Effects of Different Parameters on Delamination Factor of Glass Fiber Reinforced Plastic (GFRP)

Vikas Sharma, Department of Mechanical Engineering, Haryana Institute of Engineering and Technology, Bahdurgarh, India

Vinod Kumar, Mechanical Engineering Department, Thapar University, Patiala, Punjab, India

Harmesh Kumar, Department of Mechanical Engineering, UIET, Panjab University, Chandigarh, Punjab, India

ABSTRACT

The experimental investigations of the delamination factor of glass fiber reinforced plastic at different cutting parameters are reported in this study. This paper has involved the determination of different factors affecting the hole quality and cause of delamination in a glass fiber reinforced plastic. The various process parameters like different twist drill bits of different materails, different point angle at different speed, feed rate have been taken. The thrust forces and torque values were measured using piezoelectric dynamometer. Mathematical model has been developed for different machining conditions using Minitab software with help of Taguchi design to plan the experiments. The Universal microscope has been used which determines delaminated diameter in GFRP specimens. The finite element method has been applied by using Ansys11.0 software which helped to find out delaminated diameter. It was experimentally observed that for the tungsten carbide and M_{50} drill bits, the thrust force and torque significant increases on increasing the point angle and feed rate.

Keywords: *Delamination Factor, Feed Rate, Glass Fiber Reinforced Plastic, Point Angle, Speed*

INTRODUCTION

Composite materials are basically hybrid materials formed of multiple materials in order to utilize their individual structural advantages in a single structural material. A composite material is a heterogeneous material created by the synthetic assembly of two or more components, one a selected filler of reinforcing material and the other a compatible matrix binder, in order to obtain specific characteristics and performance.

In a glass fiber reinforced composite structures, the glass fibers carry the bulk load and the matrix serves as a medium for the transfer of the load. It becomes very important to study about drilling in case of composite materials. Different tools and methods are used for drilling depending on the type of material, the size

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of the hole, the number of holes, and the time to complete the operation. Poor surface finish and faster tool wear led to the further study of composite machining. Unlike metals, composites need separate tools and working conditions. A number of research endeavors have been made in the recent past to fully characterize the drilling process for FRP composite materials. The efforts have been made in the direction of optimization of the operating variables and conditions for minimizing the drilling induced damage around the hole.

The work of various authors on drilling composite materials, have shown that the hole surface quality (surface roughness) is strongly dependent on cutting parameters, tool geometry and cutting forces (thrust force and torque). Latha et al. (2010) studied the modeling and analysis of surface roughness parameters in drilling GFRP composites using fuzzy Logic. Caprino and Tagliaferri (2000) compared the interaction mechanisms between drilling tool and material. The results obtained are useful describing the damage history and help design drill geometries specifically conceived for composite machining and also reported that the type of damage induced in a composite material during drilling is strongl dependent on the feed. Palanikumar et al. (2012) analyzed the drilling of glass fiber reinforced polymer (GFRP) composites using grey relational analysis. Zhang et al. (2003) studied the assessment of the exit defects in CFRP plates caused by drilling and concluded that delamination (spalling and fuzzing) are the major mechanism in an exit defect caused by drilling. Kumar et.al (2012) investigated the drilling of glass fiber/vinyl ester composites with fillers. Chen (1997) studied the variations of cutting forces with or without onset damage during the drilling operations and concluded that the damage-free drilling processes may be obtained by the proper selections of tool geometry and drilling parameters. Lin and Chen (1999) carried out a study on drilling composite material at high speed and concluded that an increase of the cutting velocity leads to an increasing drill wear. In this way the fact of increasing the wear of drill causes a rising of thrust force. Bhatnagar et al. (2004) studied the machining induced damage characteristics of fiber reinforced plastic composite laminates. Enemuoh et al. (2001) realized that with the application of the technique of Taguchi and a multi-objective optimization criterion, it is possible to achieve cutting parameters that allow the absence of damage in drilling of fiber reinforced plastics. Palanikumar et al. (2010) studied the modeling and analysis of delamination factor and surface roughness in drilling GFRP composites. Mathew (1999) studied that thrust is a major factor responsible for delamination and it mainly depends on tool geometry and feed rate. Trepanning tools, which were used in this study, were found to give reduced thrust while making holes on thin laminated composites. Lee (2001) studied the machinability of GFRP by means of tools made of various materials and geometries were investigated experimentally. By proper selection of cutting tool material and geometry, excellent machining of the work piece was achieved. The surface quality relates closely to the feed rate and cutting tool. Bhatnagar et al. (2004) investigated damage in drilling of glass fiber reinforced plastic composite laminates. Hocheng and Tsao (2003) suggested saw drill and candle stick drill over conventional twist drill for reducing delamination at the exit side of drill. Tsao and Hocheng (2004) established a relationship between spindle speed, feed rate and drill diameter to induced delamination in a CFRP laminate using multiple regression analysis. Davim and Reis (2003) also used design of experiments technique to develop the correlations between cutting parameters (cutting speed and feed rate) to cutting power, specific cutting pressure and delamination factor on CFRP composites. Kao (2005) highlighted the application of coatings in micro-drills to improve the wear resistance and hole quality characteristics at high-speed drilling. But, only few investigations in high-speed drilling of polymer–matrix composites have been reported. Rajmohan and Palanikumar optimized the machining parameters for surface roughness and burr height in drilling hybrid composites. Piquet et al. (2000) carried out a study on drilling thin carbon/ epoxy laminates with two types of drills: a twist drill (4.8mm diameter, twist angle

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