OPTIMIZING THE DRILLING PARAMETERS FOR MINIMUM SURFACE ROUGHNESS IN DRILLING OF MDF COMPOSITES USING TAGUCHI AND RESPONSE SURFACE METHODOLOGY

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Abstract

Medium Density Fiber board is an industrial wood product belongs to wood based composite. It is made out of wood waste fibers clued together with resin by heat and pressure. Nowadays the MDF products are preferred over solid waste in many applications due to certain comparative advantages and mainly used in furniture industry. This paper discusses the use of Taguchi and Response surface methodologies for minimizing the surface roughness in drilling MDF material by a (K20) Brad and spur carbide drill bits. The experiments have been conducted based on Taguchi's experimental design technique. The drilling parameters used are speed, feed rate and drill diameter. The effect of drilling parameters on surface roughness is evaluated and the optimum cutting condition for minimizing the surface roughness is determined. Second order model have been established between the drilling parameters and surface roughness using response surface methodology. The experimental result reveals that the most significant drilling parameter for surface roughness is feed rate followed by speed. The predicated values and measured values are fairly close, which indicates that the developed model can be effectively used to predict the surface roughness in the drilling of MDF composites. The predicated results are validated by using validation experiments.

Key words: Taguchi technique, Analysis of Variance (ANOVA), Drilling, MDF board, Response Surface Methodology, Surface finish

I. INTRODUCTION

Medium Density Fiber board (MDF) is made from lingo-cellolosic fibers derived from defibrated wood chip is typically composed of 85-100% soft wood and 0-15% hard wood. Medium Density Fiber boards are appropriate for many interior and exterior industrial applications. The degree of surface roughness of the MDF board plays an important role, since any surface irregularities reducing the final quality of the product [1].Surface finish is an important parameter in manufacturing engineering, which can influence the performance of final parts and production. In Metal drilling and turning had been studied extensively in the literature, but MDF drilling has not received much attention. However, many works of various authors [2-6] representing about the machining of MDF. They strongly recommended that the machinability is dependent on the mechanism of cutting tool and work piece material. The drilling of MDF materials requires special consideration about the wear resistance. Carbon tool steel is not suitable as a tool material owing to its tool wear and poor surface finish. Hence K20 carbide tools are used as suitable cutting tool materials [7,8].Surface roughness plays an important role in many areas and is factor of great importance in the evaluation of machining accuracy. Surface roughness of the machined product could affect several of products functional attributes such as contact causing surface friction, wearing, light reflection, heat transmission and resisting fatigue [9].

From the literature, it has been asserted that the machining MDF is strongly dependent on the machining parameters. Philibin and Gordon [10] studied the application of PCD tool in machining MDF. According to his study the major benefit of using PCD is extended tool life resulting from its superior properties over the traditional materials. Lin et al [11] reports about the machinabilty of MDF.These authors confirm that the board densities were found to have major influence on the machinability characteristics of the panel. Recently Davim et al [12] presents the study of surface roughness aspect in milling MDF. In his study the surface roughness in milling increases with increasing feed rate, and decreases as the spindle speed is increased.

In order to get good surface quality and dimensional properties, it is necessary to employ optimization techniques to find optimal cutting parameters and theoretical models to do predications. Tagucghi and response methodologies can be conveniently used for these purposes. Suresh et al.[13] used the response surface methods and genetic algorithms for predicating the surface roughness and optimizing the process parameters.Kawak [14] has applied Taguchi and response methodologies for optimizing geometric errors in surface grinding process. The response surface method is more practical, economical and relatively easy to use [15] In the present study, effect of cutting parameters on the surface roughness in drilling of MDF composites by K20 carbide Brad and spur tool is evaluated and second order model is developed for predicating the surface roughness. The predicated and measured values are fairly close to each other, which indicates the developed model can be effectively use to predicate the surface roughness in the drilling of MDF composites.

II. MATERIALS AND METHODS

The work material used for present investigation is MDF board. The boards are supplied by ASIS, India, which is manufactured by them. These board are commercially available and used for furniture industry. The important properties of the board as per ISO 12406 are given in Table 1.

Table 1. Mechanical and Physical Properties of MDF composite

Tensile strength N/mm²	Modulus of rupture N/mm²	Elasticity modulus N/mm²	Humi dity %	Density Kg/mm³
0.8	28	2800	5-8	600-900

A. Taguchi Method

This paper uses Taguchi method for analyzing drilling parameters in drilling MDF composites, which is very attractive and effective method. In this method, main parameters are assumes to have influence on process results which are located at different rows in a designed orthogonal array. This method is useful for studying the interactions between the parameters, and also it is a powerful design of experiments tool, which provide a simple, efficient and systematic approach to determine optimal cutting parameters. Compared to the conventional approach of experimentation, this method reduces drastically the number of experiments that are required to model the response functions [16,17].It is proposed for the purpose to improve the quality of products based on the concepts of statistics and engineering. The difference between the functional value and objective value is emphasized and identified as the loss function. The loss function is derived as Eq.(1)

$$L(y) = \frac{L''(m)(y-m)^2}{2!} = k(y-m)^2 = k(MSD) \qquad (1)$$

Where L(y) is loss function, y is value of the characteristic, m is the target value of *y,k* is proportionality constant, which depends on financial criticality of *y* and MSD is mean square deviation. Eq.(1) can be expressed by signal -to -noise ratio(S/N) and can be written as:

$$S/N = -10\log_{10}(MSD) \qquad (2)$$

In the case of surface roughness, smaller values are always preferred. The equation for calculating S/N ratio for smaller –the –better characteristic (in decibels) is:
Smaller-is-the better (minimize):

$$S/N_{SB} = -10\log_{10}\left(\frac{1}{n}\sum_{i=1}^{r} y_i^2\right) \text{ i=1,2,..,n} \qquad (3)$$

Where Yi is the value of surface roughness for the *i*th tests in that trial, n the number of tests. In the case of surface roughness (R_a), smaller values are always preferred. The equation for the smaller –the-better is taken for analysis. High signal to noise ratio are always preferred in Taguchi's experiments. For lower the better characteristics, this method translates into lower process average and improved consistency from one unit to the next or both. In Taguchi method, for reducing the number of experiments and to determine the optimal cutting parameters orthogonal array is introduced. Once the levels of each design parameters have been identified, analysis of the influence of drilling parameters on surface roughness has been performed using response table for S/N ratio, which indicates the response at each level of control factors. Response tables are used to simplify the calculations needed to analyze the experimental data. The optimum level of cutting parameters can be found from its corresponding S/N ratios .The analysis of variance is performed finally to find the significant parameters.

B. Response Surface Methodology

RSM is the collection of mathematical and stastical technique that are useful for the modeling and analysis of problems in which a response of interest is influenced by several variables and the objective is to optimize this response[18].It is advantageous over conventional methods, since it includes less number of experiments, its suitability for multiple experiments and search for common relationship between various factors towards finding out the most suitable production conditions and forecast responses. In RSM, the factors that are considered as most important are used to build a polynomial model in which the independent variable is experiment's response. The surface finish of drilled MDF parts is important in furniture industry applications which are considerable effect on some properties.

In many engineering field, there is a relationship between a output variable of interest '*y*'and a set of controllable variables $\{x_i x_2,.....x_n\}$.In some systems, the nature of relationship between *y* and *x* values might be known.

Then, the model can be written in the form

$$Y= f(X_i X_2.......Xn) + \varepsilon \quad (4)$$

Where ε represents noise or error observed in the response *y*. In most RSM problems the form of relationship between the response and the independent variable is unknown. The general form of regression equation is

$$y = \beta_0 + \sum_{i=1}^{k} \beta_i x_i + \sum_{i=1}^{k} \beta_{ii} x_i^2 + \sum_{i<j} \beta_{ij} x_i x_j + \varepsilon \quad (5)$$

Where *y* is the response and x_i are the values of the i[th] drilling parameters [14,15]. The term β are the regression coefficients The second term under the summation sign of this polynomial equation is attributable to linear effect, whereas the third term corresponds to the higher-order effects; the fourth term of the equation includes the interactive effects of the process parameters. The residual ε measures the experimental error of the observations.

III. EXPERIMENTAL DETAILS

The experiments are planned using Taguchi's orthogonal array in the design of experiments (DoE), which helps in reducing the number of experiments. In this work, MDF board has been used for experimentation. The Experimental design is used to conduct experiments with less number of observations. They constitute a systematic method concerning the planning of experiments, collection and analysis of data with near optimum use of available sources. The factors, considered for experimentation and analysis are speed and feed rate and drill diameter. Since the considered factors are multi level variables and their outcome effects are not linearly related, it has been decided to use three level tests for each factor. The condition and notations for the input parameters are given in Table 2.

Factor	Notation	Unit	Factor levels		
			1	2	3
Spindle speed	N	rpm	1000	2000	3000
Feed rate	f	mm/ min	100	300	500
Drill diameter	d	mm	4	8	12

By using Taguchi's orthogonal array [17], the most suitable array is L_{27}, which needs 27 runs and has 26 degrees of freedom (DOFs).It can conduct three level of parameters .To check the degrees of freedom (DOF) in the experimental design, for the three level test the three main factors take 6 (3 x (3-1)) DOFs. Square effects and interaction between parameters take remaining DOFs.

The condition with real values, coded values of parameters and experimental results are presented in Table 3.

The drilling tests were performed on VMC 100 machining centre with following specifications: Table size:1270 x 230mm ;spindle speed 60-5000 rpm; maximum feed rate:4000mm/min.The drill bit used in the investigation is carbide (K20) Brad and spur type, having drill diameter of 4,8,12 mm .The set up for the drilling machine and drill bits used are shown in Fig.1.

Fig. 1. Experimental setup

The surface roughness used in this study is the arithmetic mean average surface roughness (R_a), which is mostly used in the industry. The roughness has been measured number of times and averaged. The surface roughness is the integral of the absolute value of the roughness profile height over the evaluation length and is denoted by the following equation

$$R_a = \frac{1}{L} \int_0^L [Y(x)] dx \quad (6)$$

Where the L is the length taken for observation and Y is the ordinate of the profile curve. The surface roughness of MDF has been measured by using Taylor Hobson surface roughness measuring instrument. The experiments are repeated for 3 times and average values have been taken up for response surface model.

IV. RESULTS AND DISCUSSION

Surface roughness plays an important role in many areas and is a factor of great importance in the evaluation of machining accuracy. Although many factors affect the surface condition on the part, drilling parameters such as cutting speed, feed rate and drill diameter plays a major role. The fig 2(a-b) shows the SEM micrograph of MDF composite material at different feeds, when drilling with carbide (K20) brad and spur type, drill bits.

Table 3. Experimental design, drilling conditions and results

Expt No	Coded values			Actual setting values			Experimental results of (µm)			S/N Ratio,dB	Average Ra(µm)
	f	N	d	f	N	d	1	2	3		
1	1	1	1	100	1000	4	5.65	5.56	6.11	-15.23856	5.78
2	1	1	2	100	1000	8	6.74	6.30	6.47	-16.27161	6.51
3	1	1	3	100	1000	12	7.50	7.90	8.09	-17.87852	7.83
4	1	2	1	100	3000	4	5.15	5.55	5.35	-14.57098	5.35
5	1	2	2	100	3000	8	6.10	5.80	5.83	-15.43202	5.91
6	1	2	3	100	3000	12	6.45	6.95	6.82	-16.56842	6.74
7	1	3	1	100	5000	4	4.03	4.55	4.20	-12.57501	4.26
8	1	3	2	100	5000	8	4.12	5.02	6.10	-14.12043	5.08
9	1	3	3	100	5000	12	4.03	4.20	4.40	-12.48012	4.21
10	2	1	1	300	1000	4	7.95	7.77	7.65	-17.83157	7.79
11	2	1	2	300	1000	8	8.88	8.53	8.45	-18.70697	8.62
12	2	1	3	300	1000	12	9.14	9.54	9.64	-19.50216	9.44
13	2	2	1	300	3000	4	7.01	6.80	7.07	-16.85519	6.96
14	2	2	2	300	3000	8	7.32	7.42	7.82	-17.52457	7.52
15	2	2	3	300	3000	12	8.15	8.35	8.55	-18.42987	8.35
16	2	3	1	300	5000	4	5.97	6.07	5.57	-15.36645	5.87
17	2	3	2	300	5000	8	6.89	6.69	6.49	-16.51092	6.69
18	2	3	3	300	5000	12	7.05	7.25	7.45	-17.20631	7.25
19	3	1	1	500	1000	4	9.25	9.30	9.65	-19.46324	9.40
20	3	1	2	500	1000	8	10.10	9.94	10.65	-20.19488	10.23
21	3	1	3	500	1000	12	10.95	11.00	11.20	-20.86960	11.05
22	3	2	1	500	3000	4	8.25	8.61	8.85	-18.66205	8.57
23	3	2	2	500	3000	8	8.71	9.52	9.16	-19.20950	9.13
24	3	2	3	500	3000	12	9.56	10.06	10.36	-19.96195	9.96
25	3	3	1	500	5000	4	7.25	7.51	7.68	-17.47300	7.48
26	3	3	2	500	5000	8	8.20	8.15	8.55	-18.38349	8.30
27	3	3	3	500	5000	12	8.59	9.10	8.90	-18.94831	8.86

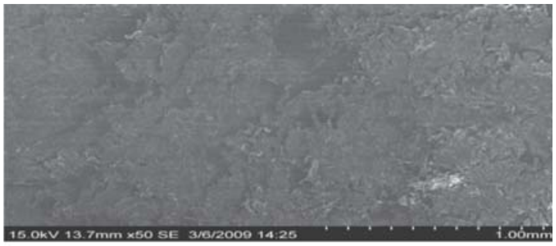


Fig. 2a. SEM of drilled material at low feed rates.

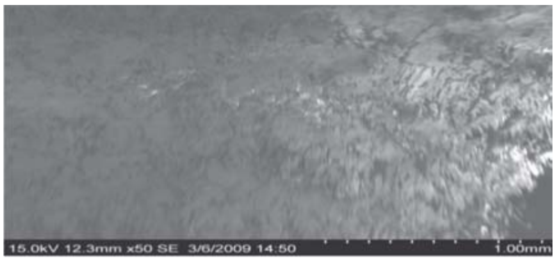
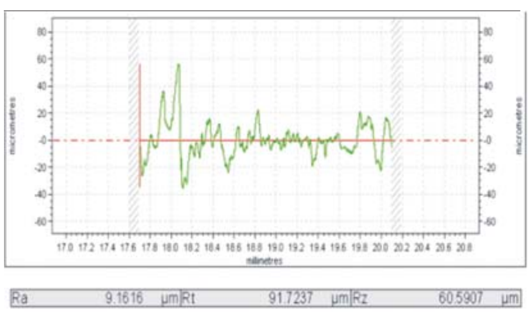
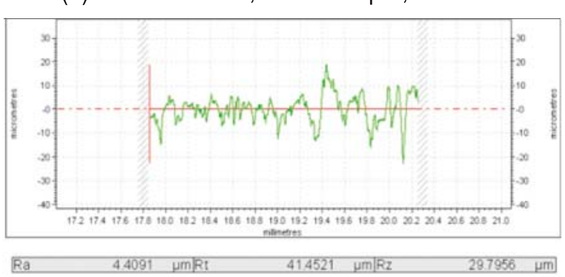


Fig. 2b. SEM of drilled material at high feed rates.

This micrograph reveals, the drilled hole surface observed drilling the MDF board at low and high feed rates. The typical surface profile observed on the drilled MDF composite is presented in Fig 3.(a-b) which is obtained from the Taylor Hobson surface roughness measuring instrument.



(a) f=500 mm/min, N=1000 rpm, d=4 mm



(b) f=100 mm/min, N=5000 rpm, d=4 mm

Fig. 3. Typical surface roughness plot at different drilling conditions.

A. Effect of control parameters on surface roughness

In Taguchi method, the term 'signal 'represents the desirable value and 'noise' represents the undesirable value. The objective of using S/N ratio is measure of performance to develop products and process insensitive noise factors[17]. Process parameter setting with the highest S/N ratio always yield the optimum quality with the minimum variance. The S/N ratio for each parameter level is calculated by averaging the S/N ratio obtained when the parameter is maintained at that level. Table 4 shows Response table for Surface roughness. Similarly the fig .4 shows Mean S/N graph for surface roughness of drilled MDF composites.

Table 4. Response Table for Surface roughness

Level	Feed rate	Speed	Diameter
1	-15.298	-18.43	-16.448
2	-17.548	-17.47	-17.373
3	-19.241	-16.18	-18.266
Δ(delta)	3.943	2.26	1.818
Rank	1	2	3

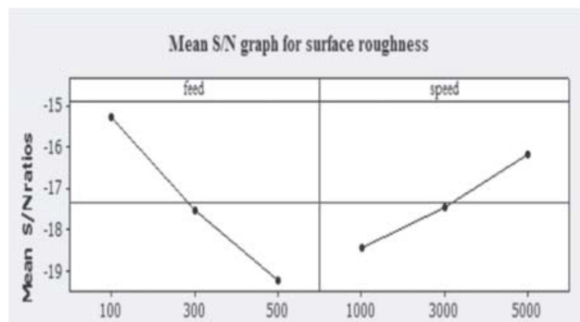


Fig. 4. Mean S/N graph for surface rougness

As shown in Table 4. and figure 4 feed is dominant factor on the surface roughness followed by speed. The drill diameter had lower effect on the surface roughness. Always lower surface roughness is preferred. The surface roughness observed at low speed is more than the surface roughness at high speed. In the present investigations, when the speed as value of 5000 rpm is applied, the surface roughness could be minimized. From the experimental results, it is observed that at high drill diameter the surface roughness is minimum. The reason being, the increase in feed increases the heat generation, which in turns results in higher surface roughness. The results shown prove that the roughness of the drilled part is highly influenced by the feed. The optimum conditions for the minimum surface roughness can be established at:

- Speed (N): 5000 RPM
- Feed (f) : 100 mm/min
- Drill diameter : 12 mm

It is emphasized that these conditions only provide minimum surface roughness among drilling conditions tested. Table 5. shows the ANOVA table for response surface 2F1 model for surface roughness (R_a).And also indicates that the most significant parameter is feed followed by speed and drill diameter.

B. Response surface Analysis

The second order response representing the surface roughness can be expressed as function of drilling parameters such as speed (N), feed (f), drill diameter (d).The relationship between the surface roughness and drilling parameters has been expressed as follows:

$$R_a = \beta_0 + \beta_1 (f) + \beta_2 (N) + \beta_3 (d) + \beta_4 (f N) + \beta_5 (f d) + \beta_6 (N d) \quad (7)$$

From the observed data for surface roughness, the response function has been determined in uncoded units as:

$$R_a = 4.43 + 0.00919f - 0.000322N + 0.240d - 1.87E - 007fN - 4.7E - 005fd - 1.25E - 005Nd \quad (8)$$

The optimal surface roughness parameters are obtained by analyzing the contour plots. The statistical analysis of the model were carried out using analysis of variance (ANOVA). The result 2F1 response model is fitting in ANOVA.

The analysis of variance is used to check the adequacy of the proposed 2F1 model. The value of "Prob > F" in Table 5 for model is less than 0.05 which indicates that the model is adequately significant at 95% confidence level, which is desirable as it indicates that the term in the model have a significant effect on the response. Similarly, the main effect of feed rate (f), speed (N) and drill diameter (d), and the interactions of speed and feed rate (Nf), feed rate and drill dia (fd), and speed and drill diameter (Nd) are significant. The effectiveness of the model has been checked by using 'R^2'value. In the present work R^2 value is 0.996 which is very close to 1 and hence the model is very effective. The "Pred R-Squared" of 0.992 is in reasonable agreement with the "Adj R-Squared" of 0.995.The Adj R-Squared value is particularly useful when comparing models with different number of term. "Adeq Precision" measures the signal to noise ratio.

Ratio greater than 4 indicate adequate model discrimination. In this case, the value is well above 4,hence the response function developed is quiet adequate. Further, the experimental values and the predicated values by using the aforesaid model are plotted as shown in Fig.5, which indicates a good correlation.

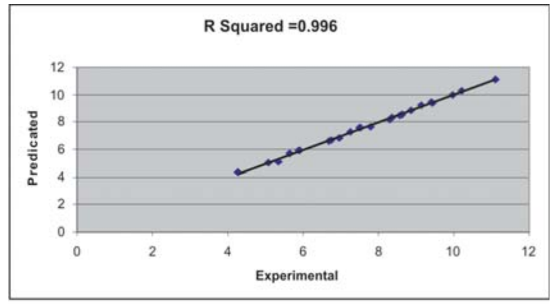


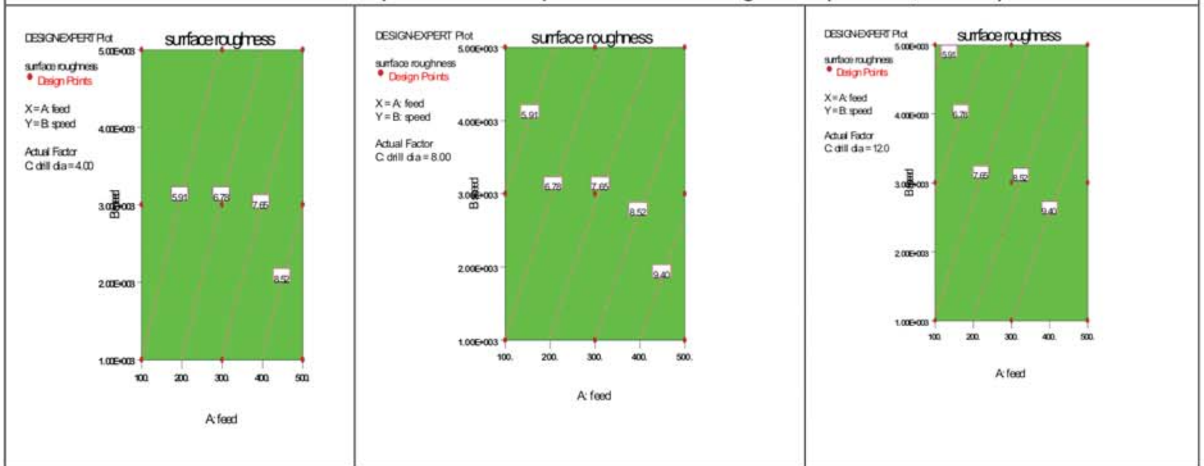
Fig. 5. Correlation graph for carbide (K20) Brad and spur type drill bit

Table 5. ANOVA for Response Surface 2FI Model

Source	Sum of squares	DF	Mean square	F Value	Prob > F
Model	76.7	6	12.8	872	< 0.0001
Feed(f)	49.6	1	49.6	3.38 E+003	<0.0001
Speed (N)	16.5	1	16.5	1.13E+ 003	<0.0001
Drill (d)	10.4	1	10.4	707	<0.0001
f N	0.0672	1	0.0672	4.58	0.0448
f d	0.0134	1	0.0134	0.913	0.351
N d	0.121	1	0.121	8.26	0.00936
Residual	0.293	20	0.0147		
Cor Total	77	26			
SD	0.121		R-squared		0.996
Mean	7.58		Adj R-squared		0.995
C.V	1.60		Pred R-squared		0.992
PRESS	0.0582		Adeq Precision		110

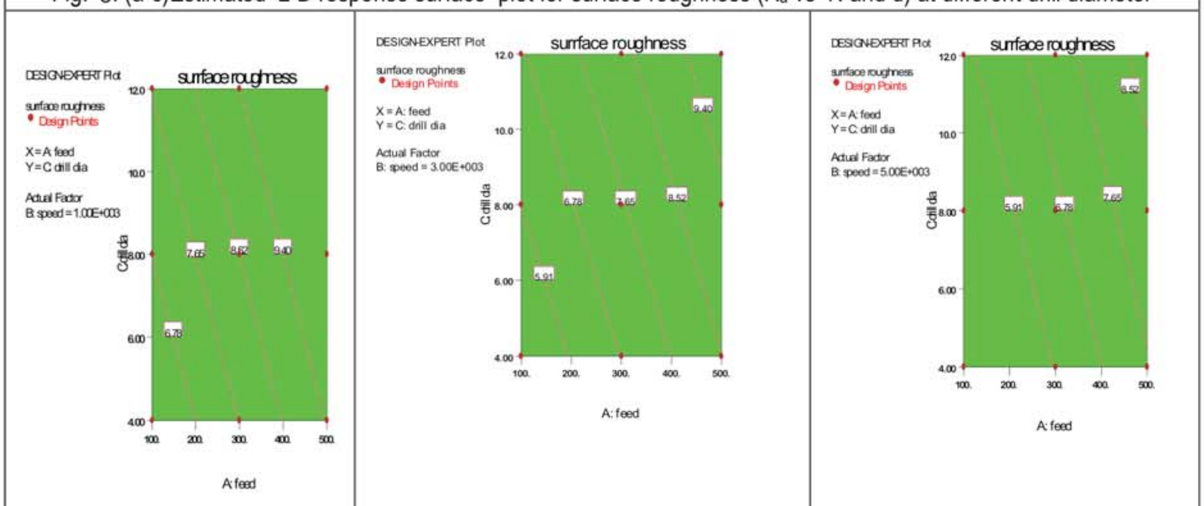
Also the R^2 values for the models are very close to 1, which indicates that there is high correlation that exists between the developed model and experimental results. Eq.(8) is plotted in Fig 6 (a-c) as 2 D contour plots of the each response surface plot for surface roughness (R_a vs N and d) at different drill diameter. Fig 7(a-c) as 2 D contour plots for each of the response surface plot for surface roughness (R_a *vs* N and d) at different speed. Fig 8(a-c) as 2 D contour plots for each of the response surface plot for surface roughness (R_a vs N and d) at different feed. The typical three dimensional (3D) surface plots also reveals the same in terms of the process variable are shown in Fig, 9-11. From the Fig 9 (a-c) shows the estimated 3D response surface plot for surface roughness (R_a vs N and d) at different feed rate. Fig 10(a-c) shows the 3D response surface plot for surface roughness (R_a vs f and d) at different speed. Fig 11 (a-c) shows the estimated 3D response surface plot for surface roughness (R_a vs f and N) at different drill diameter.

Estimated 2D response surface plot for surface roughness (R_a vs N,f and d)



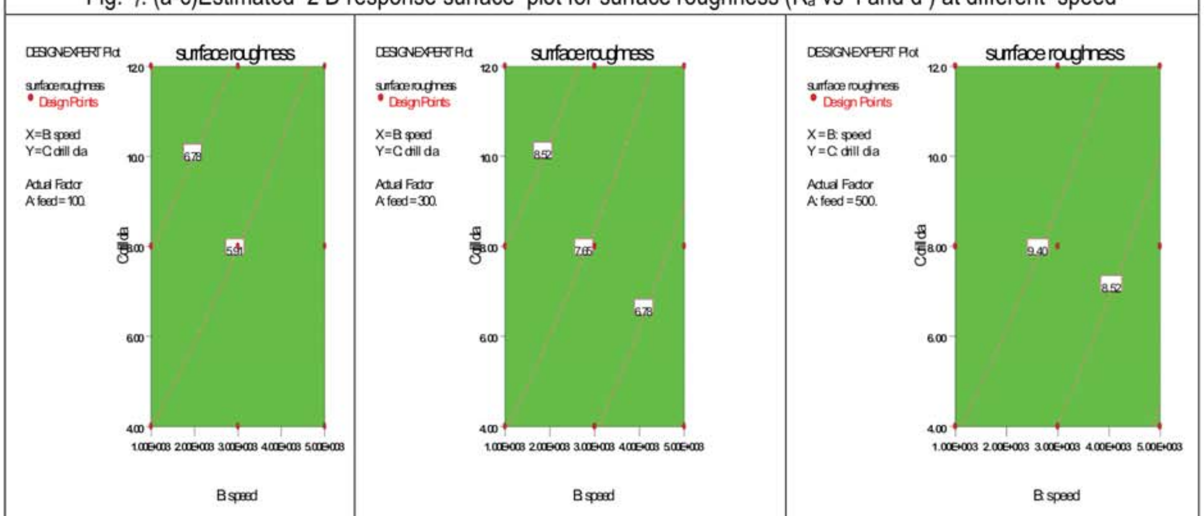
(a) Drill diameter 4 mm | (b) Drill diameter 8 mm | (c) Drill diameter 12 mm

Fig. 6. (a-c)Estimated 2 D response surface plot for surface roughness (R_a vs N and d) at different drill diameter



(a) Speed 1000 rpm | (b) Speed 3000 rpm | (c) Speed 5000 rpm

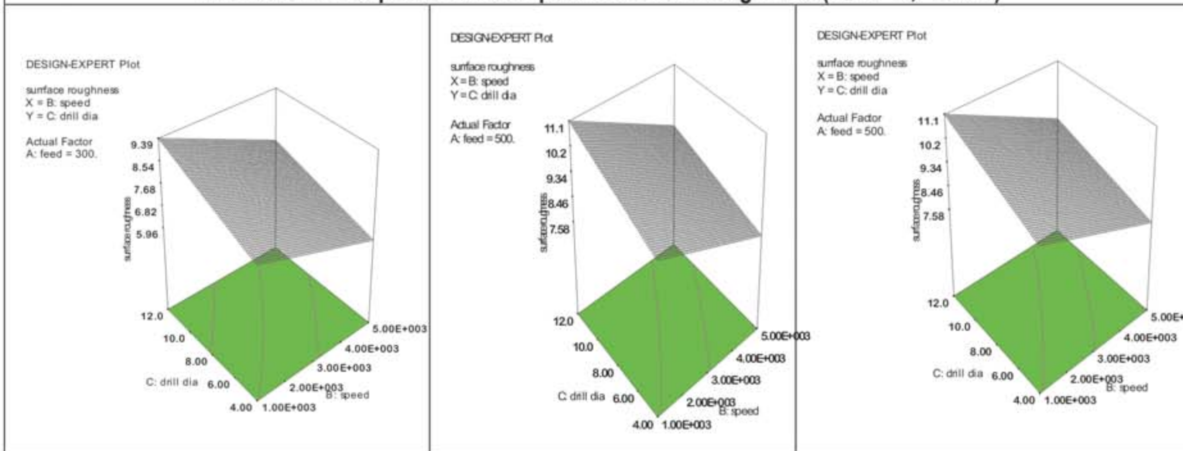
Fig. 7. (a-c)Estimated 2 D response surface plot for surface roughness (R_a vs f and d) at different speed



(a) Feed rate 100 mm/min | (b) Feed rate 300 mm/min | (c) Feed rate 500 mm/min

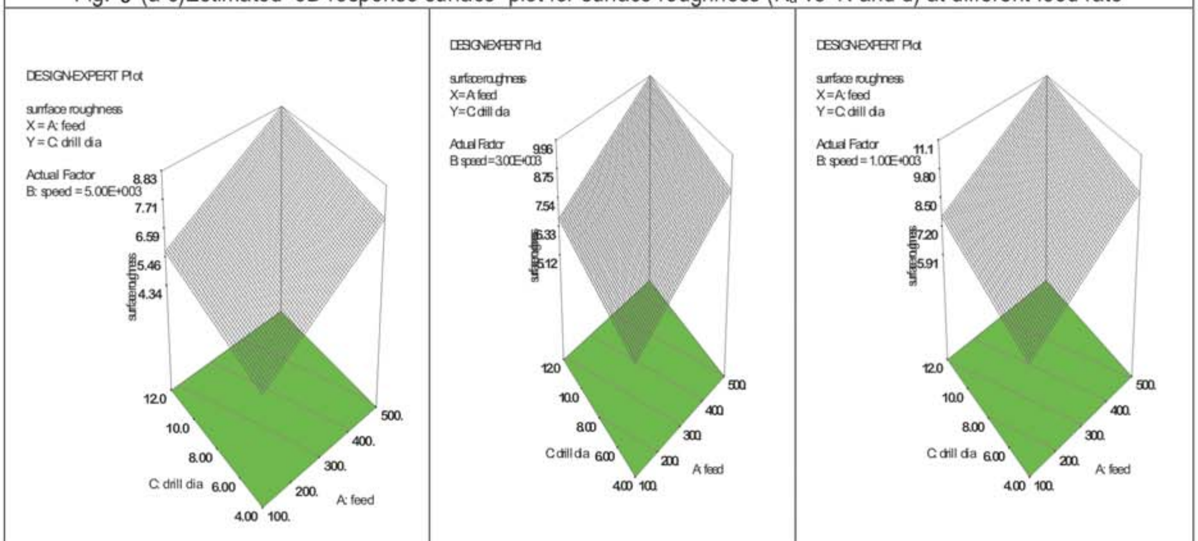
Fig. 8. (a-c)Estimated 2D response surface plot for surface roughness (R_a vs f and N) at different feed rate

Estimated 3D response surface plot for surface roughness (R_a vs N,f and d)



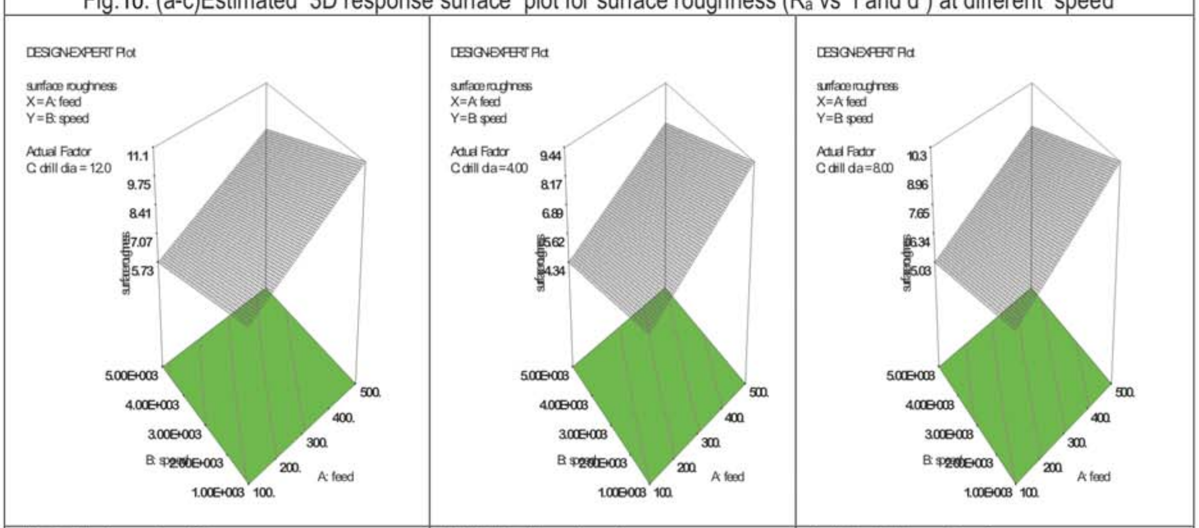
(a)Feed rate 100 mm/min (b)Feed rate300 mm/min (c) Feed rate 500 mm/min

Fig. 9 (a-c)Estimated 3D response surface plot for surface roughness (R_a vs N and d) at different feed rate



(a) Speed 5000 rpm (b) Speed 3000 rpm (c) Speed 1000 rpm

Fig.10. (a-c)Estimated 3D response surface plot for surface roughness (R_a vs f and d) at different speed



(a) Drill diameter 12 mm (b) Drill diameter 4 mm (c) Drill diameter 8 mm

Fig. 11. (a-c)Estimated 3D response surface plot for surface roughness (R_a vs f and N) at different drill diameter

Fig. 12-14 shows the effect of two varying parameters by keeping the third variable at middle level.

Fig. 12. shows the effects of speed at different feed on surface roughness. With a fixed value of feed the surface roughness reduces with increase of speed. During drilling, at lower speed, larger material flow with the cut fibers has been noticed which in turn produces high surface roughness. From the figure, it can be concluded that the high speed and low feed are preferred for drilling MDF composites.

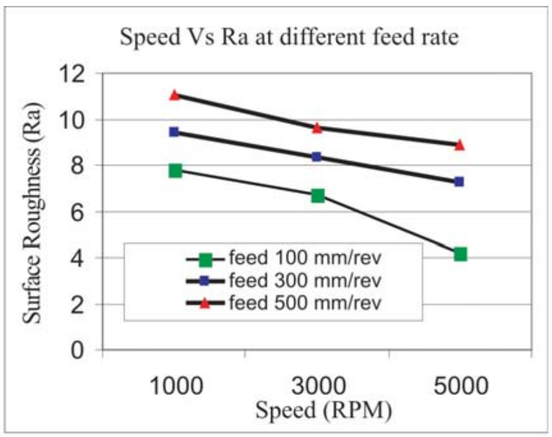


Fig. 12. Effect of speed at different feed rate on surface roughness

Fig. 13. shows the effects of speed at different drill diameter on surface roughness. With a fixed value of speed the surface roughness reduces with increase of drill diameter. The reason being, at low drill diameter, the fibers in the composites cannot be removed fully which leads to high surface roughness Where as at high drill diameter, the fibers are being clear off from the surface and produces good surface finish

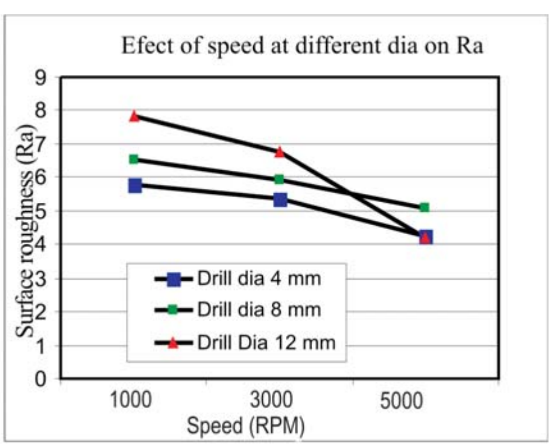


Fig. 13. Effect of speed at different drill diameter on surface roughness

Fig. 14. shows the effects of feed at different drill diameter on surface roughness. The observed surface roughness is better only at low feed and high drill diameter. From the S/N and ANOVA analysis, it is found that the feed is more significant factor than any other parameters, whilst drill diameter is the least significant parameter. Further more, the surface roughness reduces with the increase of speed and drill diameter and it increase at lower feed rate. The surface roughness produced on the MDF composite is mainly due to the feed rate. This is consistent with the results from the study of Else Eriksen [20].

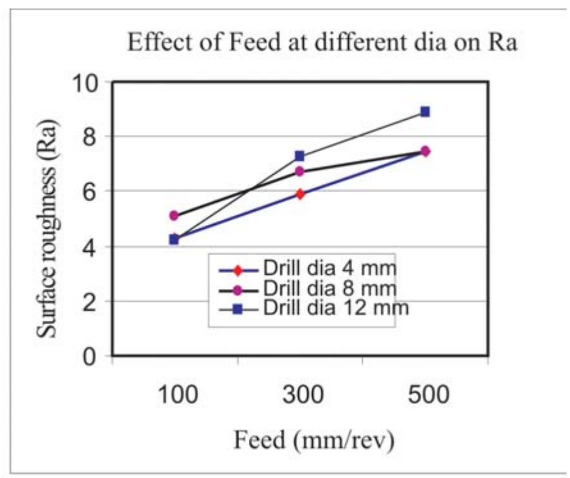


Fig. 14. Effect of feed at different drill diameter on surface roughness

The diagnostic checking of the model has been carried out using residual analysis and the results are presented in Fig.14 -15. In the figures color point indicates the value of Surface Roughness. The normal probability plot is presented in Fig. 14.

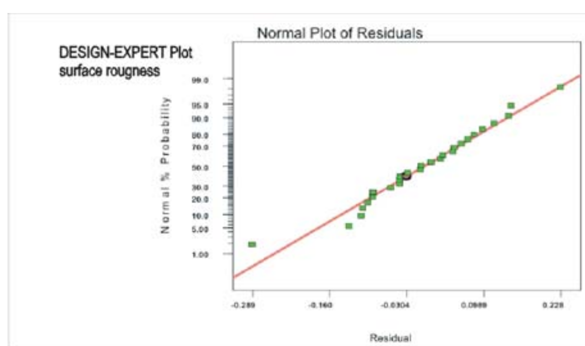


Fig. 15. Normal probability plot of residuals

The fig. 15. trend represents that the residuals falls on straight line indicates that the errors are distributed normally. Fig. 16. shows the actual values with respect to the predicated values.

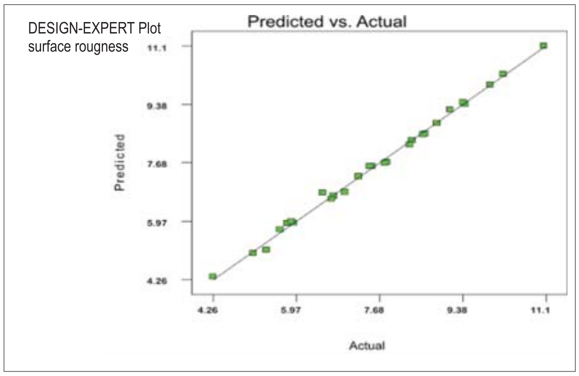


Fig. 16. Plot of Actual *vs* Predicated values

The residual values are distributed in both positive and negative direction with uniform pattern, which implies that the model is adequate and there is no violation of independence or constant variance assumption

V. VALIDATION OF EXPERIMENTAL RESULTS

To predict and verify the improvement in surface roughness for drilling of MDF composite by drilling process with respect to chosen initial parameter setting, the verification test are used. The predicated optimal condition can be calculated by meas of additive law. Based on optimal conditions presented in section (IV), the minimum possible surface roughness has been calculated from the fallowing expression

$$\eta_{predicted} = \eta_m + \sum_{j=1}^{k} (\eta_j - \eta_m) \quad (9)$$

where

η_m = grand mean of S/N ratio

η_j = mean S/N ratio at optimum level

k = number of main design parameters that affect the quality characteristics

η_m predicated = -12.25012db =4.20 microns

Figure 17. shows the validation of experimental results for surface roughness. Test numbers 1 and 2 shows the comparisons of experimental results with additive model Eq.(9). The result shows that the predicated value is same for both tests. But small variation has been observed in experimental results. The validity of the response model has been checked by using test numbers 1,5,7,10,19,21,27 in Fig.16. The figure shows the experimental values and their corresponding predicated values through Eq.(8). From the analysis of figure it can be observed that the predicated values are very close to the experimental results. Additional errors may result from hooking of the fibers to the stylus [21] and hence it is recommended that the surface roughness should be measured number of times at different places of work piece and averaged. From the above results, it is proved that the drilling conditions are optimized and minimum surface roughness values are obtained for drilling of MDF composites.

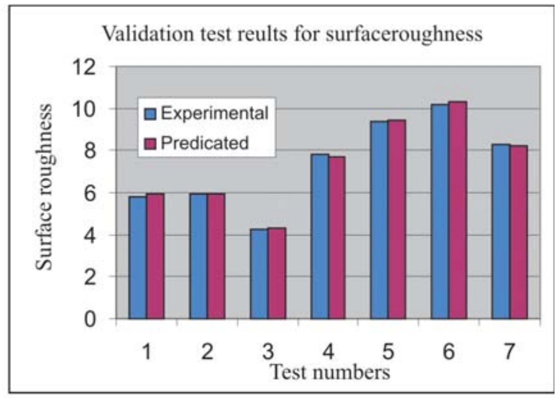


Fig. 17. Validation Test reults for surface roughness

VI. CONCLUSION

The following conclusions are drawn from experimental results during drilling of MDF board using carbide (K20) Brad and spur type, drill bits of different drill diameter under different drilling conditions using Taguchi's orthogonal array

1. The effect of drilling parameters on the surface roughness is evaluated with the help of Taguchi method and optimal drilling conditions to minimize the surface roughness are determined

2. The two factor interaction surface model for surface roughness is developed from the observed data using response surface methodology

3. The surface roughness decreases with increasing feed rate but decreased with increased with higher spindle speed

4. The established equations clearly show that the feed factor which influences surface roughness followed by spindle speed and drill diameter.

5. The predicated and the measured values are close to each other which indicates that the developed surface roughness predication model can be effectively used for predicating the surface roughness during drilling of MDF panel with 95% confidence level.

6. The results revealed that the minimal surface roughness could be arrived significantly for composite drilling operations. Verification test results revealed

that the determined optimal combination of drilling parameters satisfy the real requirement of drilling operation in the drilling MDF composites.

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