexure strength. Figure 7 reveals the interaction of the process parameters with respect to the tensile strength values. The response of the weight percentage of the bagasse fibre from the third level depends on the response of the weight percentage of the palm kernel fibre, compression pressure and Thickness of the plates.

Table 8. Summary of main effects plot and ANOVA (flexure strength)

S	R-sq	R-sq(adj)	R-sq(pred)
0.0165279	100.00%	100.00%	100.00%

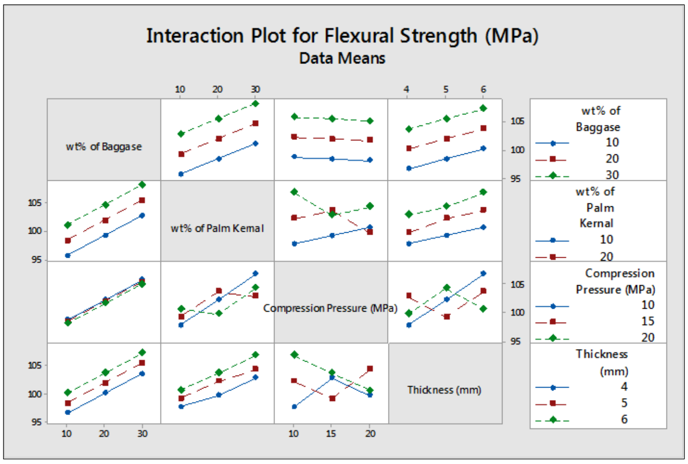

Figure 7. Interaction plot of data means flexural strength

3.3. Influence of hardness

The hardness influences the main effects plot by the mean value achieved in this rational value is 38.75 in 30 wt% of bagasse Fibre. The deviation value between the parameters was 0.47 and this contributes the most influencing parameters, whereas the palm kernel achieved the maximum level at 30 wt%. The contact pressure achieves a minimum level and the Thickness of the plate should be maximum to achieve optimum Hardness. Figure 8 shows the graph plot of SN ratio and Table 9 shows the response table of graph plot.

Table 9. Response value of graph plot (Hardness)

Level	wt% of bagasse	wt% of Palm Kernel	Compression pressure, (MPa)	Thickness (mm)
1	38.26	38.33	38.55	38.39
2	38.50	38.49	38.50	38.49
3	38.73	38.66	38.44	38.60
Delta	0.47	0.34	0.11	0.21
Rank	1	2	4	3

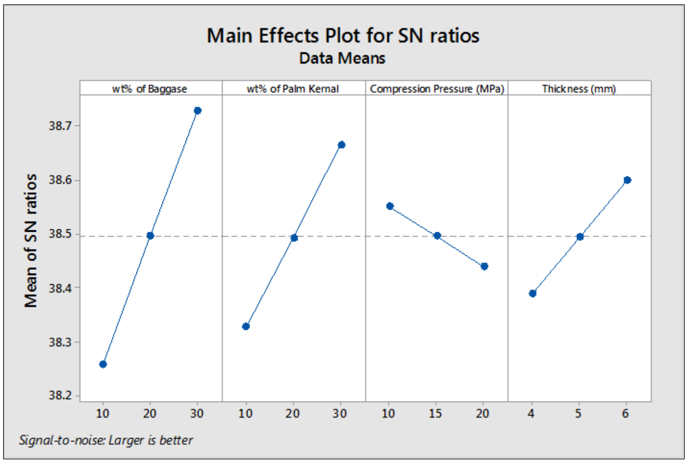

Figure 8. Graph plot of SN ratio in Larger is better criteria (Hardness)

The variance of the parameters has been analyzed; the process parameters' contribution is maximum at the wt% of the Bagasse (56.22%), followed by the wt% of the palm kernel (29.19%). This is followed by the Thickness of the plate (11.29%). In this research work, the error percentage is very minimum. Table 10 shows the ANOVA of natural fibre composites regarding Hardness and Table 11 shows a summary of the main effects plot with respective Hardness. The hardness results imitated the general results obtained when natural fibers are reinforced with polymers [26].

Table 10. Analysis of variance of natural fibre composites in Hardness aspects

Source	DF	Adj SS	Adj MS	Percentage of contribution
wt% of Bagasse	2	92.698	46.3489	56.22
wt% of Palm Kernel	2	48.128	24.0638	29.19
Compression Pressure (MPa)	2	5.440	2.7201	3.29
Thickness (mm)	2	18.580	9.2900	11.29
Error	18	0.022	0.0012	0.01
Total	26	164.867		100

Table 11. Summary of main effects plot and ANOVA (Hardness)

S	R-sq	R-sq(adj)	R-sq(pred)
0.0348821	99.99%	99.98%	99.97%

Figure 9 reveals the interaction of the process parameters concerning the tensile strength values. The weight percentage of the bagasse fibre from the third level depends on the response of the weight percentage of the palm kernel fibre, compression pressure and Thickness of the plates.

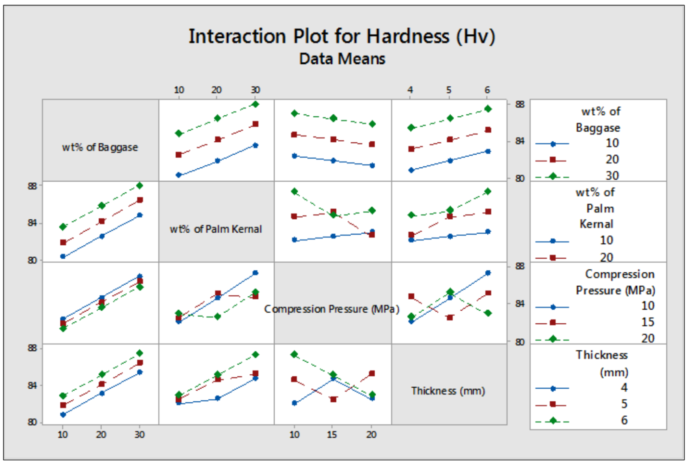

Figure 9. Interaction plot of data means Hardness

3.4. Multi criteria decision making using TOPSIS

TOPSIS is formulated by defining two points of reference, a positive and negative ideal solution. The optimistic approach maximizes the desirable constraints and minimizes the non-desirable criteria. The pessimistic approach, on the other hand, maximizes the non-desirable constraints and minimizes the desirable criteria. The TOPSIS approach determines the best option in a decision-making problem, reducing the optimum solution's difference maximizing the optimal negative solution's distance. This approach is expected to increase or decrease per attribute/criterion monotonically. The Euclidian distances of alternatives are essentially calculated with its beneficial ideal and negative ideal solution and the preferential order of the alternatives is given when comparing the Euclidian distances. The TOPSIS process's proper steps are presented briefly in this regard.

Step I: The values of the optimized output constraint are normalized decision elements for violating the units. The normalized matrix has been calculated using the direct output constraints shown in Equation 1.

$$n_{matrix} = \frac{d_{matrix}}{\sum_1^n d_{matrix}{}^2}\text{, matrix = 1,2,3 …. n} \qquad (1)$$

Step II: Adding the weightages to the normalized matrix (n_{matrix}) the contribution of the output parameters should be weighted with priority. The weightages has been applied as per the priority of the normalized matrix which is calculated using Equation 2.

$$w_{matrix} = w_{criterion}\, X\, n_{matrix}\text{, criterion = 1,2,3 …. N} \qquad (2)$$

Step III: Calculate the best and worst ideal solutions.

Step IV: To analyze the Euclidian distances for the ideal best and ideal worst solutions.

$$S_i(positive) = \sqrt{\sum_{n=1}^{m}[a_i(k) - ideal\ best]^2} \qquad (3)$$

$$S_i(negative) = \sqrt{\sum_{n=1}^{m}[a_i(k) - ideal\ worst]^2} \qquad (4)$$

The comparison given between the optimized and normalized matrix values is tabulated in Table 12. The distance of Euclidean is determined using the best and worst values. Table 13 displays the Euclidean distance from the normalized matrix of the best and the worst values. Where m = values of numeric to n criteria. Where m Finally, Equation 5 was used to determining the output index. P(a) showed the performance index.

Table 12. Comparison values of the optimized and normalized matrix

EX. No	**Optimized Outputs**			**Normalized Matrix**		
	Tensile strength	Flexure strength	Hardness	Tensile strength	Flexure strength	Hardness
EXP1	73.59	94.13	79.77	0.1796	0.1777	0.1824
EXP2	74.34	95.59	80.20	0.1814	0.1804	0.1834
EXP3	75.10	97.04	80.74	0.1833	0.1832	0.1846
EXP4	76.77	98.68	82.35	0.1873	0.1863	0.1883
EXP5	77.52	100.14	82.84	0.1892	0.1890	0.1894
EXP6	74.54	96.19	80.25	0.1819	0.1815	0.1835
EXP7	79.95	103.30	85.05	0.1951	0.1950	0.1945
EXP8	76.97	99.28	82.49	0.1878	0.1874	0.1886
EXP9	77.72	100.73	83.03	0.1897	0.1901	0.1899
EXP10	76.12	97.69	82.05	0.1858	0.1844	0.1876
EXP11	76.88	99.14	82.49	0.1876	0.1871	0.1886
EXP12	77.63	100.60	82.98	0.1894	0.1899	0.1898
EXP13	79.30	102.24	84.64	0.1935	0.1930	0.1935

EXP14	80.06	103.69	85.13	0.1954	0.1957	0.1947
EXP15	77.08	99.74	82.50	0.1881	0.1882	0.1887
EXP16	82.48	106.79	87.33	0.2013	0.2015	0.1997
EXP17	79.50	102.84	84.78	0.1940	0.1941	0.1939
EXP18	80.26	104.29	85.20	0.1959	0.1968	0.1948
EXP19	78.66	101.24	84.34	0.1919	0.1911	0.1929
EXP20	79.41	102.70	84.78	0.1938	0.1938	0.1939
EXP21	80.16	104.15	85.18	0.1956	0.1966	0.1948
EXP22	81.84	105.79	86.93	0.1997	0.1997	0.1988
EXP23	82.59	107.25	87.42	0.2015	0.2024	0.1999
EXP24	79.61	103.23	84.83	0.1943	0.1948	0.1940
EXP25	**85.02**	**110.34**	**89.62**	**0.2075**	**0.2083**	**0.2049**
EXP26	82.04	106.39	86.98	0.2002	0.2008	0.1989
EXP27	82.79	107.84	87.47	0.2020	0.2035	0.2000

Table 13. Weighted normalized matrix and performance index with rank

EX.No	**Weighted Normalized Matrix**			**Performance Score and Rank**			
	Tensile strength	Flexure strength	Hardness	Si+	Si-	Pi	Rank
EXP1	0.0898	0.0533	0.0365	0.0147	0.0000	0.0000	27
EXP2	0.0907	0.0541	0.0367	0.0137	0.0009	0.0642	26
EXP3	0.0916	0.0549	0.0369	0.0128	0.0019	0.1292	24
EXP4	0.0937	0.0559	0.0377	0.0106	0.0041	0.2768	22
EXP5	0.0946	0.0567	0.0379	0.0097	0.0050	0.3413	18
EXP6	0.0910	0.0545	0.0367	0.0135	0.0012	0.0811	25
EXP7	0.0975	0.0585	0.0389	0.0065	0.0081	0.5545	10
EXP8	0.0939	0.0562	0.0377	0.0103	0.0043	0.2941	20
EXP9	0.0948	0.0570	0.0380	0.0094	0.0053	0.3591	16
EXP10	0.0929	0.0553	0.0375	0.0114	0.0033	0.2227	23
EXP11	0.0938	0.0561	0.0377	0.0105	0.0042	0.2867	21
EXP12	0.0947	0.0570	0.0380	0.0095	0.0051	0.3512	17
EXP13	0.0968	0.0579	0.0387	0.0073	0.0073	0.4995	14
EXP14	0.0977	0.0587	0.0389	0.0064	0.0083	0.5639	9
EXP15	0.0940	0.0565	0.0377	0.0102	0.0044	0.3029	19
EXP16	0.1006	0.0605	0.0399	0.0033	0.0114	0.7773	4
EXP17	0.0970	0.0582	0.0388	0.0071	0.0076	0.5169	12
EXP18	0.0979	0.0590	0.0390	0.0061	0.0085	0.5806	7
EXP19	0.0960	0.0573	0.0386	0.0081	0.0065	0.4455	15
EXP20	0.0969	0.0581	0.0388	0.0072	0.0075	0.5094	13
EXP21	0.0978	0.0590	0.0390	0.0063	0.0084	0.5730	8
EXP22	0.0999	0.0599	0.0398	0.0041	0.0106	0.7222	6
EXP23	0.1008	0.0607	0.0400	0.0031	0.0115	0.7866	3
EXP24	0.0971	0.0585	0.0388	0.0069	0.0077	0.5259	11
EXP25	**0.1037**	**0.0625**	**0.0410**	**0.0000**	**0.0147**	**1.0000**	**1**
EXP26	0.1001	0.0602	0.0398	0.0038	0.0108	0.7388	5
EXP27	0.1010	0.0611	0.0400	0.0029	0.0118	0.8031	2

The rating method was conducted using the Performance Index (Pi). Figure 10 displays the performance parameter rating procedure. This rating procedure has been carried out using the TOPSIS system to identify the optimal tensile strength, flexure strength and Hardness.

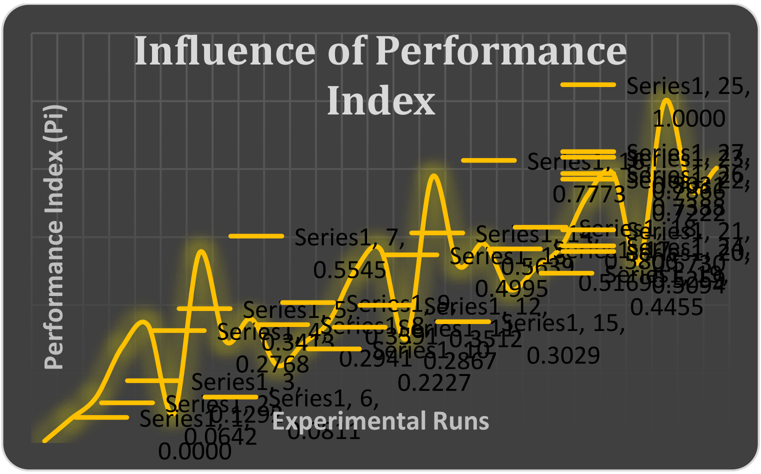

Figure 10. Graph plot for the performance index of TOPSIS

From Figure 10, the graph plot of the performance index of TOPSIS values has been plotted and the value of the 25th experimental run has been recorded as the maximum performance index and the corresponding values have been identified as 85.02 MPa tensile strength, 110.34 MPa flexural strength and 89.62 Vickers hardness values. The optimum process parameters are 30 wt% of Bagasse fibre, 30 wt% of Palm Kernel fibre, 10 MPa Compression Pressure and 6 mm Thickness, respectively.

4. Conclusions

This research work comprises the mixture of bagasse fibre and palm kernel fibre plates by varying Thickness and the results are discussed below:

-in this research work, recycling the waste of bagasse fibre, palm kernel fibre is dried and powdered. It has been fabricated using compression pressure moulding to the desired Thickness;

-the input parameters are 10, 20, 30 wt% of bagasse fibre, 10, 20, 30 wt% of palm kernel fibre, 10, 15, 20 MPa of compression pressure and 2, 4 6 mm of the thickness of the plate. The validation parameters are Tensile strength in MPa, Flexural strength in MPa and Vickers Hardness value;

-the maximum tensile strength, maximum flexural strength and Hardness have been achieved by using 30 wt% of bagasse fibre, 30 wt% of palm kernel fibre, 10 MPa compression pressure and 6 mm thickness of the plate;

-by the influence of tensile strength, the most convincing parameter is wt% of bagasse fibre. The ANOVA results state that 53.71% of contribution has been achieved from wt% of bagasse fibre followed by the 31.35% of wt% of palm kernel fibre and 12.94% of Thickness and 2% of compression pressure;

-by the influence of flexural strength, the most convincing parameter is wt% of bagasse fibre. The ANOVA results state that 53.43% of contribution has been achieved from wt% of bagasse fibre followed by the 32.12% of wt% of palm kernel fibre and 13.919% of Thickness and 0.53% of compression pressure;

-by the influence of Hardness, the most convincing parameter is wt% of bagasse fibre. The ANOVA results state that 56.22% of contribution has been achieved from wt% of bagasse fibre followed by the 29.19% of wt% of palm kernel fibre and 11.29% of Thickness and 3.29% of compression pressure;

-by the analysis of TOPSIS, the optimum strengths and Hardness has been achieved by the 30 wt% of bagasse fibre, 30 wt% of palm kernel fibre, 10 MPa compression pressure and 6 mm thickness of the plate;

-the graph plot shows that the highest rank is achieved at the 25th experimental run by the influence of a performance index that has corresponding optimum tensile strength, optimum flexural strength, and optimum hardness levels.

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