Optimization on Drilling Performance of Tic Filled Banana Fibre Reinforced Composites

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Abstract

Bio-degradability and sustainability have become major objectives in the field of materials engineering. Due to this, the utilisation of natural reinforcement is gaining immense attention. There are various machining process in which drilling is most useful process for the assembly of different work pieces. Drilling is one of the most challenging aspects in secondary processing of composite fabrication. To most effectively drill or machine of machine this material it is important to understand what makes these composites different. Composites have metal like characteristics in material properties, they are very different in a sense of how they are processed through drilling and machining processes.

Introduction

Composite materials are increasingly used in various fields of science and engineering due to their unique properties such as high stiffness, lightweight, good corrosive resistance, low thermal expansion, etc. Although most of fiber reinforced composite (FRP) material parts are processed to a near net shape, machining is often necessary, like finishing, trimming, drilling, grinding, etc. Due to these reasons, conventional machining on the FRP composite has gained importance to meet the required dimensional accuracy and good surface quality. Among these machining processes, drilling is frequently used in industries owing to the need for component assembly in mechanical structures.

Various parts of an automotive vehicle such as the door panel, headliner, bumper, engine cover and roof cover are now manufactured using composite materials. Drilling in certain cases falls as the last few operations in the schedule during the assembly of the structures. Any defect that leads to the rejection of the parts in these stages represents a big loss. Drilling of natural fiber-reinforced composites needs thrust force of a smaller magnitude and results in smaller tool wear compared to the drilling of conventional metallic automotive parts. Variations in volume fraction of the fibers make the drilling process more complex, as proper feed, and speed should be given to produce a perfect hole Drilling in the fiber-reinforced composites involves some independent parameters such as the type of reinforcement and matrix, volume fraction of fiber and matrix, speed, feed and drill bit diameter.(1) These independent parameters have an effect on some dependent factors such as peel up and push down delamination, surface roughness, cutting force, tool wear and residual strength. While drilling of natural fiber reinforced polymer composites, surface roughness and delamination in the drilled hole are 20 considered as a major response parameter. Early researches showed the effect of speed and feed rates on surface roughness and delamination marginally.(2)

Machining of FRP parts include turning, drilling, milling, grinding and the like(3). Also machining is desirable for making precision components, prototype development and when the production volume is not large enough to justify the investment for moulds and moulding equipment. Hence, there has been an increased demand for machining of FRP in recent years.

Materials and methods

In this study the composite specimen was prepared using general purpose epoxy and pure banana fiber which is procured from Suntech Chennai. The specimens were prepared by using the hand lay-up process.

Drilling engages the taking away the material from work piece such that a hole is obtained. Drilling is a difficult process; it needs methodical and quantitative swots on all the major controlling parameters on machining performance in order to structure the rule base under a wide range of work conditions(4). In the present investigation the drilling experiments were carried out in radial drilling machine. The machining samples were prepared in the form of 100 mm × 100 mm × 10 mm blocks for each material. Solid carbide Drills with diameter of 10 mm, a helix angle of 30°, and a point angle of 90° and 118° were used.

The thrust force is measured directly from the strain gauge dynamometer. The surface roughness of the workpiece is measured with a Mitutoyo portable Surftest SJ-201 P/M contact profilometer at 2.4 mm cut-off value. Delamination is a damage phenomenon that occurs due to the anisotropic and brittleness of composite materials. The delamination was measured by using a coordinate measuring machine (CMM). The delamination factor is determined by the ratio of the maximum diameter Dmax of the delamination zone to the hole diameter D.

Results and discussion

ANOVA RESULTS FOR THRUST FORCE

The machinability in this work was assessed by surface roughness (Ra) of the drilled surface of the work piece, thrust force and delamination. The Factorial design of experiments and desirability function analysis are applied in this project work for the identification of best levels of drilling parameters, significance, and optimisation of parameters.

Table 1

Analysis of variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	4	1549.4	387.349	45.03	0.001
Speed	1	438.61	438.615	50.98	0.002
Feed	1	67.54	67.536	7.85	0.049
Diameter of drill	1	443.24	443.244	51.52	0.002

Table 2

Model summary

S	R-sq	r-sq(adj))	R-sq(pred)
2.93307	97.83%	95.65%	89.44%

Thrust force = 73.52 - 0.01140 Speed + 0.1118 Feed + 4.297 Dia of drill .

Using the composite desirability value, ANOVA is formulated for identifying the significant parameters. The results of ANOVA are given in the Table 1

Mathematical models have been created for finding thrust force at any feed or spindle speed for the three different drill diameters.

Conclusion

In the experimental study of optimization of drilling parameters of banana composite, the DOE was carried out using Taguchi's approach of orthogonal array. ANOVA was used to find the optimum level for thrust force. Thrust force induced due to drilling increases with feed rate from and decreases with increase in spindle speed. ANOVA analysis concluded that feed rate was the most critical parameter in controlling thrust force. The thrust force increases with the increase in the feed. The Thrust force increases suddenly with increase in point angle, but the thrust force decreases with the increase in the speed.

References:

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