Effect of Feed Rate on Surface Roughness in Abrasive Waterjet Machining of Jute Fibre Reinforced Polyester Composites

Kalirasu S, Rajini N, Rajesh S, Jessy Michla J. R, Sathish kumar S.

***Abstract**: The common fiber strengthened composite are as a rule progressively utilized in different applications like space, flying machine, marine, building and car segment on account of their prevalent physical and mechanical properties despite the fact that they are somewhat expensive. AWJM speaks to a worldwide adaptable instrument supporting the machining of every normal material that are with no harm by straight contact with water. In this present work plans to explore jute fiber strengthened unsaturated polyester resin composite material investigating surface Roughness by changing three parameters, for example, Pressure, Standoff distance and Feed rate an ideal state of the material can be found and furthermore investigation of the cut surface geography after grating water stream machining. Rough utilized for cutting is garnet 80 mesh abrasive particles. It catalyzes the cutting and gives phenomenal surface completion.*

***Keywords**: Jute Fiber, Surface Roughness, Abrasive water jet Machining*

I. INTRODUCTION

Progressed machining is the developing innovation contributed in various building segments in the field of aviation, marine, design and vehicle areas. In mechanically created world, cutting of metals, steels and combinations are simple yet machining regular composite fibre is an extreme occupation in light of warm impact happens in the material. Biodegradable materials have shown up greater scope among the researchers as well as in the industrial areas [1]. More commonly natural fibers such as aramid, basalt, coconut sheath, banana fiber, glass, etc. are used for its better properties. [2]. In some cases, hybrid composites for example Basalt-Curaua fiber is used for its enrichment mechanical properties without affecting the durability [3]. this exploration work dominatingly covers on surface harshness on JF/UPR composites.

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Explored on rigidity on regular filaments and ordered into two gatherings and jute is characterized into elite characteristic fibre [4]. Explored mechanical properties of common strands and said that jute material is useful for its flexural property. Numerous works have been tended to utilizing AWJM for fiber fortified polyester composites [5, 6, and 7]. S. Abrate studied the benefits and negative marks of customary and different progressed machining process on composite materials concerning heat affectability, harm and instrument wear [8]. Distributed a detail consider on grating water stream machining process on glass/epoxy composite cover and affirmed that by expanding the active vitality of AWJM process produce better cut [9]. Inferred that with medium transverse speed satisfactory unpleasantness will be picked up and diminish of grating particles somewhat changes the surface roughness [10]. Inquired about on surface unpleasantness on aluminum combination 7075 and inferred that at low weight and low S_d surface harshness of the material is improved [11]. Inquired about on tempered steel and inferred that high transverse speed prompts less expulsion of material and abatement in S_d and V_f prompts improve machining execution and furthermore depicts that the determination of spout and opening will improve the nature of the kerf [12]. Nearness of harms in types of holes, edges, broken filaments and inserted rough particles by SEM analysis are carried out [13]. Cease that while machining SiC and Al_2O_3 by AWJM when S_d diminishes decrease cut increments. Whenever P and S_d builds decrease cut abatements. In the event that V_f is more decrease cut increases [14]. Examined multidirectional CFRP Laminates on AWJM and came about that for better surface quality high weight, low V_f and little S_d is recommended [15]. Moreover, different techniques are used to optimise the process parameters theoretically like Taguchi method, fuzzy logic, ANOVA, etc. [16]. Here, a practical approach is considered to minimise the Ra of the fabricated composite.

II. EXPERIMENTAL DETAILS

A. Materials Used

In this method, UPR is used as matrix, JF as reinforcement, methyl-ethyl-ketone peroxide (MEKP) as catalyst and cobalt napthenate as accelerator respectively. These products are delivered from vasavibala resin (P) Ltd, Chennai. While Purchasing of JF is from GVR enterprises, Madurai.

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B. Equipment Details

It has the possibility to cut the materials of approximately with speed of 0.25 mm/s without producing any toxic gas, dust or any other thermal accomplishments. The schematic diagram of abrasive water jet machining is shown in Figure 1. The diameter of the nozzle is about 0.76 mm and the sample thickness of 3mm composites laminates are used. Other parameters including the pressure limit from 150 MPa to 250 MPa, S_d is about 1mm to 3mm and the fluid velocity or the V_f is of 20mm to 40mm.

Fig. 1. A schematic diagram of AWJM

C. Fabrication Techniques

JF/UPR composites are manufactured by Hand layup technique is shown in Figure 2. The density of the jute fiber is of 1.5 g/cm^3. Hand layup manufacture forms include some type of embellishment, to shape the sap and fortification. A form apparatus is required to give the unformed resin/fiber that blends its shape before and amid fix. At first, cleaning the surface plate with wax helps to evade the matrix adhesion. Each layer of JF is of 10 gram in weight and is layered with five successions. The polyester resin was blended with 1.5 wt. % of the impetus and 1.5 wt. % of the quickening agent before it was connected on every fiber surface. Finally, layer by layer with resin coating form of material was placed on the top of the mould and subjected to cure over one day under room temperature. After 24 hours of treatment, JF/UPR composite plate (30wt %) of thickness (3mm) is obtained.

Fig. 2. Composite Fabrication by Hand layup technique

D. AWJ Machining of JF/UPR Composites

Abrasive feeder in AWJM as shown in Figure 3(a) and Figure 3(b) denote the AWJM cutting of JF/UPR composite laminate as per parameter selection.

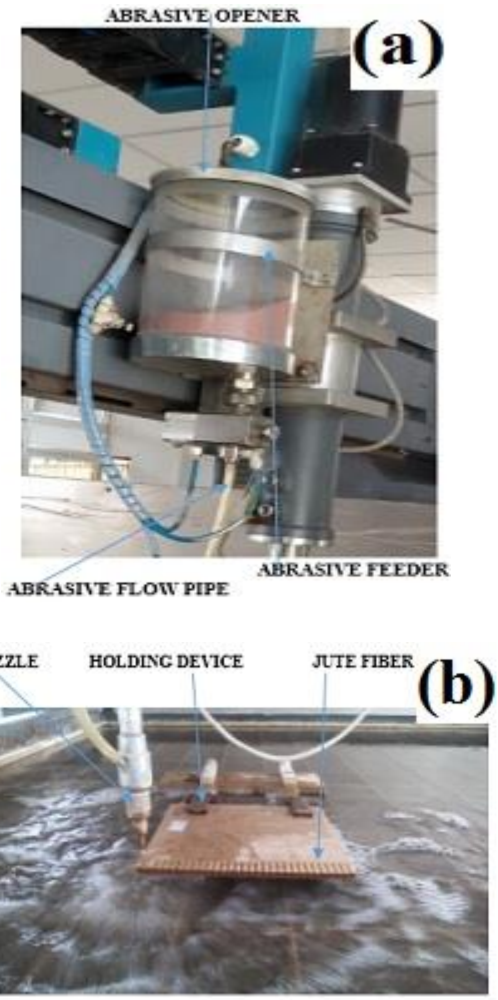

Fig. 3. (a) Abrasive Feeder (b) Nozzle setup with JF/UPR composite

E. Surface Roughness test

Once after machining the Ra of the fabricated composite machined surface is measured using Surftest SJ-301 (Make: Mitutoyo) profilometer with the speed of 0.25mm/s. The maximum measuring limit of the profilometer is about 350 μm. First of all, adjusting the probe by touching the plate and the readings are taken down based on the various intervals. Likewise, the values are measured and marked for various optimal parameters. The average of two Ra values is reported. Thus by recording the optimum condition of all materials has been analyzed.

Figure 4 (a) shows the measurement of Ra, (b) cutting direction and the arrow indicates the side of probe measures the work and (c) SEM analysis of cutting surface.

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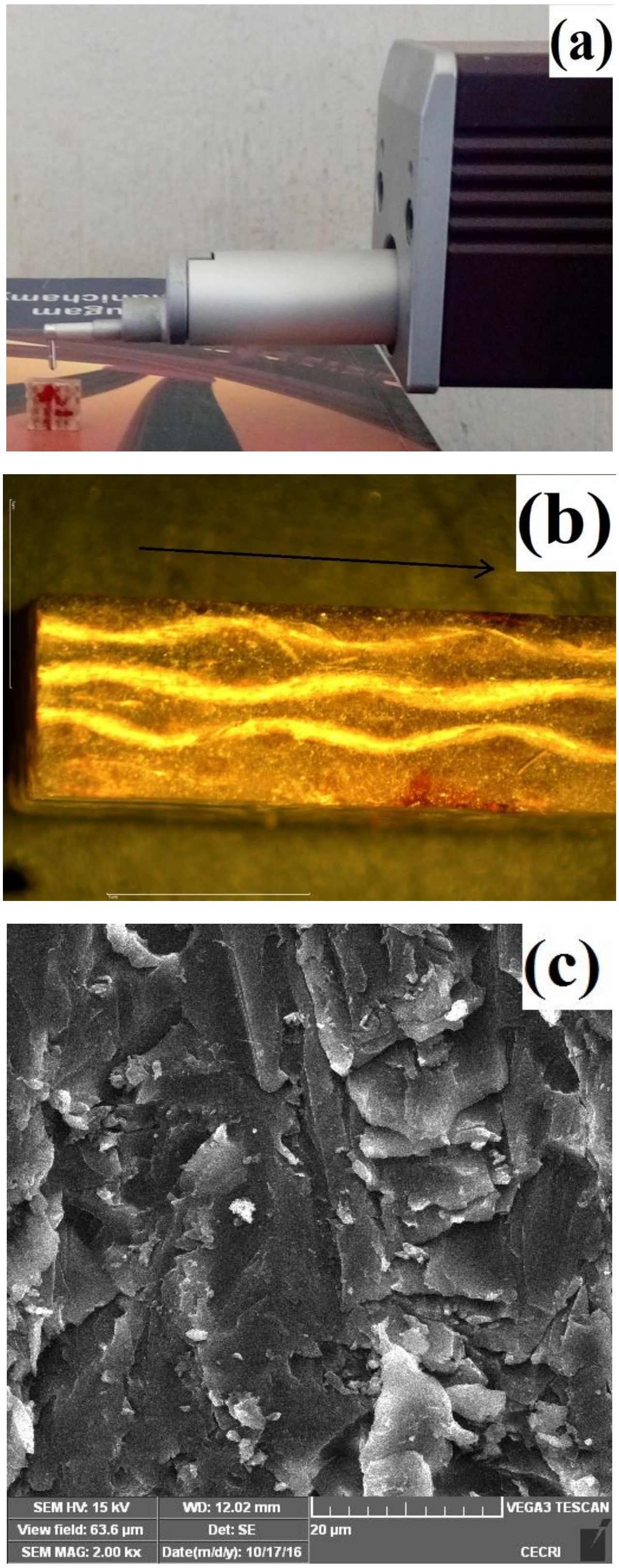

Fig. 4. (a) Roughness measurement (b) Cutting direction and (c) SEM image of cutting surface

III. RESULTS AND DISCUSSIONS

From this figure, the R_a is calculated by changing the V_f and maintaining the pressure and S_d as constant say (150 MPa and 1 mm). Accordingly increasing the V_f, the surface roughness slightly increases even after keeping the S_d and pressure the same.

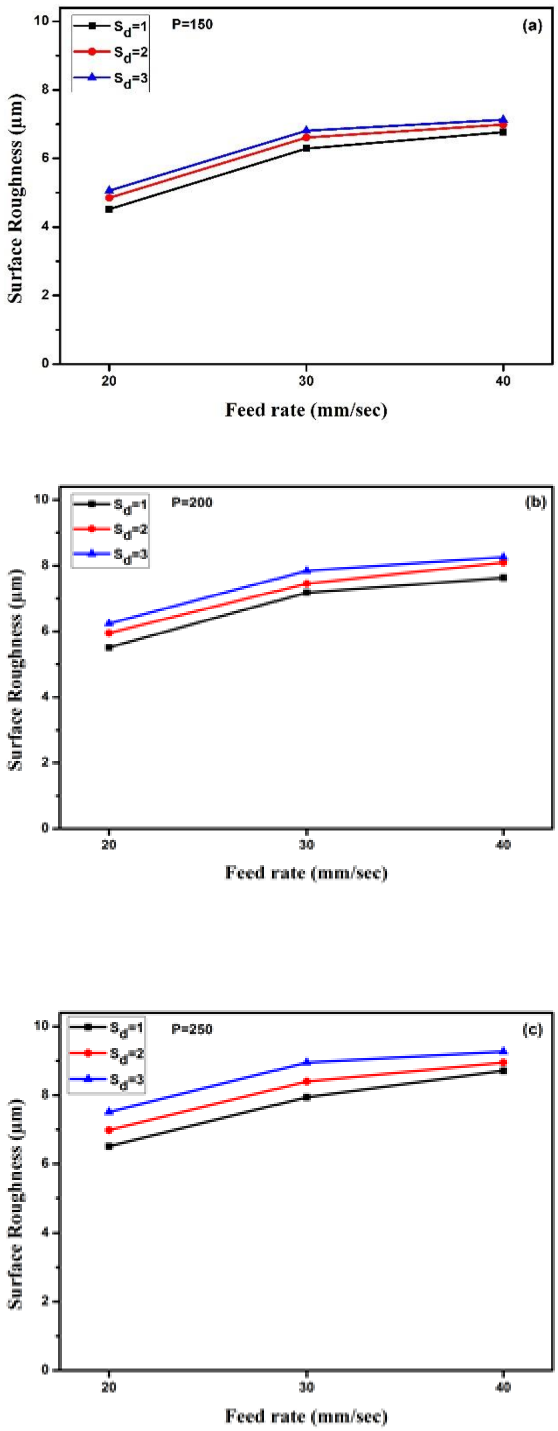

Fig. 5. Surface roughness with effect of feed rate (a) 150 pressure (b) 200 pressure and (c) 250 pressure

In the figure 5 (b and c) represents similar process for the pressure and S_d of 150 MPa, 200MPa, 250MPa and 1mm, 2mm, 3mm and by varying the feed rate the surface roughness tend to increase with increase in pressure and S_d. Finally, by comparing the three graphs, it can be concluded that when S_d and V_f is minimum the surface roughness of the material is low.

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IV. CONCLUSIONS

This experimental output is based on the surface roughness, pressure and feed rate and all such process parameters are studies and analyzed. Regarding the optimal parameters, the feed rate has the possibility to affect the outcome. It is cleared that from the graph that as P = 150MPa, S_d = 1 mm, V_f = 20 mm/sec is the optimum condition of R_a in JF/UPR material.

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