STUDY OF DRILLING TOOL GEOMETRY
WHILE MACHINING OF GLASS FIBRE REINFORCED PLASTIC

ABSTRACT

In recent years, the fibre reinforced composite materials are being increasingly used in various fields of science and engineering applications due to their unique properties. The present technique of fabricating to near-net shape is incomplete unless the component is subjected to secondary machining operations. Among the machining processes, drilling is most frequently used in industries due to the need for the assembly of components in mechanical structures. However, the properties of fibre reinforced plastic (FRP) materials like anisotropy, non homogeneity and abrasiveness provide problems like excessive tool wear, poor surface finish, delamination, fibre pullout, dimensional variation, etc. Requirements to overcome these limitations motivated the present research - a study on the problems of drilling on glass fibre reinforced plastic (GFRP) materials.

Cutting with minimum possible thrust is a pre-requisite for drills, especially for those used for drilling composite materials. Since the chisel edge and cone angle of a drill have a major influence on the magnitude of the thrust force, modifying their geometries produces improvements in performance. Drilling experiments were conducted on GFRP specimens to evaluate the influence of spindle speed, feed rate and chisel edge width on hole quality, tool wear and delamination. From the experiments it was found that the force and delamination increase with the increase in spindle speed, feed rate and chisel edge width. Lower thrust force and torque values were

found at 1 mm chisel edge width whereas the usual chisel edge width is (0.2 to 0.25) D for drills from 6 to 10 mm diameter (Arshinov 1976).

Drilling experiments were conducted on GFRP composite specimens with tool points namely standard twist drill, Zhirov point drill and multifacet drill by varying spindle speed and feed rate to study the surface quality, delamination and tool wear using high speed steel (HSS) and carbide tool materials. Statistical models were developed to determine the magnitude and direction of the effect of each parameter on the machinability of GFRP specimens and examined which parameter has higher effect and more importance using ANOVA (Analysis of variance) technique. From the experimental results it is found that Zhirov point can drill more number of holes with lower thrust force for the same operating conditions when compared to standard twist drill and multifacet drill.

It is well known that the most effective way of achieving good quality holes while drilling FRP is by reducing the thrust force and torque. High spindle speed reduces the cutting force requirements. In drilling of composites, high spindle speed and low feed rate improves the machinability aspects within the range examined. Standard twist drill and Zhirov point drill were found suitable for producing more number of holes at high spindle speed with low feed rate. With high speed drilling, a considerable reduction in thrust force is seen.

When drilling with conventional drills, the crack propagation around the drilled holes is found to be more severe when the cutting lips pass

through the bottom laminates. This problem becomes more severe when drilling with thin laminates, because most of the drilling takes place in a transient cutting region. Hence, experiments were conducted to study the effect of drilling forces and hole quality using trepanning tool (with arc cutting edges) and compared with standard twist drill. It is observed that trepanning tool could be effectively used to machine holes with less thrust force and delamination.

The damage generated during the drilling of GFRP is detrimental to the mechanical behavior of the composite structures. Experiments were conducted to analyze the influence of drilling parameters (spindle speed and feed rate) on the strength of the glass fibre reinforced woven fabric laminates. Drilling parameters cause change in cutting forces, which lead to difference in the quality of the holes in terms of surface finish, circularity, delamination, fibre pull out, matrix cratering, etc. It is observed from the literature that the damage increases with both the cutting parameters (spindle speed and feed rate). While drilling, if thrust force is increased above its critical value, delamination is initiated which decreases the strength of the structure whereas, at lower spindle speed and lower feed, cutting action may not be steady. The specimens drilled at different spindle speed and feed rates showed variation in tensile strength, compressive strength, shear strength and bearing strength. The specimens drilled at higher feed rates failed at lesser load compared to specimens drilled at lower feed rates. Moreover, at a spindle speed of 3000 rpm and feed rate of 0.02mm/rev, the mechanical strength is high compared to other spindle speeds and feed rates.