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Machining of Glass Fiber Reinforced Plastic

Raj Kumar Verma[1], Dr. Jaswanti[2], Seema Singh[3], K.L.Meena[4]
[1]Mechanical Engg Deptt,Beant College of Engineering & Technology, Gurdaspur, Punjab, India.
[2]Electrical Engg Deptt, Chandigarh College of Engineering & Technology (CCET), Chandigarh, India.
[3,4]Mechanical Engg Deptt, Chandigarh College of Engineering & Technology (CCET), Chandigarh, India

ABSTRACT

Glass fiber reinforced plastic (GFRP) composite materials are a feasible alternative to engineering materials. It's have excellent properties such as high strength to weight ratio, high stiffness to weight ratio, higher fatigue limit, better impact characteristics, corrosion resistance and design flexibility. One of the major machining operations that are carried out on fiber reinforced metal composite materials owing to the need for components assembly in mechanical structures is, drilling. There are many problems encountered when drilling fiber-reinforced composites. These problems include delaminating of the composite, rapid tool wear; poor surface roughness and fiber pull out. In present experiment the effect of various machining parameters i.e. cutting speed, the feed rate, and the drill diameter on the quality of the drilled holes produced after drilling of fiber reinforced plastic sheet. Surface roughness of each hole is measured with help of Perthometer. ANOVA Technique has been employed to study the effect of the interactions between different drilling parameters on surface roughness of holes. After experiments suggests the optimal conditions for better surface roughness.

Key words : ANNOVA, Composite Material, Deviation, GFRP, and Perthometer.

1. INTRODUCTION

The Glass fiber reinforced plastic (GFRP) composite materials have excellent properties such as high strength to weight ratio, high stiffness to weight ratio, higher fatigue limit, better impact characteristics, corrosion resistance and design flexibility. So that it's have wide applications. In Automotive sector, composites are widely used in the designs of engine blocks, push rods, frames, piston rods etc. In Electrical sector, used in motor brushes, cable electrical contacts etc. In medical sector, used in Prostheses and manufacturing of wheel chains etc. In sports sector, fiber reinforced plastics are widely used in tennis racquets, ski poles, skis, fishing rods, golf clubs, bicycle frames, motor cycle frames etc. and Textile sector.

The major machining operations for components assembly in mechanical structures is, drilling. It is most commonly used machining processes in various industries such as automotive, aircraft and aerospace, Dies/Molds, Home Appliance, Medical and Electronic equipment industries. The quality of the drilled hole can be critical to the life of the joints for which the holes are used. There is a huge effect of the machining parameters and tool conditions on the damage, finish and mechanical properties of fiber reinforced composite materials, damaged the surface roughness and cutting mechanism in drilling. Aspects of hole such a waviness/roundness of its wall surface, axial straightness and roundness of the hole cross sections can cause high stresses on the joints, leading to its failure. The effects of variation of these machining parameters on drilling were analyzed by ANNOVA method. Surface roughness of each hole is measured with help of Perthometer.

2. EXPERIMENTAL SETUP

Glass fiber reinforced plastics (GFRP) have been fabricated by using hand lay-up techniques. The plan of experiment constitutes 72 experiments. There are three levels for feed rate, four levels for drill diameters and six levels for spindle speed. The first column is assigned to drill diameter (D), the second column to the spindle speed (N) & third to the feed rate (F) and the remaining to the interactions. The holes generated at the specimen with various parameters using Radial Drilling Machine. Surface roughness of the drilled holes is measured with the help of Perthometer.. The surface Texture of the drilled holes will be analyzed using high pixel camera.

Table - 1

Spindle speeds	45 rpm	125rpm	355rpm	710rpm	1000rpm
Drill Diameters	4 mm	6 mm	8 mm	10 mm	
Feed Rates	015 mm/rev	0.35 mm/rev	0.5 mm/rev		

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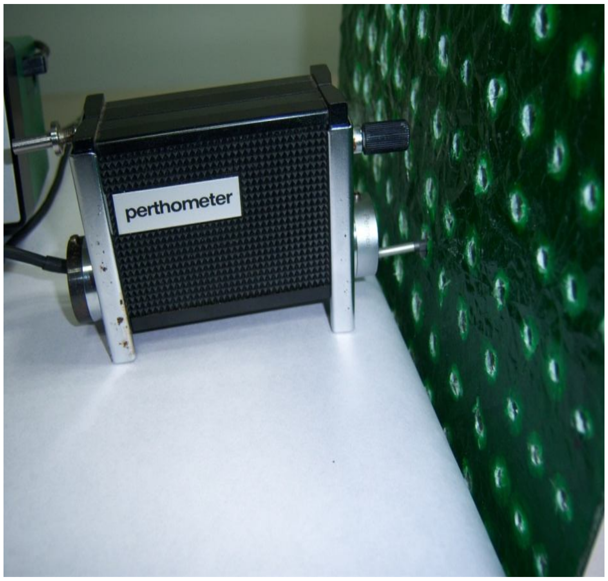

Fig: 1: Analysing surface roughness by Perthometer

3. RESULTS AND DISCUSSION

Numerical results in respect for various drilling parameters are presented in graphical form. Analyses of Variance (ANOVA) for surface roughness are shown in Table –2.

Table 2. ANOVA table for surface roughness.

Source	Degree of Freedom (DOF)	Sum of Squares (S)	Mean Square V=S/DOF	Variance ratio $F=V/V_e$	F_a=1 %	Significant
A	3	9.085	3.028	7.058	4.11	Yes
B	5	20.02	4.004	9.33	3.32	Yes
C	2	14.84	7.42	17.3	4.97	Yes
AB	15	3.02	0.2013	0.469	2.33	No
AC	6	1.12	0.1867	0.435	3.11	No
BC	10	22.9	2.29	5.34	2.60	Yes
ABC	30	3.79	0.1263	0.294	2.01	No
Error	72	30.89	0.429			
Total	143	1037				

Various Surface Roughness graphs have been plotted to analyze the variation between Spindle Speed, feed rate, drill diameter and surface roughness.

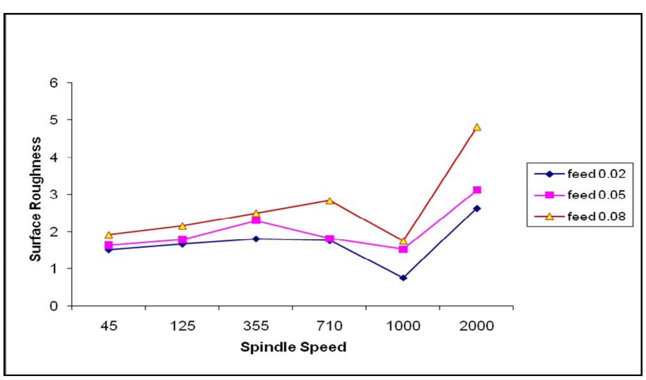

Fig. 2 (a) - 4mm ϕ Drill and different Feed Rates

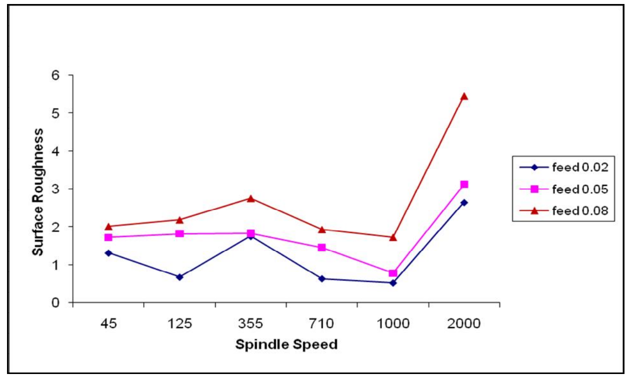

Fig 2 (b) – 6mm ϕ Drill and different Feed Rates

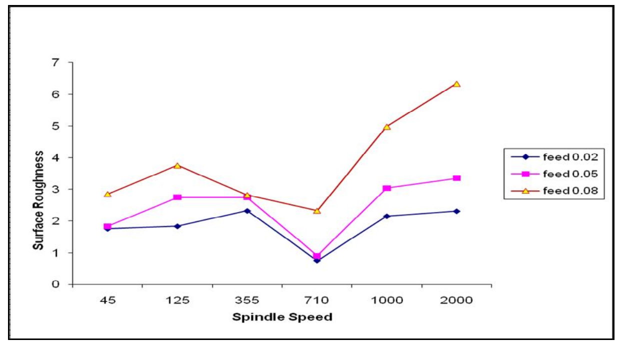

Fig 2 (c) –8mm ϕ Drill and different Feed Rates

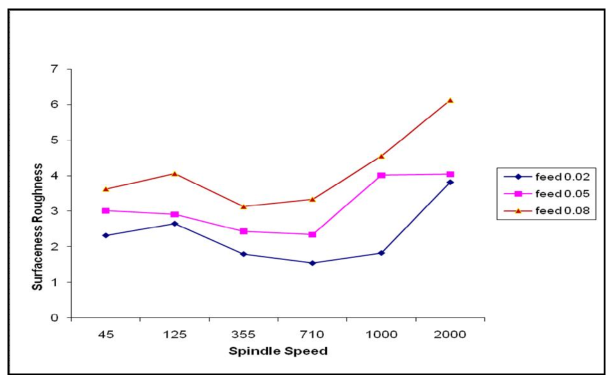

Fig 2 (d) – 10mm ϕ Drill and different Feed Rates

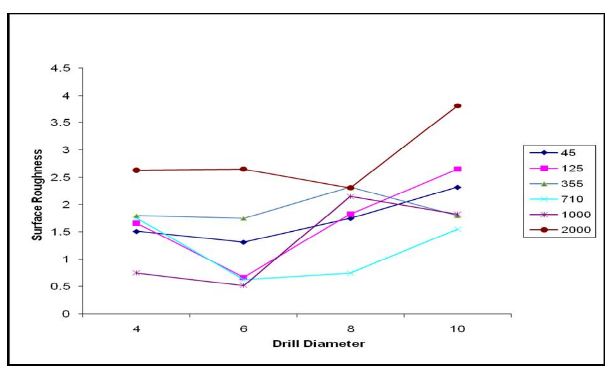

Fig 3 (a) – 0.02 mm/rev Feed Rate and different Spindle Speeds

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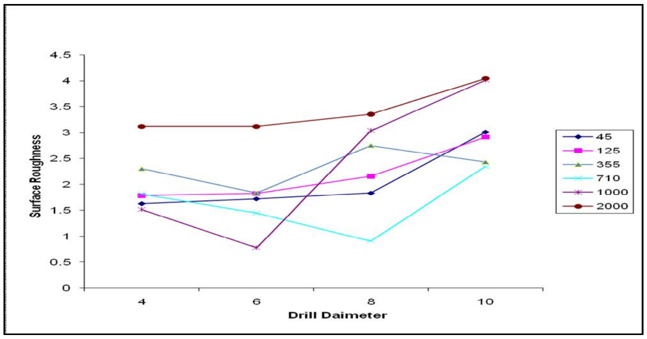

Fig 3 (b) – 0.05 mm/rev Feed Rate and different Spindle Speeds

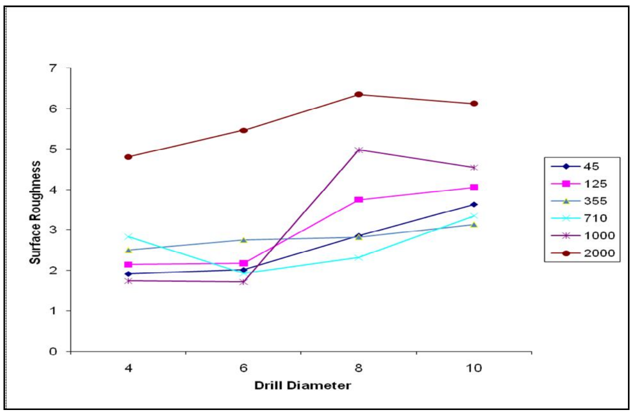

Fig 3 (c) – 0.08 mm/rev Feed Rate and different Spindle Speeds

From fig. 2(a), 2(b), 2(c), 2(d), we analyze that, with increase in feed rate, the roughness value increases.

From fig. 3(a), 3(b), 3(c), we analyze that, with increase in drill diameter, the surface roughness value increases.

From fig. 3(a), 3 (b), 3(c), we analyze that, for drill diameters of 4 mm, the surface roughness value is minimum for spindle speed of about 1000rpm.

From fig. 3(a), 3(b), 3(c), we analyze that, for drill diameter of 6 mm, the surface roughness value is minimum for spindle speed in between 710-1000 rpm. But spindle speed is more towards 1000rpm.

From fig. 3(a), 3(b), 3(c), we analyze that for drill diameter of 10 mm; the surface roughness value is minimum for spindle speed in between 355 rpm and 710 rpm.

As discussed in previous section, with the increase in drill diameter, the wear increases. So the surface quality of the drilled holes becomes poor. Hence the result that surface roughness values increases. Increase in feed rate also increases the value of surface roughness. There is a particular set of spindle speed at which the surface roughness is low.

5. CONCLUSION

For the case of surface roughness, all the three variables i.e. drill diameter, spindle speed, feed rate, interaction between spindle speed and feed rate have significant effect on the surface roughness of the drilled holes. From the different results obtained we can draw the following conclusion about drilling of fibre reinforced plastics with different drilling parameters.

- High quality surface texture can be achieved at lower values of feed rates viz.0.02 mm/rev in this case.
- Good surface texture can be obtained for lower values of drill diameters.
- Each drill diameter has a particular spindle speed at which we can obtain good surface texture.
- For 4 mm diameter, 1050 to 1100 rpm gives good surface texture.
- For 6 mm diameter, a range of 900 to 950 rpm gives good surface texture.
- For 8mm diameter, a range of 650 to 700 rpm gives good surface texture.
- For 10 mm diameter, 500 to 550 rpm gives good surface texture.

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