IJMTARC – VOLUME – VI – ISSUE – 24, OCT-DEC, 2018

ISSN: 2320-1363

EXPERIMENTAL INVESTIGATION TO OPTIMIZE PROCESS PARAMETERS IN DRILLING OPERATION FOR COMPOSITE MATERIALS

[1]Jatavatu Hari Prasad Naik [2]Mr.Naveen Kumar Mindi

[1]P.G student (advanced manufacturing systems) Sai Ganapathi Engineering College.

[2] Assistant Professor Sai Ganapathi Engineering College.

ABSTRACT: The imperative objective of the science of metal cutting is the solution of practical problems associated with the efficient and precise removal of metal from work piece. It has been recognized that the reliable quantitative predictions of the various technological performance measures, preferably in the form of equations, are essential to develop optimization strategies for selecting cutting conditions in process planning.

In this thesis experiments will be conducted to improve the surface finish quality of GFRP (glass fiber reinforced polymer) composites work piece by using 8mm, 10 mm&12mm diameter HSS (M2) drill. The type is bull nose tip.

In this project we are considered parameters, The spindle Speeds are 1500 rpm,2000 rpm and 2500 rpm , point angle at 116°,1180 and120

Taguchi method is used to study the effect of process parameters and establish correlation among the cutting speed, feed and depth of cut with respect to the major machinability factor, surface finish. Validations of the modeled equations are proved to be well within the agreement with the experimental data.

INTRODUCTION

Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is usually a rotary cutting tool, often multipoint. The bit is pressed against the work piece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the work piece, cutting off chips (swarf) from the hole as it is drilled.

In rock drilling, the hole is usually not made through a circular cutting motion, though the bit is usually rotated. Instead, the hole is usually made by hammering a drill bit into the hole with quickly repeated short movements. The hammering action can be performed from outside of the hole (top-hammer drill) or within the hole (down-the-hole drill, DTH). Drills used for horizontal drilling are called drifter drills.

In rare cases, specially-shaped bits are used to cut holes of non-circular cross-section; a square cross-section is possible.

INTRODUCTION TO SURFACE FINISH

Surface finish, also known a surface texture or surface topography, is the nature of a surface as defined by the 3 characteristics oflay, surface roughness, and waviness. It comprises the small local deviations of a surface from the perfectly flat ideal (a true plane).

Surface texture is one of the important factors that control friction and transfer layer formation during sliding. Considerable efforts have been made to study the influence of surface texture on friction and wear during sliding conditions. Surface textures can be isotropicor anisotropic. Sometimes, stick-slip friction phenomena can be observed during sliding depending on surface texture.

Each manufacturing process (such as the many kinds of machining) produces a surface texture. The process is usually optimized to ensure that the resulting texture is usable. If necessary, an additional process will be added to modify the initial texture. The latter process may be grinding (abrasive cutting), polishing, lapping, abrasive blasting, honing, electrical discharge machining (EDM), milling,lithography, industrial etching/chemical milling, laser texturing, or other processes.

LITERATURE REVIEW

Lachaud,et al [9] stated that using a twist dril causes several types of defects in the laminates, which can be divided inn to four main types. Hole entry defect, through it does not appear on every occasion, is related to the fibrous characters of the material and the drill geometry. It leads to the tearing of the first ply of the first layer in contact with the drill. Circular defect is linked to the presence of angle created by the direction of the fibers of the ply concerned and by the direction of the cutting edge. Depending upon the angular position of the cutting edges and just before being cut, the fibers are subjected to an alternating action of bending or compression stresses. The unilateral behaviour of carbon fibres leads to an elliptical hole shape. Damage from a heat source is due to the friction between the fibers and two minor cutting edges of the drill. It can cause to Experimental Investigation Of Drilling Parameters On Composite Materials www.iosrjournals.org 32 | Page damage to the matrix at the hole edge, thus increasing the likelihood of torn fibers due to the mechanical action of the minor cutting edges. Removal of fibers leads to the roughness defect on the sidewall of the hole. Damage factor at the exit hole is caused by the cutting conditions in which the chisel edge of the twist drill cannot cut through the material. The trust force of the drill may cause normal stress i.e. likely to open the ply interface. Damage factor between plies spread beyond the hole diameter, and can occur at varying depths as the drill progress. Damage factor occurs mainly because of the localised bending in the zone situated at the point of attack of the drill. A number of researches came up with other forms of damage. Mathew et al [10] identified matrix burning, damage factor, debonding, fiber pull-out as the major sources of damage. Di paola et al [11] stated three distinguishable mechanisms for damage, namely plate bulge, crack opening, and fiber tearing or twisting. Ho-cheng and Dharan [7] found that damage takes place both at the entrance and the exit and thus differentiated the damage as peel-up at entrance and push-out at the exit and illustrates a few forms of drilling induced damage. Effect of tool geometry on cutting forces has been analysed by chen [7], miller[13] in his exclusive study on drill bit configurations concluded that eight-faced drill point gave best result for graphite-epoxy laminates. Greater number of holes to failure was encountered while drilling with carbide drills as reported by ramulu et al [14]. A number of experimental forays for operating conditions optimization [7], [14] and [15] have been made but a global function still elude the composite industry

Problem Identification

The machining of composite materials is a growing problem in various fields such as aeronautical, automotive, wind turbine industries. The drilling of these materials, required to assemble different parts, is difficult to control and often leads to delamination at the exit of the laminates. This can affect the strength of the structure. Analysis and study of this machining process can be helpful for reducing induction of stresses and preventing change in dimension of component.

Process Parameters:

1. Cutting speed

2. Feed rate

3. Depth of cut

Objectives

ISSN: 2320-1363

1. To improve the quality of drill with minimum delaminating.

2. To study delamination factor using various parameters

3. To study the effect of cutting speed, feed rate & depth of cut on surface roughness,

4. To study the effect of variation of machining parameter on response factor.

5. To study the contribution of parameters on response factor.

Methodology

The methodology of presents investigation include following steps:

Step1: Selection of raw material and preparation of GFRP plate of required dimension.

Step2: Selection of machine.

Step3: Selection of drill.

Step4: Selection of drilling parameter.

Step5: Selection of levels and parameter values.
Step6: Selection of Taguchi method to optimise parameters.

Step7: Conduction of experiment

. Step8: Recommending optimum level of machining parameters while concluding work.

EXPERIMENTAL PROCEDURE

Drilling of natural fiber reinforced polymer laminates depend on the cutting speeds (S) and drill bit (f) along with other parameters. In the present study these are recognized as the prime factors that influence the drilling induced damage. The matrix was GFRP resin with hardener catalyst and cobalt as the accelerator. The specimens were cut to size of 100mm x 50mm x3mm.

The experiments were carried out at three different levels of cutting speeds and four feed rates. We used carbide drills because of better surface finish and more number of holes

The experiments are done on the drilling machine with the following parameters:

WORK PIECE MATERIAL – GFRP (glass fiber reinforced polymer)

DRILL BIT DIA-8mm, 10 mm, 12mm

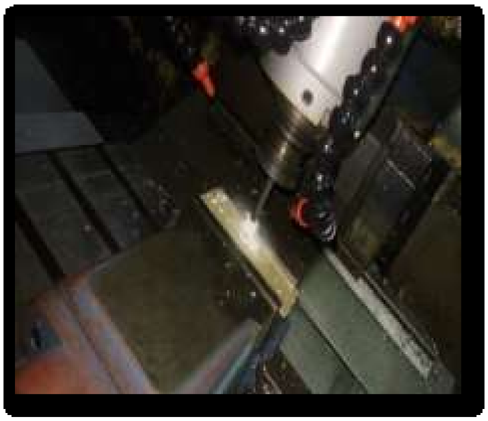
CUTTING SPEED – 1500rpm, 2000rpm, 2500rpm,

POINT ANGLE-116^{0}, 118^{0}, 120^{0}.

EXPERIMENTAL PHOTOS

IJMTARC – VOLUME – VI – ISSUE – 24, OCT-DEC, 2018

ISSN: 2320-1363



Drilling process

Final component

INPUT PARAMETERS

PROCESS PARAMETERS	LE VEL1	LEVEL2	LEVEL3
SPEED(rpm)	1500	2000	2500
DRILL BIT DIA(mm)	8	10	12
POINT ANGLE	116^0	118^0	120^0

JOB NO.	SPEED (rpm)	DRILL BIT DIA(mm)	POINT ANGLE (°)
1	1500	8	116
2	1500	10	118
3	1500	12	120
4	2000	8	116
5	2000	10	118
6	2000	12	120
7	2500	8	116
8	2500	10	118
9	2500	12	120

IJMTARC – VOLUME – VI – ISSUE – 24, OCT-DEC, 2018

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SURFACE FINISH VALUES

JOB NO.	SPEED (rpm)	DRILL BIT DIA(mm)	POINT ANGLE (°)	Surface finish (R_a) µm
1	1500	8	116	0.565
2	1500	10	118	0.727
3	1500	12	120	0.912
4	2000	8	116	1.05
5	2000	10	118	1.21
6	2000	12	120	1.64
7	2500	8	116	2.145
8	2500	10	118	2.521
9	2500	12	120	2.742

INTRODUCTION TO TAGUCHI TECHNIQUE

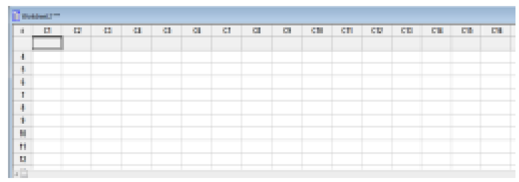
Taguchi defines Quality Level of a product as the Total Loss incurred by society due to failure of a product to perform as desired when it deviates from the delivered target performance levels.

This includes costs associated with poor performance, operating costs (which changes as a product ages) and any added expenses due to harmful side effects of the product in use.

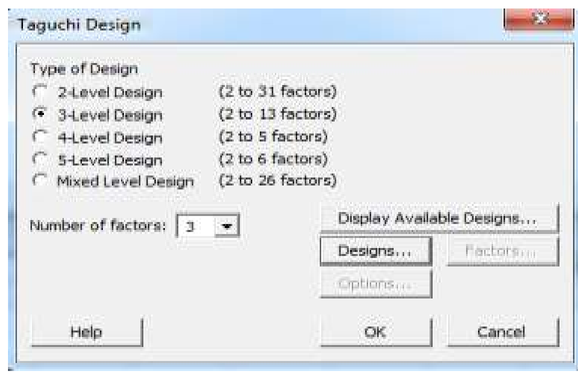
OPTIMIZATION OF ULTIMATE TENSILE STRENGTH USING MINITAB SOFTWARE

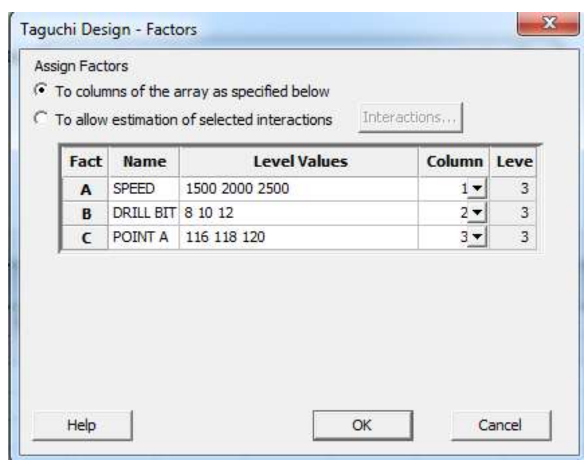
Design of Orthogonal Array

First Taguchi Orthogonal Array is designed in Minitab17 to calculate S/N ratio and Means which steps is given below:



FACTORS





OPTIMIZATION OF PARAMETERS

IJMTARC – VOLUME – VI – ISSUE – 24, OCT-DEC, 2018

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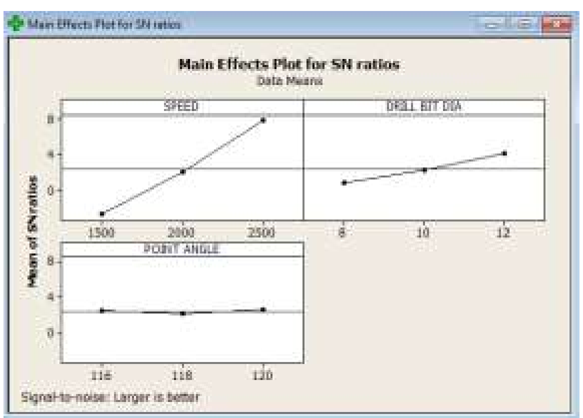
Worksheet 1 ***

↓	C1	C2	C3
	SPEED	DRILL BIT DIA	POINT ANGLE
1	1500	8	116
2	1500	10	118
3	1500	12	120
4	2000	8	118
5	2000	10	120
6	2000	12	116
7	2500	8	120
8	2500	10	116
9	2500	12	118

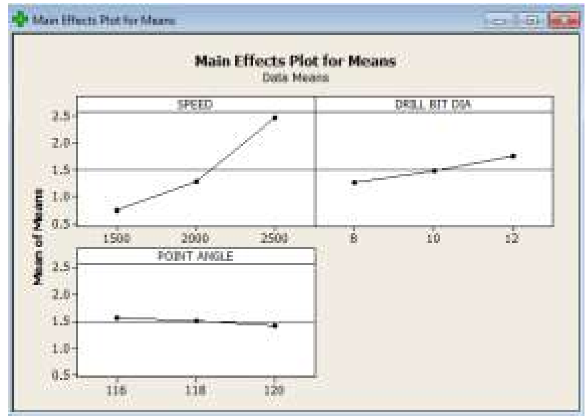
Worksheet 1 ***

↓	C1	C2	C3	C4	C5
	SPEED	DRILL BIT DIA	POINT ANGLE	SURFACE FINISH	SURFACE FINISH 1
1	1500	8	116	0.565	0.610
2	1500	10	118	0.727	0.717
3	1500	12	120	0.912	0.941
4	2000	8	118	1.050	1.040
5	2000	10	120	1.210	1.209
6	2000	12	116	1.640	1.562
7	2500	8	120	2.145	2.146
8	2500	10	116	2.521	2.491
9	2500	12	118	2.742	2.781

S/N ratio plot



Means plot



CONCLUSION

In this thesis an attempt to make use of Taguchi optimization technique to optimize drilling parameters during work piece material durlene fiber.

The drilling parameters are speed and feed rate for drilling of work piece durlene fiber. In this work, the optimal parameters of cutting speed are 1500rpm, 2000rpm and 2500rpm, drill bit diameters are 8mm, 10mm and 12mm and point angles1160 ,118 0and 1200. Experimental work is conducted by considering the above parameters. surface finish values are validated experimentally.

By observing the experimental results and by taguchi, the following conclusions can be made:

To get better surface finish, the optimal parameters are speed – 2500rpm, drill bit diameter -12 mm and point angle -118 0.

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