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

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KEYWORDS
GFRP, TAGUCHI method andparameters.

ABSTRACT

With the use of 8mm, 10mm, and 12mm diameter HSS (M2) drills, spindle speeds of 1200, 1000, and 800 rpm, and feeds of 30, 40, and 50 mm/min, this study will perform tests to enhance the surface finish quality of GFRP (glass fibre reinforced polymer) composites work pieces. The Taguchi technique is a powerful tool for studying the impact of process parameters and finding the relationship between surface finish—the most important machinability factor—and cutting speed, feed, and depth of cut. The experimental results and the validated model equations are found to agree quite well.

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INTRODUCTION

The use of a drill bit to carve out a hole with a circular cross-section in solid materials is known as drilling. Rather of using a circular cutting motion to create the hole, rock drill bits are typically turned. Instead, the hole is often created by rapidly repeating brief motions while pounding a drill bit into the hole. Two methods exist for hammering: the top-hammer drill, which operates from above the hole, and the down-the-hole drill, which operates from below the hole. Drills that are designed to be used for horizontal drilling are known as drifter drills. In very unusual circumstances, non-circular cross-sections (such as squares) may be cut using specially-shaped pieces.

Fig: drillingprocess

PROCESS

Drilled holes are easily identifiable by their pointed entry and exit surfaces, as well as the presence or absence of burrs on the latter. On the inside of the cavity, you can usually see helical feed marks.

Drillingin metal

Methylated spirits as a lubricant for high-velocity metallic twist bits used for drilling aluminium In typical operation, the drill bit's fluting is used to lift and transport swarf away from the bit's top. The additional chips generated by the cutting edges keep the chips moving away from the hole. If the holes are deeper than usual or there isn't enough backing off (removing the drill bit from the hole partially or completely) then the chips will be excessively closely packed. As a side effect, cutting fluid may cool and lubricate the tip and chip waft, extending the life of the device and making this problem go away. As is common with gun drills, coolant may be supplied via holes in the drill shank. Cutting fluid is especially useful when working with aluminium since it prevents the metal from clinging to the drill bit when drilling and guarantees a clean, accurate hole.

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Drillingincomposites

The most difficult component of machining composite materials is usually drilling. Drilling into metal requires nothing more than chipping away at the substance and clearing the hole. On the other hand, when drilling into a multi-layered composite, the drill bit will most likely advance the layers ahead of it, leading to undesirable delamination near the exit.

General Tool, a contract manufacturer with 240 employees and extensive experience in composites machining, employs Earl Wilkerson as their CNC programming and tooling supervisor. He says that using a regular drill bit on composites is like trying to drill through plywood without any supports. "A regular drill for metalworking would simply blow out the rear of the hole," he explains. In most cases, a special drill bit is needed for drilling composites.

SURFACEROUGHNESS

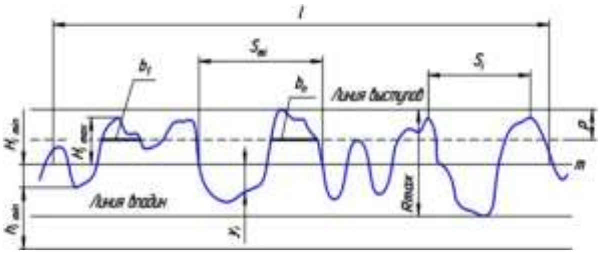
The process of measuring the topography (or surface roughness) of precise surfaces is called surface measurement or surface metrology. whether you want to know whether a surface is good for anything, you should measure it. Inadequately created precision surfaces, whether from a machine that isn't set up correctly or a method that can't consistently provide the required surface quality, are a common cause of component failures. Visual differences are the most visible result of variations in surface roughness, but these variations also affect many other properties. Some examples include the following: the degree of wear, the capacity to create a seal upon contact with another surface, and the paint thickness required to cover a component. For this reason, measuring surface roughness—the microscopic asperity of surfaces—is essential.It is possible to measure microscopic asperity in an infinite number of ways. on a 1 mm 0.04" square area, for instance, you can find the level difference between the highest and lowest points; in a 2mm 0.08" long straight line, you can find the level difference between the average of five high points and the average of five low points. But discrepancies could arise if standards are decided in such a random way.

Parameters

Aroughnessvaluecaneitherbecalculatedonaprofile(line)oronasurface(area).Theprofileroughness parameter (Ra, Rq,...) are more common.The area roughness parameters (Sa, Sq,..) give moresignificantvalues.

Profileroughnessparameters

The profile roughness parameters are included in BSEN ISO 4287:2000 British standard, identicalwiththeISO4287:1997standard.[5]Thestandardisbased onthe ″M″ (meanline) system.



LITERATUREREVIEW

Under varying lubrication conditions, Venkata Ramana (2017) turned titanium alloy and showed how process factors affected surface roughness. Cutting performance under Minimum Quantity Lubrication circumstances reduced surface roughness more effectively than dry and flooded settings. The surface roughness is the primary parameter that feed rate affects. Using grey relational analysis (GRA), Akhil K.T. et al. (2017) shown how to optimise drilling properties in glass fibre reinforced polymer (GFRP).When it comes to process parameters that affect surface roughness and delamination factor, cutting speed is king. According to the results, cutting speed is the most important performance feature, followed by feed rate.The use of taguchi-Grey relational analysis to optimise micro-drilling parameters was examined by Aravind.S et al. (2017). As a consequence, we can see the optimal values for the material removal rate and the minimised delamination factor. (Sunmugesh et al., 2018). International Journal of Engineering Research & Technology (IJERT) (ISSN: 2278-0181). Online publication by Ijert A study conducted in 2017 for the ICONNECT conference examined the use of grey relational analysis to optimise multiple answers in drilling of materials made of carbon fibre and epoxy. Surface roughness, delamination factor, and circularity are three performance variables that are examined in this research as they pertain to the drilling of CFRP composite materials using HSS, TiAlN, and TiN drill tools at different cutting speeds and feed rates. The feed rate is the single most important characteristic that determines the reaction. In their 2017 study, Shunmugesh et al. looked at how glass fibre reinforced polymer (GFRP) drilling properties may be optimised using grey-fuzzy logic. Surface roughness and delamination factor were both improved by drilling with the determined

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optimal parameter values within the study's predetermined ranges. Johan Merzouki et al. (2017) looked at the technique for measuring radial forces due to hole shrinkage in Ti6Al4V drilling. Internal residual stresses, thermal expansion, and other thermomechanical loads imparted to the tool and work piece are the reactions that need to be taken into account. Ti-6Al4V, a titanium additive developed by Giuseppe Bonaiti et al. (2017), was shown to be micromilling machinable. A decrease in porosity and an improvement in the samples' overall integrity are the results of increasing the laser power. As the depth of cut and feed rate, two cutting parameters, are increased, the roughness also rises. The modelling of temperature distribution in titanium drilling was examined by Hemant S et al. (2017). We concurrently forecast the tool and work piece temperature distributions for variations in cutting speed and feed rate. In both instances, the temperature rises significantly when the cutting speed and feed rate are increased.

METHODOLOGY

Dr. Genichi Taguchi is a quality management consultant from Japan who has been instrumental in advancing the Taguchi Method. A statistical metric for overall performance called the Signal-to-Noise (S/N) ratio is used, and the approach delves into the concept of quadratic excellent loss characteristic. Both the mean and the variability are considered by the S/N ratio. S/N is the signal-to-noise ratio, which measures the signal-to-noise ratio as a function of the standard deviation. The ratio is conditional on the optimisation target product's or process's desirable attributes. Nominal is Best (NB), Lower is Better (LB), and Higher is Better (HB) are the most common S/N ratios.

Table:Inputparametersandtheirstages

PROCESSPARAMETERS	LEVEL1	LEVEL2	LEVEL3
SPEED(rpm)	1200	1000	800
DRILL BITDIA(mm)	8	10	12
Feed(rev/min)	30	40	50

OBJECTIVE

Themainobjectiveindesignofexperimentistostudytherelationshipbetweentheresponseandvariables.Designofexperimentisamethodtominimizethenumberofexperimentsinordertoreachoptimumconditions.Toexploretherelationship betweentheresponseandtheindependent variables, the data required are obtainedexperimentally.Toreducethenumberofexperiments,thenumberofdatawaskeptatminimum.Inthiswork,9samplesbasedonfullfactorial design of the experiments employing three-level cutting parameters and three-level angle pointsare given in Table 2. The parameter levels are chosenbased onthe primaryexperiments.

EXPERIMENTALINVESTIGATION

The experiments are done on the drillingmachinewiththe followingparameters:

WORKPIECEMATERIAL–GFRP(glassfiberreinforced polymer)

DRILLBIT DIA-8mm,10 mm,12mm

CUTTINGSPEED –1200rpm,1000rpm,800rpm,

Feed-30mm/min,40mm/min,50mm/min.

JOBNO.	SPEED (rpm)	DRILL BITDIA(mm)	FEED (Rev/min)
1	1200	8	30
2	1200	10	40
3	1200	12	50
4	1000	8	40
5	1000	10	50
6	1000	12	30
7	800	8	50

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8	800	10	30
9	800	12	40

Table:DesignOfExperiments

EXPERIMENTALPHOTOS

Drillingprocess

SURFACEROUGHNESSVALUES

JOB NO.	SPEED (rpm)	DRILLBITDIA(mm)	FEED (Rev/min)	Surface roughness(R_a) µm
1	1200	8	30	2.56
2	1200	10	40	2.24
3	1200	12	50	1.86
4	1000	8	40	2.97
5	1000	10	50	3.21
6	1000	12	30	3.14
7	800	8	50	3.56
8	800	10	30	4.52
9	800	12	40	3.86

Table: Surface Roughness ValuesINTRODUCTIONTOTAGUCHITECHNIQUE

When a product falls short of its promised performance standards, Taguchi says that society suffers a total loss. This is the product's quality level. Included in this category are operational expenses (which fluctuate

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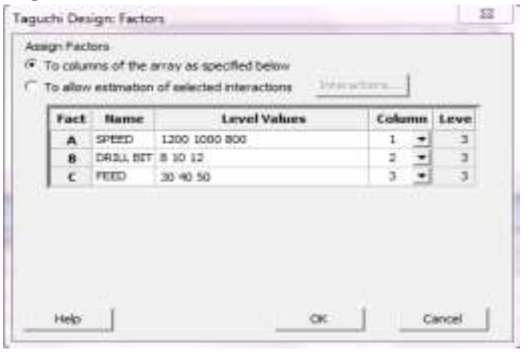
according to factors such asgoods depreciates) and any additional costs incurred as a result of detrimental product side effects during use. Methods by Taguchi • Assist businesses in implementing the Quality Fix! Issues with product or process quality may arise from noise, which can be defined as any unwelcome influence that raises variability. To address this, it is recommended to do thorough issue analyses. Work with interdisciplinary groups • Carry out predetermined experimental investigations • Apply analysis of variance and signal-to-noise methods to the evaluation of experiments. The three-dimensional dynamometer was used to quantify cutting forces while the specimen was spun using a randomization approach. The cutting forces experimental data is shown in the tables. Given that feed and radial forces are 'lower is better' machining quality criteria, the signal-to-noise ratio for this response type was and is shown below:

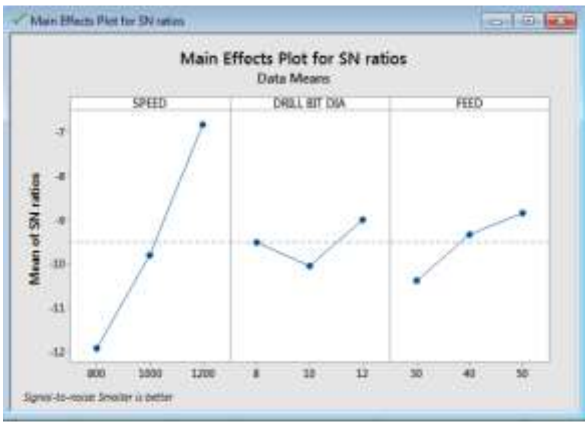
$$\text{S/N ratio} = -10 \log\left[\frac{1}{n}(y_1^2 + y_2^2 + \ldots + y_n^2)\right] \quad \ldots (1)$$

Wherey1,y2,…..,ynaretheresponsesofthemachiningcharacteristicsforeachparameteratdifferentlevels.

OPTIMIZATION OF SURFACE FINISH USINGMINITAB SOFTWARE

Fig:Factors





Plot:signaltonoiseratioRESULTS

Taguchi method stresses the importance of studyingtheresponsevariationusingthesignal–to–noise(S/N)ratio,resultinginminimizationofqualitycharacteristicvariationduetouncontrollableparameter.Thecuttingforce isconsideredasthequality characteristic with the concept of "the larger-the-better".TheS/NratiofortheSmaller-the-betteris:

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S/N=-10 *log(Σ(Y2)/n))

Worksheet 1 ***

↓	C1	C2	C3	C4	C5	C6	C7
	SPEED	DRILL BIT DIA	FEED	SURFACE ROUGHNESS	SURAFCE ROUGHNESS1	SNRA1	MEAN1
1	1200	8	30	2.56	2.561	-8.1665	2.5605
2	1200	10	40	2.24	2.210	-6.9468	2.2250
3	1200	12	50	1.86	1.851	-5.3692	1.8555
4	1000	8	40	2.97	2.923	-9.3864	2.9465
5	1000	10	50	3.21	3.211	-10.1315	3.2105
6	1000	12	30	3.14	3.123	-9.9151	3.1315
7	800	8	50	3.56	3.540	-11.0046	3.5500
8	800	10	30	4.52	4.510	-13.0932	4.5150
9	800	12	40	3.86	3.820	-11.6867	3.8400

Wherenisthenumberofmeasurementsinatrial/row,in this case,n=1andy is themeasuredvalueinarun/row.TheS/Nratiovaluesarecalculated by taking into consideration above Eqn.withthe help ofsoftware Minitab **17.CONCLUSION**

This thesis makes an effort to optimise drilling parameters during work piece material durlene fibre optimisation using the Taguchi optimisation approach.

When drilling through durlene fibre, the two most important variables are feed rate and speed. The best cutting speeds for this job are 800, 1000, and 1200 rpm, with feed rates of 30, 40, and 50 mm/rev, and a point angle of 1200. When carrying out experiments, the aforementioned factors are taken into account. experimental validation of surface finish values is performed.

By observing the experimental results and by taguchi,thefollowingconclusionscanbemade:

To get better surface finish, the optimal parametersarespeed–1200rpm,feed–50mm/rev.

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