

A Study on Surface Roughness of Turning of E –Glass FRP Composite

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ABSTRACT: The fiber reinforced polymer composites (FRP) are used in a variety of structures, ranging from spacecraft to aircraft to buildings and bridges. Accordingly, the need for accurate machining of composites has increased. Superior specific strength and stiffness of fiber-reinforced composites compared to traditional metals and alloys high corrosion resistance and capability to withstand hostile environmental conditions and ability of tailoring additional properties has made advanced composites in general and fiber-reinforced polymer composites in particular indispensable for various industries. Machining of composite materials is difficult to carryout due to the anisotropic and non-homogeneous structure of composites and to the high abrasiveness of their reinforcing constituents. There has been a great interest for improving the machining of composite materials. Surface roughness (Ra), is an important parameter in the manufacturing engineering, for produced components. This paper describes a study of the influence of cutting force on surface roughness in turning of glass-fiber-reinforced plastics (GFRP). A plan of experiments was performed on controlled machining with cutting parameters prefixed in work piece. A statistical technique, using full factorial design has been employed to investigate the influence of cutting parameters on surface roughness in turning GFRPs rods using carbide cutting tools. The objective was to obtain the effect of the cutting parameters namely cutting velocity, feed rate and depth of cut on the surface roughness of GFRP work piece.

KEYWORDS: Glass fiber reinforced plastics; surface roughness; carbide tool; Tool dynamometer:

I. INTRODUCTION

The need to reduce weight and increase performance combined with minimum maintenance problem in aircraft, automobile and other applications has led to the development of glass-fibre-reinforced plastics (GFRPs) GFRPs are characterized by high strength, stiffness and simultaneously low weight, and are superior to metallic materials in many cases. In addition, fatigue strength/weight ratios of many FRPs are excellent. Therefore, GFRPs have replaced conventional materials like resistant or structural elements in a great number of applications. The use of GFRPs requires the development of suitable manufacturing processes for obtaining mechanical pieces with rigorous dimensional characteristics and a correct surface roughness. Turning is a commonly used machining operation in the industry, producing a variety of components and meeting high accuracy and reliability requirements. Mating surfaces for many tribological applications are processed currently by turning operations. Therefore, modeling of the turning database to associate cutting parameters with cutting performance is very important for the industry. Turning of GFRPs differs from turning of metals, because they are anisotropic and inhomogeneous material. The physical and thermal properties of fibres and polymer matrix are different and depend largely on the type of fibre, the fibre content, the fiber orientation and variabilities in the matrix material. This fact has an important influence on the machinability and the tribological behavior of GFRPs. The high mechanical resistance of fibres is the reason for an excessive wear down of cutting tool and a great damage in the polymeric matrix, since the fibres are taken of the matrix. In general, a cutting tool fails by gradual wear or by fracturing. The degree of tool wear influences the surface quality. The exact degree of surface roughness can be of considerable importance, affecting the functioning of a component made of GFRPs. Surface roughness is also important in areas such as contact mechanics, fluid flow and semiconductor surfaces. It has been found that surface roughness highly dependent on the cutting parameters.

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II. EXPERIMENTAL PROCEDURE

In order to achieve the objective of this experimental work, mainly obtaining the influence of cutting parameters on surface roughness in turning process with carbide cutting tools, machining issues were effectuated with different cutting parameters.

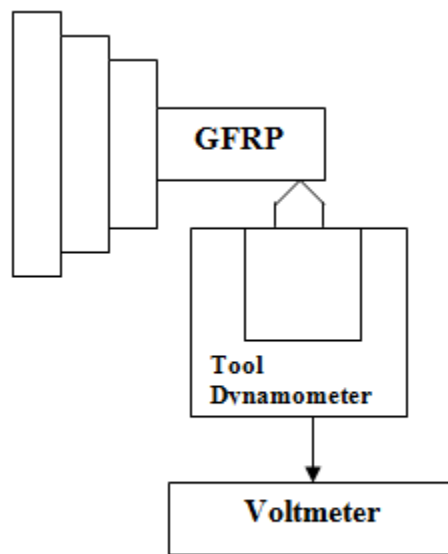


Fig. 1. Schematic diagram of the experimental apparatus.

The GFRP workpiece in this study is of cylindrical rods with a 45 ° fiber angle. The components of GFRP subjected to the present experiments are glass fiber and epoxy resin.

Fig. 1 shows the experimental apparatus using an Engine lathe (all geared). In order to measure the cutting force, the tool holder is installed in a dynamometer, the cutting force signal being measured by a pick-up and passed to a voltmeter.

III. EXPERIMENTAL RESULTS AND DISCUSSION

3.1. Analysis of surface roughness

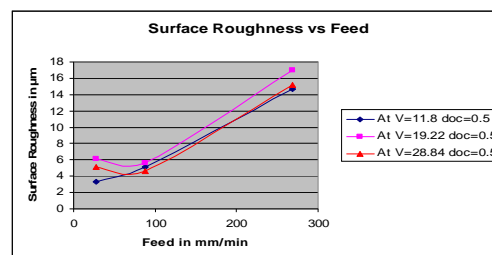


Fig.2.a. Surface roughness vs. feed at doc=0.5mm

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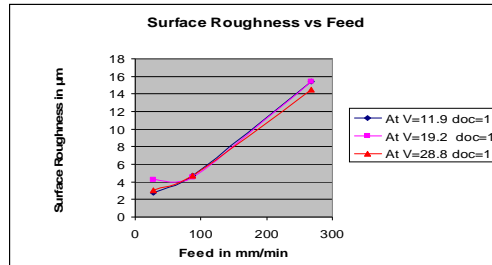


Fig.2.b. Surface roughness vs. feed at doc=1.0mm

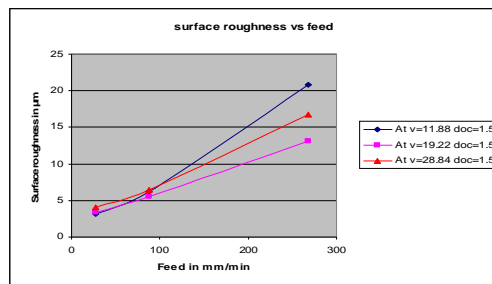


Fig.2.c. Surface roughness vs. feed at doc=1.5mm

The Figures fig 2a, fig 2b and fig 2c shows the surface roughness of GFRP for various feed rates, with a fixed depth of cut of 0.5, 1.0 and 1.5 mm respectively. Surface roughness increases with increase in feed rate in all the above cases. As the feed rate increases there is a gradually increase in surface roughness at lower speed and lower depth of cut, but there is a steep increase in surface roughness at lower speed and higher depth of cut. At lower depth of cut and lower speed, surface roughness increases gradually with the increase in feed rate. Whereas, there is a steep increase in surface roughness at lower speed and at higher depth of cut. It is found that the surface roughness is minimum at speed 11.88m/min, depth of cut is 1.0mm and feed rate of 27mm/min as shown in fig 2b. As there is an increase in the feed rate and depth of cut in the medium range, it has a deleterious effect on surface quality in GFRP machining, a further decrease in the feed rate and depth of cut or further increase in the feed rate and depth of cut is thus required for obtaining good surface quality.

The minimum surface roughness Ra is 2.75.

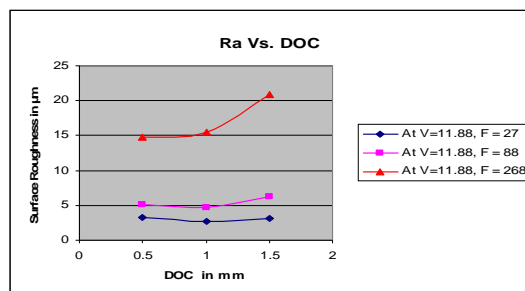


Fig.3.a. Surface roughness vs. doc at v=11.88

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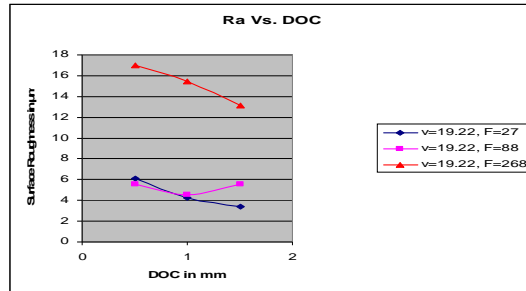


Fig.3.b. Surface roughness vs. doc at v=19.22

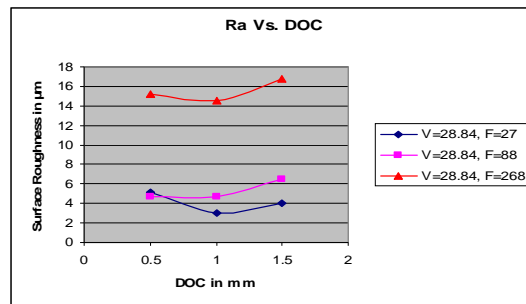


Fig.3.c. Surface roughness vs. doc at v=28.84

The Figures fig 3a, fig 3b and fig 3c show the relationship between the surface roughness and the depth of cut at constant cutting speed and the feed rate. High feed rate affects surface roughness largely, but depth of cut has less influence. This phenomenon is such that the plastics in GFRP are of good machinability, but the glass fiber itself is difficult to cut because of brittleness, this quality of the fibers influencing the machining properties of the composites.

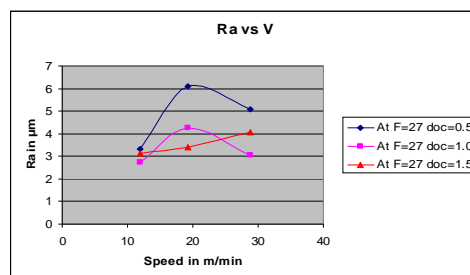


Fig.4.a. Surface roughness vs. cutting speed at F=27

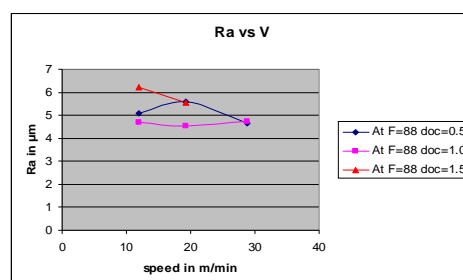


Fig.4.b. Surface roughness vs. cutting speed at F=88

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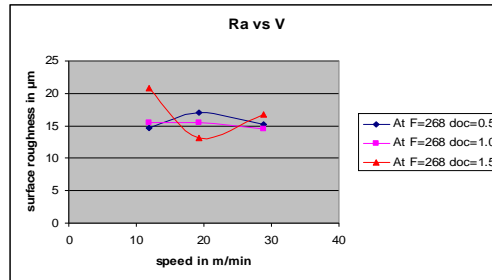


Fig.4.c. Surface roughness vs. cutting speed at F=268

The Figures fig 4a, fig 4b and fig 4c have shown the change in surface roughness with cutting speed, at constant feed rate and depth of cut. It is noted that there is no much change in the surface roughness in relation to increases in the cutting speed: this phenomenon is therefore very different from that in ordinary metal cutting. The surface roughness according to the depth of cut and the cutting speed in GFRP cutting is affected significantly by the feed rate.

3.2. Analysis of cutting force

The Figures fig 5a, fig 5b and fig 5c have shown the relationship between the cutting force and the depth of cut at constant feed rate. The cutting force increases with increase in the depth of cut at higher and lower feed rate in all the above cases. But the cutting force It is also observed that the force increases as the depth of cut increases at lower feed rate. Therefore cutting force is found to be higher at low feed rate.

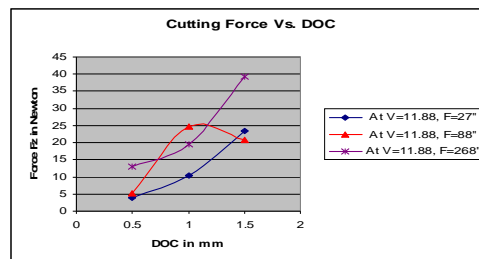


Fig.5.a. Cutting force vs. doc at V=11.88

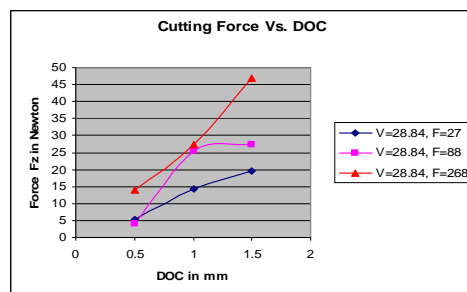


Fig.5.b. Cutting force vs. doc at V=19.22

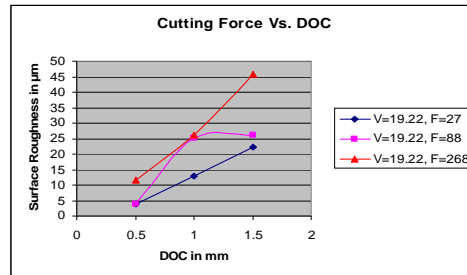


Fig.5.c. Cutting force vs. doc at V=28.84

IV. CONCLUSIONS

From the experimental results in the machining of GFRP, particular conclusions emerge, as follows:

1. Feed rate 27mm/min and depth of cut 1.0mm is found to be optimum for good surface quality.
2. Surface quality is improved with decrease in the feed rate.
3. At lower feed rate, lower depth of cut and lower cutting speed the cutting force is minimum.
4. For minimum surface roughness the optimum cutting force is 10.45N.

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