Investigation of Surface Roughness and Machinability of Gfrp Composite Material In Cnc Turning

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ABSTRACT

Nowadays, glass fiber reinforced plastics (GFRP) composite splay a vital role new line in many engineering applications as an alternative to various heavy exotic materials. Surface roughness and delamination factor are parameters that have a great influence on dimensional precision and performance of mechanical pieces.. Yet no special machines have been developed to machine for composite materials, still traditional metal cutting tools and techniques are being used. In the present work, many attempt has to be made to investigate the machining characteristics of GFRP composite tubes with various process parameter and carried out to the surface roughness (Ra), Machining timing & amp; MRR has to be analyzed with various input parameter like nose radiuses and speed & amp; feed

INTRODUCTION:

OVER VIEW OF FRP:

In recent years, Fiber reinforced plastics (FRPs) are continuously replacing traditional engineering materials because of their superior advantage over other engineering materials. The advantages include high strength to weight ratio, high fracture toughness, and excellent corrosion and thermal resistance.

The glass fiber reinforced plastic (GFRP) composites are being extensively used in various fields like Aerospace, Automobile, Chemical industries, Off shore power plants ,Refinery, Oil and Gas, Pulp and paper, Waste and waste water etc, .The application filed of FRP composites, expands the opportunity of machining such as cutting off, drilling, milling, turning etc, has increased for its fabrication.

However, the users of FRP have faced difficulties to machine it, because knowledge and experience acquired for conventional materials cannot be applied to such new materials, of which machinability is completely different from that of conventional materials.

The two types of constituent phases are matrix and reinforcement.

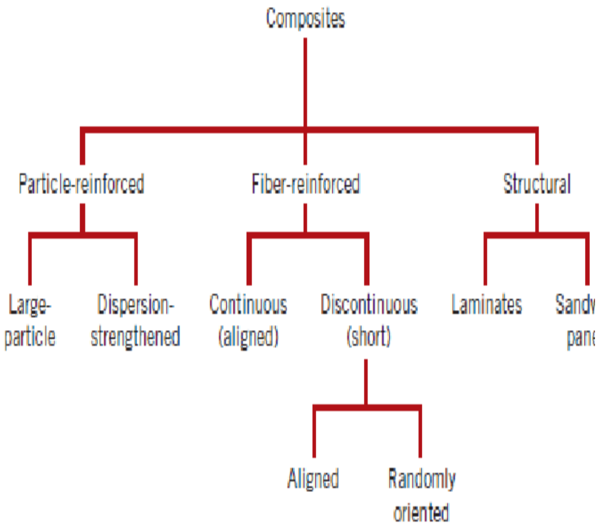
Generally, most materials, especially brittle ones, exhibit an important characteristic that a small-diameter shape is much stronger than the bulk material. This feature has been taken as an advantage in FRPs.

These materials could meet the requirements of modern technology, not met by the conventional materials. The increased use of FRP composites in recent years has led to an increased demand for machining. However the users of FRP composites are facing difficulties to machine it, because of delamination, fiber pull out, short tool life, matrix debonding, burning and formation of powder like chips. However, the weakness of composite material lies in their susceptibility to machining damage when subjected to improper machining conditions. it is important to monitor process variables such as cutting speed, feed, depth of cut etc,. In most applications, traditional metal cutting machine tools and techniques are still being used.

Experimental studies on traditional turning of FRP were first reported by Koplev et al and Sakuma et al. It is known that during turning of FRP composites, the mechanism of cutting is associated with the combination of plastic deformation, shearing and rupturing of fibers along with turning matrix material .Eriksen has enumerated guidelines for the turning of Short fiber reinforced thermoplastics (SFRTP).

CLASSIFICATION OF COMPOSITIES

A simple scheme for the classification of composite materials is shown in Figure.



Particle Reinforced Composites
The various types of particle reinforced composites are discussed below. Large particle Reinforced composites. Large particle and dispersion-strengthened composites are the two sub classifications of particle-reinforced composites. The distinction between these is based upon reinforcement or strengthening mechanism. The term “large ”is used to indicate that particle-matrix interactions
cannot be treated on the atomic or molecular level. For most of these composites ,the particle phase is harder and stiffer than the matrix. These reinforcing particles tend to retain the movement of the matrix phase in the vicinity of each particle.
In essence, the matrix transfers some of the applied stress to the particle, which bears a fraction of the load. The degree of reinforcement or improvement of mechanical behavior depends on strong bonding the matrix– particle interface.

Dispersion strengthened composites
For dispersion-strengthened composites, particles are normally much smaller, having diameter between 0.01 and 0.1 µm. Particle-matrix interactions that lead to strengthening occurs at the atomic or molecular level. Matrix bears the major portion of an applied load, and the small dispersed particles hinder the motion of dislocations. Thus plastic deformation is restricted so that yield and tensile strengths, as well as hardness are improved.

Fiber reinforced composites
A composite is a structural material which consists of combining two or more constituents. The constituents are combined at a macroscopic level and are not soluble in each other. One constituent phase is called the reinforcing phase and the one in which it is embedded is called the matrix. The reinforcing phase may be in the form of fibers, particles or flakes. The matrix phase materials are generally continuous.

Glass fibers
Over 95% of the fibers used in reinforced plastics are glass fibers, as they are in expensive, easy to manufacture and possess high strength and stiffness with respect to the plastics, with which they are reinforced. Their low densities,
resistance to chemicals, insulation capacity are the other bonus characteristics of the glass fiber. Glass fibers are available in the form of mats, tapes, cloths, continuous and chopped filaments, roving and yarns. Addition of chemicals to silica sand while making glass yields different types of glasses. The main types are E-glass (also called “fiberglass”)and S-glass. The E in E-glass stands for electrical as it was designed for electrical applications as an insulator.

Carbon fibers
Carbon fibers are very common in high modulus and high strength applications such as aircraft components etc. The advantages of carbon fibers include high specific strength and modulus, low coefficient of thermal expansion, high fatigue strength. The drawbacks include high cost, low impact resistance, high electrical conductivity.

Aramid fibers
An aramid fiber is an aromatic organic compound made of carbon, hydrogen, oxygen and nitrogen. Its advantages are low density, high tensile strength, low cost, and high impact resistance. Its drawback includes low compressive strength and degradation in all respects in sunlight. The two main types of aramid fibers are Kevlar 29 and Kevlar 49. Both types of Kevlar fibers have similar specific strength, but Kevlar 49 has higher specific stiffness. Kevlar 29 is mainly used in bullet-proof vests, ropes and cables. High performance applications in the aircraft industry use Kevlar 49.

Polymer Matrix
In matrix based composites, the matrix serves two paramount purposes viz ,binding the reinforcement phases in place and to distribute the stresses among the constituent reinforcement materials under an applied force. Polymers are the ideal materials as they processed easily, possess lightweight, and desirable mechanical properties. The two main kinds of polymers are thermosets and thermoplastics.

GLASS FIBER- REINFORCED PLASTICS (GFRP)

Glass is the most common fiber used in polymer matrix composites (PMC). Its advantages include its high strength, low cost, high chemical resistance, and good insulating properties. The draw backs include low elasticity, poor adhesion in polymers, high specific gravity, sensitivity to abrasion and low fatigue strength .The main types are E-glass also called "fiber glass" and S-glass.

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GLASS FIBER IN VARIOUS FORM

The most widely used matrices for advanced composites have been the epoxy resins. These resins cost more than polyesters. More than two thirds of the polymer matrices used in aerospace applications is epoxy based only. However, they are widely used due to the following advantages.

1. High strength.
2. Low viscosity and low flow rates which allow wetting of fibers and prevent Misalignment of fibers during curing.
3. Low shrink rates which reduce the tendency of gaining large shear stress of the bond between Epoxy and its reinforcement.
4. Resistance to creep and fatigue.
5.Resistance to solvents and chemicals.
6. Good electrical resistance.

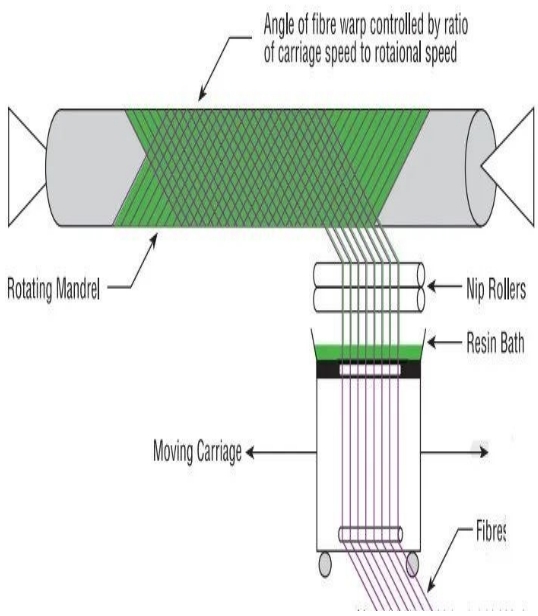
MANUFACTURING PROCESSES OF GFRP COMPOSITES

The following are the few commonly used composite production methods

a) Hand Lay-up.
b) Spray lay-up.
c) Vacuum Bagging.
d) Pultrusion.
e) Resin transfer molding (RTM)
f) Prepregs.
g) Filament winding.

FILAMENT WINDING PROCESS

Filament winding is a comparatively simple operation in which continuous reinforcement in the form of roving or monofilament is wound over a rotating mandrel. Specially designed machines, traversing at speeds synchronized with the mandrel rotation, control the winding angles and placement of the reinforcements



The basic mechanism consists of pulling a roving (Number of strands) of fibers from the creel. These are spread out using a bank of combs. The fibers then go through a bath of resin (for the case of wet winding). On exit from the bath of resin, the fibers are collimated into a band. The band goes through a fiber feed and is then placed on the surface of a mandrel. The fiber feed traverses back and forth along the length of the mandrel. The mandrel is attached to a motor, which gives it rotational motion. The fiber band is spread over the surface of the mandrel. By covering the surface of the mandrel with many layers, one can build up thickness of the part. The fiber orientation can be controlled by varying the speed of traverse of the fiber feed and the rotational speed of the mandrel. Filament winding is usually used to make a composite structure in the form of surfaces of revolution, such as cylinders or spheres. Filament winding process is illustrated in Figure

Main Advantages:

a. This can be a very fast and therefore economic method of laying material down.
b. Resin content can be controlled by metering the resin onto each fiber tow through nips or dies.
c. Fibre cost is minimized since there is no secondary process to convert fiber into fabric prior to use.

CUTTING TOOL MATERIALS USED FOR MACHINING GFRPCOMPOSITES

During cutting, the tool is exposed to thermal and mechanical stresses. It is of great interest inindustry to decrease the cutting time while new materials are designed with moreemphasis on mechanical properties. This tendency places even more pressure on the tool manufacturers to produce tools with higher wear resistance, toughness and hardness at high temperatures.

When machining GFRP composites, it is clearly seen that fibers are cut across and along their lay direction, leaving deformed, projecting, and partially disclosed fibers on the machined surface. Conventional machining of fiber reinforced composites is difficult due to diverse fiber and matrix properties, fiber orientation, inhomogeneous nature of the material, and presence of high fiber volume fraction (volume of the fiber over total volume) of hard abrasive fibers in the matrix.

OBJECTIVE

Determining the optimum parameter combination in order to satisfy the given criteria or to maximize or minimize the respective output parameter in response to the given input parameter.

PROBLEM IDENTIFICATION

Machining of glass fiber-reinforced polymer (GFRP) composite materials have always been a challenge due to host of difficulties encountered such as fiber pull-out, fiber fuzzing, matrix burning, and fiber-matrix de bonding leading to subsurface damage, reduced strength and shortproduct service life. Machining of composite parts creates discontinuity in the fibre and thus affects the performance of the part.

MATERIAL DETAILS

GFRP pipes made up of Isopathalic polyster resin are used for this study. The volume fraction of the materials is 65:35 (resin: glass). Table shows the mechanical and thermal properties of the selected GFRP material.

RESIN-Isopathalic Polyster Resin-65%

Fiber-Glass Fiber-35%

COMMON APPLICATIONS

Applications of Glass fiber-reinforced plastic: Glass-fiber-reinforced polymers Engine intake manifolds are made from glass-fiber-reinforced polymer.

Advantages this has over cast aluminum manifolds are: Up to a 60% reduction in weight Improved surface quality and aerodynamics Reduction in components by combining parts and forms into simpler moulded shapes.

SCOPE OF THE PROJECT

The project mainly concerned in developing a parameter optimization model for CNC turning machining using modified Taguchi's parameter design, the following are the major steps involved in this project.

- Selection of important control factors of CNC machine to investigate their effect on performance measures like Material Removal Rate, surface Roughness.
- Selection of levels for control factors within the available range.
- Selection of tool work piece material and working conditions like
experimental duration etc.
- Analysis of performance measures to plot the main effects of control factors.
- Determining the optimum parameter combination in order to satisfy the given criteria or to maximize or minimize the respective output parameter in response to the given input parameter.
- Predicting the values of performance measures using modified Taguchi
method.
- Validating the experimental results by comparing with predicted values.

CONCLUSION

The work piece machined with various parameters like DOC, Various Nose radius,
feed. In order to achieve to high degree surface finish aswellas minimum surface delamination damage. Along with that compare the process parameter optimization of material in next phase.

LITERATURE SURVEY

[1] Syed Altaf Hussain [1} et.al were studied of machinability of GFRP composite tubes of different fiber orientation angle vary from 300 to 900. Machining studies were carried out on an all geared lathe using three different cutting tools: namely Carbide (K-20), Cubic Boron Nitride (CBN) and Poly- Crystalline Diamond (PCD). Experiments were conducted based on the established Taguchi's Design of Experiments (DOE) L25 orthogonal array on an all geared lathe. The cutting parameters considered were cutting speed, feed, depth of cut, and work piece (fiber orientation). The performances of the cutting tools were evaluated by measuring surface roughness (Ra) and Cutting force (Fz). A second order mathematical model in terms of cutting parameters was developed using RSM.

[2] Reddy Sreenivasulu[2] et.al were analyzed the influence of cutting speed, feed rate and depth of cut on the delamination damage and surface roughness on Glass Fiber Reinforced Polymeric composite material (GFRP) during end milling. They were using Taguchi design method is to investigate the machining characteristics of GFRP. From the results of ANOVA, it is concluded that cutting speed and depth of cut are the most significant factors affecting the responses, their contribution in an order of 26.84% and 40.44% respectively.

[3] B.V.Kavada[3] were experimentally analyzed in order to maintain the integrity of the material and obtain the necessary accuracy in drilling of GFRP. That paper attempts to review the influence of machining parameter on the delamination damage of GFRP during drilling. 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. Vibration assisted drilling and Ultrasonic assisted drilling have lesser thrust and hence lesser delamination compared to conventional drilling, which indicates that both vibration assisted drilling and Ultrasonic assisted drilling are more appropriate for drilling of GFRP.

[4] Monika Kaszubskaa[4]investigated the influence of longitudinal GFRP reinforcement on shear capacity of concrete beams without stirrups and to investigated a dowel effect of this reinforcement on the shear strength. The paper presented experimental test results of T- shaped, single span, simply supported beams without stirrups reinforced with longitudinal GFRP bars. The following parameters were investigated in the research: flexural reinforcement ratio, number reinforcement layers, number and diameter of bars in one layer. Test results indicated no significant influence of the longitudinal reinforcement ratio on the shear strength in the beams with one reinforcement layer. However, in the beams with two layers of longitudinal reinforcement the significant increase in the shear strength was observed with increase in the reinforcement ratio (in a range from 1,02% to 1.85%). The beams reinforced with two layers of GFRP reinforcement showed more extensive crack pattern than the beams with one reinforcement layer. It confirms that application of two reinforcement layers more effectively enhance the shear strength mainly due to higher tension stiffening effect provided by the flexural reinforcement in the beams with two reinforcement layers.

[5]Rajesh Kumar Verma [5] were highlighted the research on GFRP composites and machining problems faced out by the manufactures. Fiber glass reinforced plastic, commonly known as fiberglass, was developed commercially during World War II. In 21st century, GFRP have been successfully substituted the traditional engineering materials and widely used in transportation, offshore and marine, spacecraft structures require high specific stiffness and strength but machining of GFRP is significantly different from conventional metals because they are isotropic and non homogeneity in nature which consist of distinctly different phases, so that their machining operation is characterized by uncontrolled intermittent fibre fracture causing oscillating cutting forces and critical bending stresses, poor surface finish in terms of fuzzing due to diverse/ crushed fibre. It is not easy for a manufacturer to obtain quantitative and consistent measures but it has been mainly assessed by three parameters including tool wear or tool life, cutting forces or power consumption and better surface finish.

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