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An Overview of Influence of Process Parameters in Case of Drilling of Composites

KEYWORDS: GFRP, Volume fraction, Delamination, Surface roughness

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ABSTRACT *Drilling of glass fiber reinforced plastic (GFRP) composite is substantially different from metallic materials due to its mechanical properties. Drilling of this material may generate delamination of drilled holes on work piece. The purpose of this review article is to investigate the influence of the cutting parameters, such as cutting speed, feed rate, point angle and volume fraction on delamination produced in case of drilling a GFRP composite. It is essential to measure Delamination, Surface roughness, Torque and Thrust Forces to optimize cutting parameters. Taguchi method and analysis of variance method (ANOVA) is used for minimization of delamination.*

INTRODUCTION

Drilling is one of the most fundamental and most applied metal removal operations in a real manufacturing environment because of its ability to remove material faster and reasonably good surface quality. It is used where quality is an important factor in the production of holes. Greater attention is given to dimensional accuracy and surface roughness of products by the industries in these days. Glass fibre reinforced plastic (GFRP) composites provides high specific strength/stiffness, superior corrosion resistance, light weight construction, low thermal conductivity, and high fatigue strength, ability to char and resistance to chemical and microbiological attacks. Design of experiment (DOE) is useful method in identifying the significant parameters and in studying the possible effect of the variables during the machining trials. This method also can developed experiment between a ranges from un-controllable factors, which will be introduced randomly to carefully controlled parameters. The factors must be either quantitative or qualitative. Experimental Design can be used at the point of greatest leverage to reduce design costs by speeding up the design process reducing late engineering design changes and reducing product material and labor complexity.

LITERATURE REVIEW

E.Kilickap [1] investigates the influence of the cutting parameters, such as cutting speed and feed rate, and point angle on delamination produced when drilling a GFRP composite. The damage generated associated with drilling GFRP composites were observed, both at the entrance and the exit during the drilling. Hence it is essential to obtain optimum cutting parameters minimizing delamination at drilling of GFRP composites. Moreover, this paper presents the application of Taguchi method and analysis of variance (ANOVA) for minimization of delamination influenced by drilling parameters and drill point angle. The optimum drilling parameter combination was obtained by using the analysis of signal-to-noise ratio. The conclusion revealed that feed rate and cutting speed were the most influential factor on the delamination, respectively. The best results of the delamination were obtained at lower cutting speeds and feed rates.

INPUT PARAMETERS : Cutting Speed, Feed Rate, Point Angle

OUTPUT PARAMETER : Delamination

T.V.Rajamurugan [2] et al attempt has been made to develop empirical relationships between the drilling parameters such as fiber orientation angle, tool feed rate, rotational speed and tool diameter with respect to delamination in drilling of GFR–polyester composites. The empirical relationship has been developed by using response surface methodology. The developed model can be effectively used to predict the delamination in drilling of GFRP composites within the factors and their limits are studied. The result indicated that the increase in feed rate and drill diameter increases the delamination size whereas there is no clear effect is observed for fiber orientation angle. The spindle speed shows only little effect on delamination in drilling of GFR–Polyester composites.

INPUT PARAMETERS : Cutting Speed, Feed Rate, Drill Diameter, Fibre Orientation Angle

OUTPUT PARAMETER : Delamination

K.Panikumar [3] presents an effective approach for the optimisation of drilling parameters with multiple performance characteristics based on the Taguchi's method with grey relational analysis. Taguchi's L16, 4-level orthogonal array has been used for the experimentation. The drilling parameters such as spindle speed and feed rate are optimised with consideration of multiple performance characteristics, such as thrust force, work piece surface roughness and delamination factor. Response table and response graph are used for the analysis. The analysis of grey relational grade indicates that feed rate is the more influential parameter than spindle speed. The results indicate that the performance of drilling process can be improved effectively through this approach.

INPUT PARAMETERS : Cutting Speed, Feed Rate

OUTPUT PARAMETERS : Thrust force, Delamination, Surface Roughness.

I.El-Sonbaty [4] et al to investigate the influence of some parameters on the thrust force, torque and surface roughness in drilling processes of fiber-reinforced composite materials. These parameters include cutting speed, feed, drill size and fiber volume fraction. The quasi-isotropic composite materials were manufactured from randomly oriented glass fiber-reinforced epoxy, with various values of fiber volume fractions (Vf), using hand-lay-up technique. Two components drill dynamometer has been designed and manufactured to measure the thrust and torque during the drilling process. The dynamometer was connected with a data acquisition, which installed in a PC computer

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INPUT PARAMETERS : Speed, Feed, Drill dia., Volume fraction.

OUTPUT PARAMETERS : Thrust force, Torque, Surface roughness.

J.Paulo Davim [5] et al study of the cutting parameters (cutting velocity and feed rate) under specific cutting pressure, thrust force, damage and surface roughness in Glass Fiber Reinforced Plastics (GFRP's). A plan of experiments, based on the techniques of Taguchi, was established considering drilling with prefixed cutting parameters in a hand lay-up GFRP material. The analysis of variance (ANOVA) was performed to investigate the cutting characteristics of GFRP's using Cemented Carbide (K10) drills with appropriate geometries. The objective was to establish a correlation between cutting velocity and feed rate with the specific cutting pressure, thrust force, damage factor and surface roughness, in a GFRP material. input and output parameters are as under.

INPUT PARAMETERS : Cutting Velocity, Feed Rate

OUTPUT PARAMETERS : Cutting pressure, Thrust force, Damage factor, Surface roughness.

N.S.Mohan [6] et al show the drilling parameters and specimen parameters evaluated were speed, feed rate, drill size and specimen thickness. A series of experiments were conducted using TRIAC VMC CNC machining center to machine the composite laminate specimens at various cutting parameters and material parameters. The measured results of delamination at the entry and exit side of the specimen were measured and analyzed using commercial statistical software MINITAB14. The experimental results indicated that the specimen thickness, feed rate and cutting speed are reckoned to be the most significant factors contributing to the delamination. A signal-to-noise ratio is employed to analyze the influence of various parameters on peel up and push down delamination factor in drilling of glass fibre reinforced plastic (GFRP) composite laminates. The main objective of this study is to determine factors and combination of factors that influence the delamination using Taguchi and response surface methodology and to achieve the optimization machining conditions that would result in minimum delamination. From the analysis it is evident that among the all significant parameters, specimen thickness and cutting speed have significant influence on peel up delamination and the specimen thickness and feed have more significant influence on push down delamination. Confirmation experiments were conducted to verify the predicted optimal parameters with the experimental results, good agreement between the predicted and experimental results obtained to be of the order of 99%.

INPUT PARAMETERS : Material Thickness, Speed, Feed, Drill diameter

OUTPUT PARAMETERS : Delamination

H.Hochenga [7] et al show the experimental investigation described in this paper examines the Theoretical predictions of critical thrust force at the onset of delamination, and compares the effects of these different drill bits. The results confirm the analytical findings and are consistent with the industrial experience. Ultrasonic scanning is used to evaluate the extent of drilling-induced delamination. The advantage of these special drills is illustrated mathematically as well as experimentally, that their thrust force is distributed toward the drill periphery instead of being concentrated at the center. The allowable feed rate without causing delamination is also increased.

INPUT PARAMETERS : Different Drill bit.

OUTPUT PARAMETERS : Delamination

M.A.J.Bosco [8] et al investigates a study on cutting parameters on the delamination in drilling of armour steel Glass fiber reinforced sandwich composites. Armour steel is used as a sandwich, which is fixed between the two glass fiber reinforced composite plates. The influence of cutting parameters on delamination in drilling is investigated in detail. From the analysis of the results, it has been known that the feed rate is the highly influential parameter which affects the delamination in drilling of sandwich composites. The results are analysed through graphs.

INPUT PARAMETERS : Speed, Feed, Drill diameter

OUTPUT PARAMETERS : Delamination

T.V.Rajamurugan [9] et al show that attempt has been made to establish an empirical relationship between the thrust force and drilling parameters(tool rotational speed, tool feed rate, drill diameter and fiber orientation angle) in drilling of GFRP Composites. Statical tool such as design of experiments, analysis of variance, and regression analysis are used to develop the relationship. The developed relationship can be effectively used to predict the thrust force of drilled holes at the 99 percent confidence level.

INPUT PARAMETERS : Speed, Feed Rate, Drill Diameter, Fibre Orientation Angle

OUTPUT PARAMETERS : Thrust force

SUMMARY

It is reviewed from above articles that cutting parameters such as cutting speed and feed rate, and point angle has maximum effect on delamination produced in drilling a GFRP composite. The conclusion revealed that feed rate and cutting speed were the most influential factor on the delamination, respectively. Parameters such as spindle speed and feed rate are optimised with consideration of multiple performance characteristics, such as thrust force, work piece surface roughness and delamination factor.

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