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Manufacturing and Delamination Study of Drilling on Glass Fiber Reinforced Plastic (GFRP)

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ABSTRACT

Glass Fiber Reinforced Polymer (GFRP) also referred to as "fiberglass rebar" are facing lot of problems in drilling operations. Different processes are being adopted in drilling operation like conventional drilling, vibration assisted drilling and ultrasonic assisted drilling. Loss of material in excess at the drilled area is the criteria for different application. The present work attempts to find the delamination of glass fiber reinforced polymer composites through incorporation of functionalized MWCNTs (Multi Walled Carbon Nano Tubes). The investigation is done on the influence of machining parameter on the delamination damage of GFRP during drilling. In conventional drilling the parameters like feed rate, tool material and cutting speed influence delamination hence machining at higher speed, harder tool material and lower feed rate have lesser delamination of the GFRP.

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INTRODUCTION

As Glass fiber reinforced plastic (GFRP) composites possess high specific strength/stiffness, superior corrosion resistance, light weight, the GFRPs are widely used in engineering applications in the fields of aero industry, automobile applications and marine applications. These materials are having added properties like resistance to chemical and microbiological attacks (Ola, A., 2015). The present work is having an importance as these are having occupied a large range of applications. Also the machining of GFRPs is an important consideration for research. Machining of the composite materials is becoming difficult because of the properties of heterogeneity, anisotropy, and high abrasiveness of fibers. Another problem faced by the machining is delamination in drilling which results fiber pull-out, hole shrinkage, spalling, fuzzing and thermal degradation (Rajamurugan, T.V., 2012). Since GFRPs are different materials a number of non-traditional machining processes like laser cutting, cutting by water-jet, ultrasonic cutting, electro discharge machining (EDM) etc., are adopted for holes making. Compared to other conventional it is difficult to make drilling in GFRPs because of the anisotropic and inhomogeneous structure of GFRPs. Generally the defects caused by drilling of GFRPs are delamination around the drill hole. The delamination result in lowering of bearing strength and can be detrimental to durability by reducing the in-service life under fatigue loads [4]. Delamination can often become a limiting factor in the use of FRPs for structural applications (Khashaba, U.A.,) This causes the present researchers to analyze the ways to improve the quality of holes in drilling of GFRPs.

Thrust force generally causes delamination and there is a 'critical thrust force' below which no damage occurs. The vibration drilling technique is to be concentrated to minimize the delamination. Both the theoretical investigations and experimental results have indicated that the machining quality of the drilled holes can be improved, as well as the thrust force being reduced by means of vibration drilling metals (Ussein M. Ali, 2013; Venkateshwaran, N. and A. ElayaPerumal).

Some research was conducted to recognize the effect of vibration in drilling and thrust force causing delamination (Murthy, B.R.,; Raghuram, K.S., Dr. N.V.S.Raju; Raja Thilagam, A. and Dr. R. Suresh Babu, 2015). These studies showed that applying vibration may reduce the amount of thrust force, delamination and wear of tool. By the process of Silanization which is the covering of a surface through self-assembly with organ of unctional alkoxysilane molecules it can reduce the thrust force and therefore the drilling induced delamination dramatically (Laxmi, N., 2015). This review paper

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shows effect of different machining process on delamination of GFRP and this will help to choose better machining process to reduce delamination while drilling of GFRP. The life of the joint can be critically affected by the quality of the drilled holes (Arif bin Ab Hadi, 2015).

Composite Fabrication:

A. ***Hand Lay-up Technique:***

Hand lay-up technique is the simplest method of composite processing. The infrastructural requirement for this method is also minimal. The processing steps are quite simple. First of all, a release gel is sprayed on the mould surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mould plate to get good surface finish of the product (Raja Ratna Kumar, V. and K.S.Raghuram) Reinforcement in the form of woven mats or chopped strand mats are cut as per the mould size and placed at the surface of mould after Perspex sheet. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardener (curing agent) and poured onto the surface of mat already placed in the mould. The polymer is uniformly spread with the help of brush. Second layer of mat is then placed on the polymer surface and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present (Aizat Abas, Z.L., 2015).

➢ Glass fiber is taken and then cut into size of 350*350 mm size and with thickness of 3 mm then different specimen were done.

1. Glass fiber with only Epoxy
2. Glass fiber without functionalized MWCNTs in Epoxy
3. Glass fiber with functionalized MWCNTs in Epoxy
4. Glass fibre with Salinized MWCNTs .

Fig. 1: Showing the Epoxy Resin and Glass Fibre

Fig. 2: Showing the Hand Lay-up Technique.

Fig. 3: of FGlass Fibre With Epoxy.

Fig. 4: of GFRP With Purified MWCNT's.

Fig. 5: of Glass Fibre With Silanized MWCNTs.

Fig. 6: of Glass Fibre With Functionalized MWCNTs.

Drilling Of Glass Fibre Composite :

Drilling experiments were conducted on a radial drilling machine. Experimental set-up consists of drilling machine, holding fixture, piezoelectric drill dynamometer, charge amplifier, connecting cables, an analog to digital (A/D) converter and a computer for data acquisition. A four component drill dynamometer was used to record the thrust force signals. These signals were then amplified using a charge amplifier. The amplified signal was passed through signal conditioning equipment to a computer system using a data acquisition card.

The Composite laminate was held in a rigid fixture attached to dynamometer mounted on machine table. Dynamometer was rigidly mounted on machine table using square headed bolts fitted into T-slots.

By Adjusting the feed and speed six holes are drilled into the glass fibre plates and the corresponding cutting forces values are noticed during the process using force dynamometer .

Delamination Factor :

Delamination can occur at any time in the life of a laminate for various reasons and has various effects. It can affect the tensile strength performance depending on the region of delamination. Among the various defects that are caused by drilling, delamination is recognized as the most critical. Other defects are spilling and fibrepull-out, but delamination can result in a reduction in the durability of the composite material and can cause a reduction in the bearing strength of the material and the structural integrity, resulting in performance issues.

Delamination has been one of the major forms of failure in drilled materials due to the composite's lack of strength in the direction of drilling. This failure can cause a reduction in the compressive load carrying capability of the structure. Some of the major reasons for the occurrence of delamination are the high thrust force and feed rate, other reasons include rapid tool wear and power. Some previous methods to avoid delamination have been to reduce the feed rate and thereby reduce the thrust force, using a backing plate. Recent methods have involved vibratory drilling

Delamination is an important problem in the use of composite materials for structural purposes since it is a method of failure that is complex to understand and duplicate on computers. It tends to occur when the laminate is under tensile forces. Delamination caused by tensile forces has been attributed mainly to the stacking sequence of laminates. It is usually caused between plies due to out-of-plane tensile stresses and is also caused by cyclic loads. This type of delamination is slow because the crack growth rate is very slow. Cyclic loads could be either tensile or compressive.

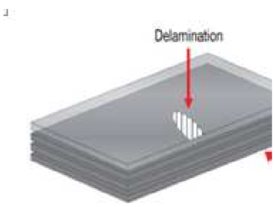

Fig. 7: Showing the delamination in layered composite material.

2.1. Peel-up at entrance:

Peel-up delamination occurs as the drill enters the laminate as shown in Figure 1(a). when the cutting edge of the drill bit come in contact with the laminate, the cutting force acting in the peripheral direction is the driving force for peel-up delamination. It generates a peeling force in the axial direction through the slope of the drill flute. The flute tends to pull away the upper laminas and the material spirals up before it is machined completely. This action results in separating the upper laminas from the uncut portion held by the downward acting thrust force and forming a peel-up delamination zone at the top surface of the laminate. The peeling force is a function of tool geometry and friction between the tool and work piece [18].

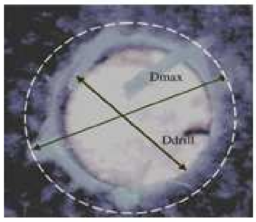

Fig. 8: Showing the delamination at the drilled hole.

The delamination factor is defined as $F_d=(D_{max}/D_{drill})$ Finding Delamination's Using Ultrasonic Testing :

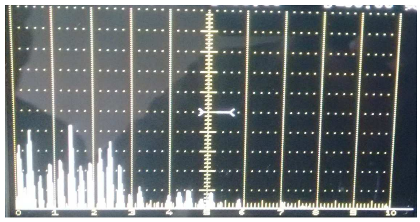

Fig. 9: Showing the Ultrasonic Testing Before Drilling Of Composite.

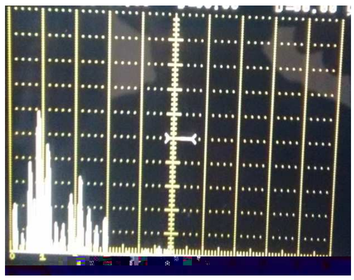

Fig. 10: Showing the Functionalized MWCNT's.

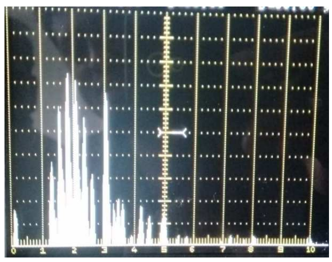

Fig. 11: Showing Salinized MWCNT's Glass Fibre.

2.2 Push-out at exit:

Push-out delamination occurs when the drill bit approaches the end to finish the hole. As the drill approaches the end, the uncut thickness gets smaller and the resistance to deformation decreases. At some point, the thrust force exceeds the inter laminar bond strength causing an exit delamination zone as the tool pierces out of the hole. This happens before the laminate is completely penetrated by the drill. Different drill geometry and cutting conditions can reduce the push-out delamination by lowering the thrust force. In practice, it has been found that the push-out delamination is more severe than that of peel-up.

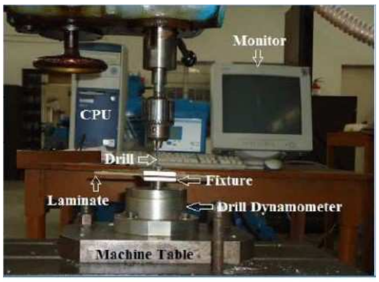

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Fig. 12: Showing the photograph of the machine set up connected to the computer unit taking the photographs at various positions mentioned in the next figure.

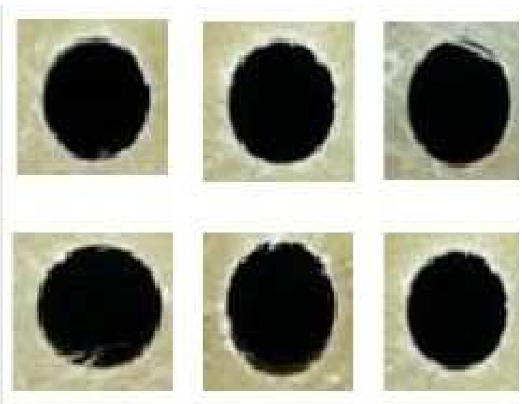

Fig. 13: Showing the Photographs illustrating the effect of feed on delamination in drilling GFRE composites: Top three photos are taken at peel-up delamination and the bottom three photographs show the push-out delamination

Conclusion:

The following conclusions can be drawn with regard to the drilling of GFRP:

- In conventional machining feed rate, tool material and cutting speed are the most influential factor on the delamination hence machining at higher speed, harder tool material and lower feed rate have lesser delamination of the GFRP.
- The use of High Speed Machining is suitable for drilling GFRP ensuring low damage levels and it is an Outstanding technology capable of improving productivity and lowering production costs.
- Vibration assisted drilling and Ultrasonic assisted drilling have lesser thrust hence lesser delamination compared to conventional drilling, which indicate that both vibration assisted drilling and Ultrasonic assisted drilling are more appropriate for drilling of GFRP.
- HSM, Vibration assisted drilling and Ultrasonic assisted drilling are new machining technique for drilling of GFRP and have better result compared to conventional drilling of GFRP.
- HSM, Vibration assisted drilling and Ultrasonic assisted drilling have scope for future work on drilling Of GFRP.
- Pure ultrasonic machining for drilling on GFRP can be investigated

REFERENCES

Rajamurugan, T.V., K. Shanmugam, S. Rajakumar, K. Palanikumar, 2012. "Modelling and analysis of thrust force in drilling of GFRP Composites using Response Surface Methodology (RSM)." Procedia Engineering, 38: 3757 – 3768.

Ussein M. Ali, H., Asif Iqbal and Li Liang, 2013. "A comparative study on the use of drilling and milling processes in hole making of GFRP composite." Sadhana, 38, Part 4, 743–760.

Ramanjaneya Reddy, A., K. Siva Bhushan Reddy, P. Hussain, B. Sidda Reddy and S. Sudhakar Babu, 2013. "An experimental study using design of experiment method to compare the performance of solid carbide and hss drills in drilling of gfrp composite material."Int. J. Mech. Eng. & Rob. Res.

Khashaba, U.A., I.A. El-Sonbaty, A.I. Selmy and A.A. Megahed, "Drilling analysis of woven glass fiber-reinforced/epoxy composites." Journal of Composite Materials 47(2) 191–205.

Venkateshwaran, N. and A. ElayaPerumal, "Hole quality evaluation of natural fiber composite using image analysis technique." Journal of Reinforced Plastics and Composites, 32(16): 1188–1197.

Murthy, B.R., Na and L.L.R. Rodrigues, "System Dynamics Approach for Optimization of Process Parameters to Reduce Delamination in Drilling of GFRP Composites." International Journal of Current Engineering and Technology

Jaya Santhoshi Kumari, Y., K.S. Raghuram and Ch.Siva Ramakrishna, 2015. "Aluminium fly-Ash Metal matrix composites – A Value added material made from thermal power plants waste disposal'';*international conference titled ''Energy Research and Environmental Management: An Innovative Approach* (ISBN:978-81-930585-2-7)'' conducted at JN University,NewDelhi on by Krishi

Sanskriti Publications, New Delhi on 14-15 Page No: 85-89.

Laxmi, N., K.S. Raghuram, Ch.Siva RamaKrishna, 2015. "Some Mechanical properties of Aluminum Alumina Silicon Carbide Matrix Particulate Reinforced Hybrid Composite"; *Journal of Material Science and Mechanical Engineering(JMSME)*,Print:ISSN:2393-9095,Online:ISSN:2393-9109, 1.

Raghuram, K.S., Dr. N.V.S.Raju, "Manufacturing results of Aluminum matrix Composite material reinforced by in situ Al2O3SiC particles"; A National Journal Bionano Frontier publication ISSN 0974-0678 page no 214-217.

Raja Ratna Kumar, V. and K.S.Raghuram, "Predictive Impact Analysis On Fiber Reinforced Laminates" International Journal of Review of Research ISSN No: 2249-894X, 36-43.

Ola, A., Mohamed, A.M. Youssef, Magada A. Elsamahy and Jean F. Bloch, 2015. Recycling Leather Wastes in Paper Industry Aiming to Improvement its Flame Retardant. J. Ind. Eng. Res., 1(2): 1-10.

Raja Thilagam, A. and Dr. R. Suresh Babu, 2015. Adaptive Time-Quantized pseudorandom Sampling scheme for Green Communication. J. Ind. Eng. Res., 1(2): 22-28.

Arif bin Ab Hadi, Prof. Dato' Ir. Dr. Abd. Wahab Mohammad, Prof. Ir. Dr. Mohd Sobri Takriff., 2015. The study of Temperature Distribution forFresh Fruit Bunch during Sterilization Process. J. Ind. Eng. Res., 1(6): 16-24.

Aizat Abas, Z.L., Gan, M.H.H. Ishak, N.S. Nasip and Soon Fuat Khor, 2015. Lattice Boltzmann Study of Vortex Street in Pressurized Underfill Manufacturing Process. J. Ind. Eng. Res., 1(10): 30-36.