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STUDY AND OPTIMIZATION OF DRILLING PARAMETERS IN GFRP

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***Abstract*- Glass fiber reinforced plastics are finding increased applications in various engineering field.GFRP composite materials offer superior properties such as high specific strength, high specific modulus of elasticity, high damping capacity, good corrosion resistanceexcellent fatigue resistance, good dimensional stability and a low coefficient of thermal expansion. In these fields, the drilling of GRFP composite materials is generally needed for the joining of composite structures. However, drilling of GFRP implies coping with problems that are not encountered when machining other conventional materials. The drilling of GFRP composite materials may lead to widespread damage and may cause many problems, such as fiber delamination, fiber breakage, fiber pull out, stress concentration, thermal damage, micro cracking, etc. This work has involved the determination of different factors affecting the hole quality and cause of delamination in a GFRP. The various process parameters like different twist drill bits of different point angle and different materials have been taken. The thrust forces and torque were measured for different machining conditions. By the use of DEFORM 3D software we simulate drilling process and we measure thrust forces and torque on varying the feed rate, speed, point angle. By the results optimal value of thrust force and torque are optained.**

***Index Terms*- GFRP Composite, Speed, Feed rate, Drill size, Point angle, DEFORM 3D,Thrust force and Torque**

I. INTRODUCTION

Drilling is the cutting process of using a drill bit in a drill to cut or enlarge holes in solid materials, such as wood or metal. Different tools and methods are used for drilling depending on the type of material, the size of the hole, the number of holes, and the time to complete the operation. Drilling is a cutting process in which a hole is originated or enlarged by means of a multipoint, fluted, end cutting tool. As the drill is rotated and advanced into the workpiece, material is removed in the form of chips that move along the fluted shank of the drill. A composite material is a heterogeneous material created by the synthetic assembly of two or more components, one a selected filler of reinforcing material and the other a compatible matrix binder, in order to obtain specific characteristics and performance. The binder and the filler have two very different properties but when combined together form a material with properties that are not found in either of the individual materials. Machining of composites involves the removal of any extra or unwanted material. Some of the most common machining processes are drilling, turning, and milling. Earlier composites machined like metals. But poor surface finish and faster tool wear led to the further study of composite machining. Unlike metals, composites need separate tools and working conditions. Although tools used for machining of metals can still be used for composites, care must be taken to maintain optimum levels of, feed rate, thrust force, and other factors. Metal tools tend to wear out faster when used for machining of non-metals. One of the main advantages of composites has been the fact that an entire part can be manufactured. This minimizes the machining of composites. However with “part integration,” sometimes composites need to be joined to form a larger part, which means that a certain amount of machining needs to be done for composites too. “A typical aircraft wing might have as many as 5,000 holes” Hence, machining is a cost factor in the production of composites. A composite might have to go through all or some of the machining processes like milling, drilling and cutting.

II. DELAMINATION

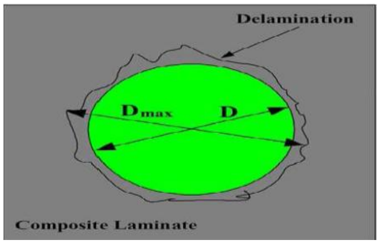
Delamination is defined as “the separation of the layers of material in a laminate.” Delamination can occur at any time in the life of a laminate for various reasons and has various effects. **Delamination factor** is defined by ratio of maximum diameter(of damaged zone around hole) to actual diameter.

Delamination factor = D max/D actual

Where

D max is damaged diameter around the hole

D actual real diameter to be drilled



III. SPECIMEN

Composite laminates are made from cross-ply glass fiber. The reinforcement was in the form of E-glass fiber tape and the matrix was Epoxy resin. The specimen plates are cut into same pieces of dimension 14cm×12 cm.10 layered lamina make the plate thickness of 5mm.Fiber volume fraction is 0.56–0.60 and specimen having density valued 3.6-3.8 gm/m3.

Table 3.1: Different properties of specimen material (GFRP)

Modulus of elasticity (X-direction)	75 GPa
Allowable tensile stress (X-direction)	560 MPa
Modulus of elasticity (Y-direction)	13 GPa
Bulk modulus	5.0 GPa
Poisson's ratio	0.3
Allowable tensile stress (Y-direction)	37 MPa

IV. DRILL BIT

High speed steel (HSS) is a form of tool steel; HSS bits are hard, and much more resistant to heat than high carbon steel. They can be used to drill metal, hardwood, and most other materials at greater cutting speeds than carbon steel bits, and have largely replaced carbon steels.

The hardness of an HSS drill bit allows for drilling at high speeds, yields better results and avoids overheating of both the bit and the material being drilled.

HSS composition 5.60- 6.40% Tungsten; 5.60- 6.40% Molybdenum; 5.0 to 7.0% Cobalt 1.20 - 1.40% carbon; 0.50% Manganese; 1.00% maximum Silicon; 3.5 to 4.5% Chromium; 2.25-2.75% Vanadium

V. VARIOUS INPUT PARAMETERS

1. Point angle
2. Feed rate
3. Speed

After research it has been found that above are important input parameters for studying Thrust forces and Torque. After literature review three main input parameters are Speed, Feed Rate, Point Angle are used for experimentation. Three type of point angle, spindle speed, and feed rate has beed used for experimentation. The specimen is made of Glass fiber reinforced plastic. The reinforcement was in the form of E-glass fiber tape and the matrix was Epoxy resin. The standard high-speed steel, twist drill of 10 mm diameter with different point angles was used in the present investigation.

VI. DESIGN OF EXPERIMENT

The objective of this research work is to study the effect of different parameters such as point angle, feed rate and speed for this design models have been prepared by choosing three levels:

- Three levels of point angles have been used.
- Three levels of feed rate have been used.
- Three levels of speed have been used.

The two most important outputs are thrust force and torque for this research work has been Analyzed . The effect of the variation in input process parameter will be studied on these two Response parameters and the experimental data will be analyzed as per Taguchi method to find out the optimum machining condition.

SELECTION OF ORTHOGONAL ARRAY & PARAMETER ASSIGNMENT

In this experiment, there are three parameters at three levels each. L27 (3*3) has been used for this experiment. Taguchi design for experimentation by applying L27 orthogonal array by taking three levels for each factor

Table 7.1 input parameters

Control Factor	Unit	Level 1	Level 2	Level 3
Point angle	Degree	90	104	118

Feed	Rev/Min	0.1	0.2	0.3
Speed	RPM	600	1200	1800

VII. DEFORM 3D SOFTWARE

DEFORM-3D is a powerful process simulation system designed to analyze the three-dimensional (3D) flow of complex metal forming processes. DEFORM-3D is a practical and efficient tool to predict the material flow in industrial forming operations without the cost and delay of shop trials.

For point angle 118° the factors need to be considers are drill diameter 10 mm, helix angle 30°, and web thickness (k) 0.9 mm. Modeling the chisel edge angle and the relief angle proved to be the most difficult to model and are very important features to model drilling simulations properly.

VIII. BOUNDRY CONDITIONS

The boundary conditions for drilling are straight forward. The edges of the workpiece are fixed in all directions. The drill bit will have a rotational velocity and a feed rate. Other parameters can be specified such as downward force and spring loaded die force, but these are usually unnecessary. The heat exchange with the environment is defined. This heat exchange is usually small because the drilling process happens very quickly.

IX. DRILL BIT AFTER MESHING

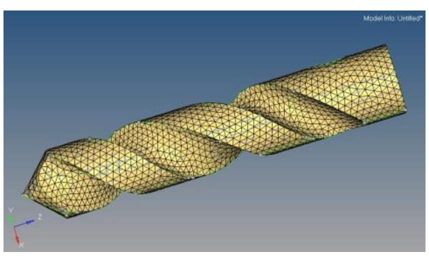


Fig 9.1 118° point angle drill bit

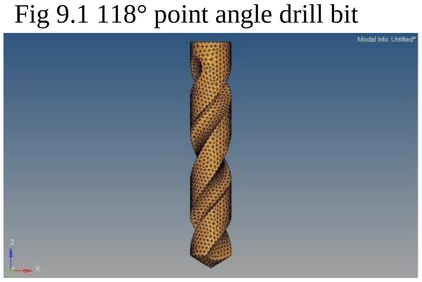


Fig 9.2 104° point angle drill bit

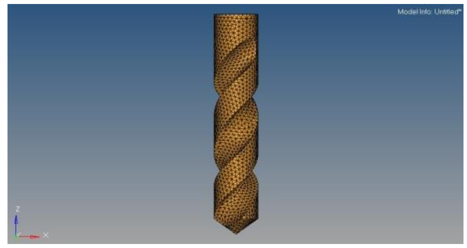
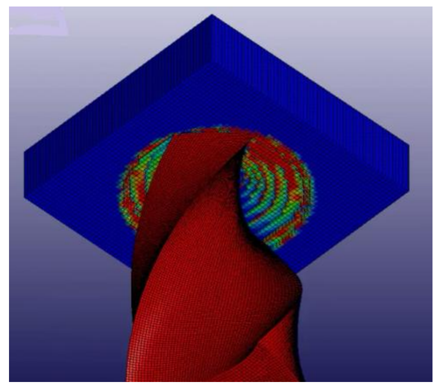


Fig 9.3 90° point angle drill bit

X. SIMULATION PROCESS

The DEFORM drilling simulations, when analyzed, will show many important features. By simulating these drilling operations, many different tool geometries can be investigated without actually making the drill bits. Different workpieces can be investigated as well.



Simulation process were carried out for various point angle,feed rate and spindle speed as already prescribed in input parameters table.

XI. RESULT AND DISCUSSION

The result has been taken for three various point angles. The point angles are 90°, 104°, and 118°. In first set of result for particular point angle **thrust force** are calculated by varying speed and feed rate.

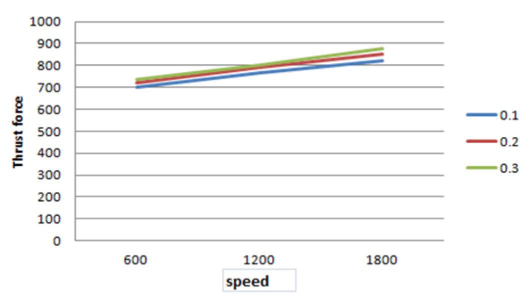


Fig 11.1 Thrust force for 90° point angle drill bit

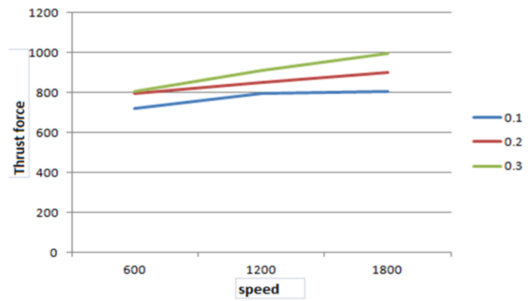


Fig 11.2 Thrust force for 104° point angle drill bit

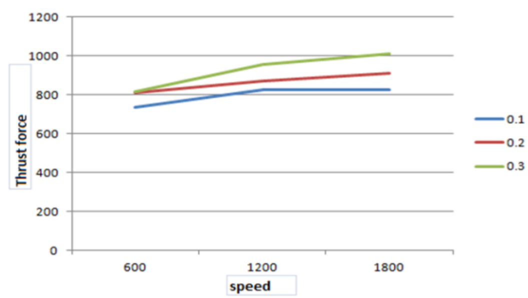


Fig 11.3 Thrust force for 118° point angle drill bit

The torque is calculated by varying the speed and cutting feed rate in a particular point angle. The speed varied from 600 to 1800 with the interval of 600. And the considerable feed rates are 0.1, 0.2, and 0.3.

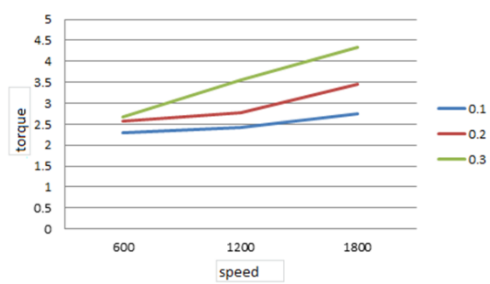


Fig 11.4 Torque for 90° point angle drill bit

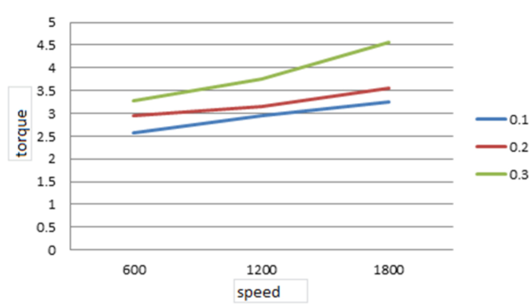


Fig 11.5 Torque for 104° point angle drill bit

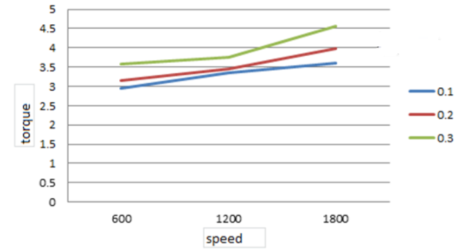


Fig 11.6 Torque for 118° point angle drill bit

XII. CONCLUSION

A drilling tool has been designed in CATIA and thrust force and torque acting on the drilling tool has been obtained by simulating the designed tool in DEFORM 3D FEA Simulation. The thrust force increased with increasing the cutting speed and feed. In torque the effect of changing feed rate increased the torque. The torque value is more at higher speeds compared to that at lower speeds.

REFERENCES

1 Ali Faraz, DirkBiermann, KlausWeinert, “Cutting edge rounding: An innovative tool wear criterion in drilling CFRP composite laminates” International Journal of Machine Tools & Manufacture 49 (2009) 1185–1196.

2 S. Jayabal, U. Natarajan, “Optimization of thrust force, torque, and tool wear in drilling of coir fiber-reinforced composites using Nelder–Mead and genetic algorithm methods” Int J Adv Manuf Technol (2010) 51:371–381.

3 R. Vimal Sam Singh, B.Latha, and V.S.Senthilkumar “Modeling and Analysis of Thrust Force and Torque in Drilling GFRP Composites by Multi-Facet Drill Using Fuzzy Logic” International Journal of Recent Trends in Engineering, Vol. 1, No. 5, May 2009.

4 L.M.P. Durão, D.J.S. Gonçalves, J.M.R.S. Tavares, V.H.C. Albuquerque, A.T. Marques and A.M. Baptista “Drilling of Carbon Fiber Reinforced Laminates – a Comparative Analysis of Five Different Drills on Thrust Force, Roughness and Delamination” Materials Science Forum Vols. 636-637 (2010) pp 206-213

5 Ali Faraz DirkBiermann,KlausWeinert "Cutting edge rounding: An innovative tool wear criterion in drilling CFRP composite laminates" International Journal of Machine Tools & Manufacture 49 (2009) 1185–1196

6 Panagiotis Kyratsis "Thrust force prediction of twist drill tools using a 3D CAD system application programming interface" Int. J. Machining and Machinability of Materials, Vol. 10, Nos. 1/2, 2011

7 Ozden Isbilir & Elaheh Ghassemieh "Finite Element Analysis of Drilling of Carbon Fibre Reinforced Composites" Appl Compos Mater DOI 10.1007/s10443-011-9224-9 40