

EFFECT OF MACHINING PARAMETERS ON DELAMINATION DURING MILLED BANANA FIBER REINFORCED POLYESTER COMPOSITES

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Abstract

Natural fiber reinforced composites are recognized as better materials for structural components due to their inherent properties. However, milling these materials presents a number of problems, such as surface delamination, which appeared during the machining process, associated with the characteristics of the material and the cutting parameters. Therefore, in this study, machining parameters and the influence of the banana fibers under delamination were investigated. Result showed that machining parameters has a significance effect on the delamination of banana fiber reinforced polyester composites.

Keywords: Milling ,Delamination, Machining parameters, Natural fiber composites

Introduction

Natural fiber composites find their application in many industries like building construction, furniture, automotive and packaging due to some advantages that they offer: they are non-abrasive to machines, renewable, bio-degradable and an abundant source of fiber, are of low cost, and have acceptable mechanical properties. Natural fibers such as hemp, flax, abaca, sisal, jute, henequen (Herrera-Franco *et al.*, 2004), kenaf, ramie, sugar palm, oil palm, pineapple leaf, banana pseudo-stem, sugarcane bagasse, coir, rice husk, wood, bamboo, chicken feather (Wool, 2005), silk and cotton have been reported as being used as fibers in polymer composites.

However, in this study, a banana fiber is used as a material to reinforce a polymer matrix in polyester composite. Banana fiber is one of the most attractive fiber can be used as a reinforcement. It has several advantages, such as the environmental load is small, because it is grows rapidly, thus it is easy to regenerate after cutting, and the banana fiber has relatively high strength compared with other natural fibers.

The manufacturing of the natural fiber-reinforced composite can broadly be classified as primary and secondary manufacturing. Machining thus becomes imperative to ascertain the structural integrity of complex composite products. Slot making is one of the important machining operations to facilitate the assembly operations. Though a number of approaches have been used for making slots in composite laminates, conventional milling is the most widely acceptable and frequently practiced machining operation till date.

Conventional milling, however, results in damage in the form of delamination, micro cracks, fiber pull out and matrix burning and may ultimately cause variation in the

performance of the component. Therefore, in this study, milling of banana fiber reinforced polyester composites by using flat end mill was investigated by evaluating delamination at various spindle speed and feed rate.

Materials and Methods

The banana fiber subsequently washed by using water to remove the dirt and later dried in the sunlight until all the moisture is removed from the fiber. No chemical treatment has been made to the coconut meat husk fiber in an attempt to simulate the original strength of the fiber. The simple hand lay-up process was followed for fabricating the composites by using 10 % of fiber volume fraction. Polyester resin is used as a matrix with 1 percent of hardener (butanox M60). Polyvinyl acetate release agent was applied to the mould surfaces to avoid the composites stick between the mould. After 1 hour, the composites were removed from the mould and cured at room temperature for 24 hour. Finally, composites plates were cut to 135 mm x 35 mm.

Milling experiments were performed on an HAAS CNC milling machine and flat end mill used was made of HSS and have a diameter of 6 mm as shown in Fig. 1.



Fig. 1 Flat end mill

Besides that three cutting speeds were used are 16 m/min, 24 m/min and 32 m/min.. In addition, the feed rate used are 0.1 mm/rev, 0.2 mm/rev and 0.3 mm/rev. The depth of cut is 2 mm. Six slot were milled for each plate, and milling is done without using a sacrificial plate. The value of the delamination factor (F_d) can be obtained by using the following equation :

$$F_d = \frac{W_{max}}{W}$$

where W_{max} is the maximum width of the damage around the slot periphery and W is width of cut, as can be observed in Fig. 2.

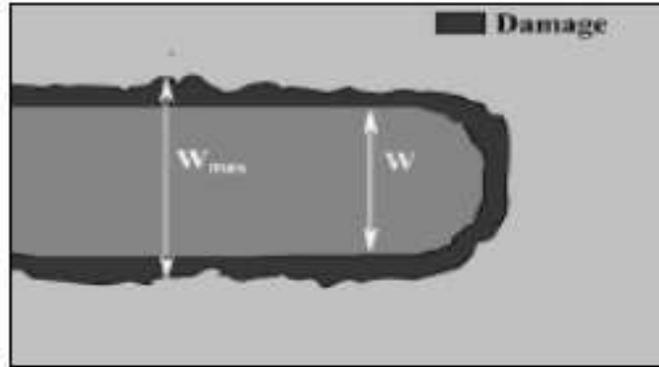


Fig. 2 Measurement of the maximum width (W_{max}).

Delamination as shown in Fig. 2, is measured using a tool maker microscope (Fig.3).



Fig. 3 Tool maker microscope

Results and Discussions

Delamination was measured according to the procedure already described. Fig. 4 shows the influence of cutting speed and feed rate by using flat end mill. The increased in feed rate of 0.1 mm/rev to 0.3 mm/rev show an increasing trend in delamination. However, for the cutting speed, it has shown a different result where by increased the cutting speed from 16 m/min to 32 m/min , the delamination factor at the highest speed showed lowest delamination size compared to the lowest cutting speed. The lowest delamination factor was from the 0.1 mm/rev feed rate and at cutting speed of 32 m/min. Meanwhile for the highest delamination factor is due when using 0.3 mm/rev and 16 m/min.

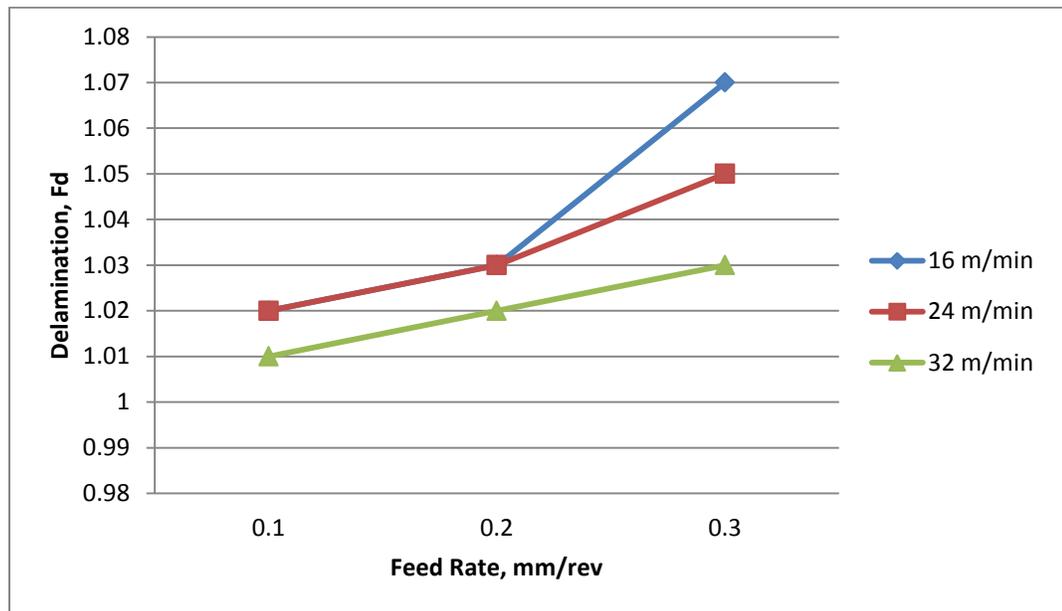


Fig. 4 Influence of cutting speed and feed rates on delamination

The result confirmed with the studied done by Davim and Reis (2003) where the author concluded that feed rate has a greater influence on delamination when higher damage by increasing the feed rate. This supported by Hocheng and Tsoa (2006) where in their work, authors concluded that thrust force varies with drill geometry and with feed rate. More recently Tsoa and Hocheng (2007) find that the influence of spindle speed was relatively insignificant. Delamination results in milling banana fiber reinforced polyester composite follow the same trend as previous researches in drilling composites where increasing the feed rate causes an increase in delamination factor. This outcome stresses the general idea that low feed rates and high cutting speed should be used when milling composites.

Conclusion

Banana fiber reinforced polyester composites has been milled under different machining parameters by using flat end mill. In can be concluded that feed rate was seen to make the largest contribution to the delamination factor. By increasing the feed rate the size of delamination also increased. Higher cutting speed also shown sudden decreased in delamination factor. The use of banana fiber as a new alternative fiber in fabricating natural fiber composites can be studied further in terms of machinability so that it can be used commercially in the future. Therefore, for the future research, it is recommended to use different tool type and geometry so that we can determine whether effect of different tool geometry will give higher or lower delamination value.

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