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PROCESS THE OPTIMIZATIONS BY TAGUCHI METHOD IN DRILLING MACHINE

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Abstract

Material removal and surface roughness response are the primary goals of this research, which investigates and evaluates the effects of various input process parameters (cutting diameter and cutting speed) on these outcomes. Various variables have been taken into account in each experiment. The L9 Orthogonal array was used to design experiments during the milling of aluminium plate (work material). “Cutting diameter (10mm), cutting speed (1000rpm), and feed rate (0.014mm/rev)” are the most important input parameters for material removal rate and surface roughness.

Keywords: Drill; drilling machine; taguchi method; Metal matrix composites; Roughness..

1. Introduction

The basic principles of electromechanical machine tool controls, production standards, and testing instruments' characteristics and uses for checking components or products made in various manufacturing facilities in various countries are all addressed in this study. The study also aims to provide students with a foundational understanding of workshop practises. Diverse hand tools (such as measuring tools and marking instruments) as well as machinery and various techniques of production are described and shown in this section of the book to aid the shaping or moulding of different raw materials into acceptable useable shapes. Ferrous and non-ferrous metals as well as their characteristics and applications are examined as part of the study of industrial environments. Knowledge of basic workshop processes such as bench work and fitting; sheet metal; carpentry; pattern-making; mould-

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making; foundry and smithy; forging and metalworking; welding; fastenings; machine shops; surface finishing; and coatings; assembly inspection; and quality control; should be included in the course curriculum. Composition, characteristics and utilises of raw materials; numerous production processes; replacement or improvement over a large number of old processes; new compact designs; improved accuracy in dimensions; quicker production methods; better surface finishes; more alternatives to the existing materials and tooling systems; automatic and numerical control systems; higher mechanization; greater output are some of the goals of this course.

1.1. Drilling Tool material

Every cutting tool used in drilling may be found in a variety of materials, which determines the qualities of the equipment and the materials for which it is most suited. Hardness, durability, and resistance to wear are included in these characteristics. The following are the most often used materials in the construction of electronic devices:

- High-speed steel (HSS)
- Carbide
- Carbon steel
- Cobalt high speed steel

For example, a machine's material is chosen based on the kind of workpiece, its cost, and its lifespan. A device's life expectancy is an important factor to consider when selecting one, since it has a considerable impact on assembly costs. Having a limited apparatus life will need the purchase of more instruments, as well as the time required to replace the device each time it becomes overly worn.

Figure 1**:** Shapes of turning cutting tool

1.2. Taguchi's Parameter Design Approach

Control factors and noise factors are the two sorts of parameter design parameters that have an impact on a product's functional characteristics. In an injection molding process, control parameters include material selection, cycle duration, and mould temperature. Noise factors are those that are difficult, impossible, or prohibitively costly to manage. Outer noise, internal noise, and product-to-product noise are all examples of different sorts of noise. There are several noise elements that might cause a product's performance to fall short of its desired value. As a result, parameter design aims to establish control factor settings that reduce the product's sensitivity to changes in the noise factors without eradicating their source.

2. LITERATURE REVIEW

(Murthy, Rangappa and Almouns, 2020) [1] The primary goal of this study is to improve the quality of holes drilled throughout the drilling process. A carbon-basalt hybrid composite is a higher performing composite at a lower cost than traditional carbon-based composites. Using the hand layup process, a hybrid composite test specimen was created for this study. The matrix substance is a general purpose polyester resin. During the production process, the composite is prepared by stacking layers of carbon and basalt.. The tests were carried out using the DOE technique of design. Each experiment's combination of parameters was determined using Taguchi's three-level and three-factor array. There are a total of 27 holes bored, each with a distinct process parameter combination. DD1, F1 and S3 combination parameters produce the lowest thrust value according to Taguchi and RSM techniques.

(Manickam and Parthipan, 2020) [2] In manufacturing, the drilling process is critical. To cut the material, several drilling process parameters were used. Material removal and surface roughness are the primary goals of this study. Based on the input parameters of speed, feed, and the chosen drill tool; the different drilled holes in AISISS317L material. After confirming the accuracy of the findings, the output parametric optimization was done in thrust force, torque, material removal rate, and surface finish.

(Krivokapić et al., 2020) [3] For drilling hardening steel EN 42CrMo4 to 28-HRC hardness, using cruciform blade twist drills made of high-speed steel with 64 HRC hardness level, this paper describes development of models for predicting surface roughness using “multiple regression and artificial neural networks (ANN)”. The models link an arithmetic mean deviation of surface roughness to torque as an input variable. Input variables (nominal twist drill diameters, speed, feed, and angle of work piece installation) were varied at three levels by Taguchi design of experiment and measured experimental data for torque and arithmetic mean deviation of surface roughness for different values of flank wear on twist drills were used in the model development. According to this comparison, the neural network model outperforms numerous linear and nonlinear regression models when applied to the inputs at the point when wear spans approach a limit value that corresponds to the moment when drills become blunt.

(Siva Prasad and Chaitanya, 2020) [4] Conventional drilling of fiber-reinforced polymer composites suffers from issues such as delamination, chipping of the matrix, heat impacted zone, and low surface roughness, hence an unusual machining approach was used. When abrasive water jet machining (AWJM) of GFRP/Epoxy composites is used, the effects of hydraulic pressure, stand of distance, abrasive flow rate, fibre orientation, material thickness, and abrasive mesh size on surface quality are studied in this work. The Taguchi L27 orthogonal array is used to design the experiments. The findings of the experiments showed that the abrasive mesh size had the greatest impact on surface roughness.

(Siva Prasad and Chaitanya, 2020) [5] Abrasive ceramic particles in metal matrix composites (MMCs) make the machining process harder. Due to MMCs' potential broad application, the development of a suitable technology is crucial for the effective machining process. Drilling settings for (LM5/ZrO2) utilising Taguchi technique are investigated. “Taguchi's Signal-to-Noise ratio analysis” was used for the investigation. Response graphs are used to examine parametric findings' response properties. The relevant factors were classified and their impact on response characteristics was measured using ANOVA. The most critical input parameters for producing the lowest possible thrust force are the spindle speed and feed rate.

(Shunmugesh and Pratheesh, 2019) [6] For the "Carbon Fiber Reinforced Plastics (CFRP)," the "Taguchi Grey Relational Analysis (TGRA)" was used to optimise micro-drilling settings. Drill bits of various sizes were used to achieve this. The micro drilling test's process parameters are feed rate, drill diameter, and spindle speed. This study used Taguchi's L27 orthogonal array as the basis for its design. "Tool wear rate," "delamination factor," "material removal rate," and "machining conditions" are the primary goals of the experiments. The Taguchi Grey Relation Analysis is used to identify the optimal values for the lowest delamination factor, the highest material removal rate, and the lowest tool wear rate. The S/N ratio is also subjected to an ANOVA in order to determine the relative importance of the various variables.

3. RESEARCH METHODOLOGY

3.1. Steps of working

1. M1TR machine is selected for drilling operation.
2. Material selection for manufacturing of specimen.
3. Feed rate and other parameter are selected for drilling operation.
4. Drilling bit material and type was selected.
5. Operation is performed on M1TR machine.
6. Surface roughness is checks by surface roughness tester.
7. Taguchi method was performed on MINITAB software.
8. Different data implemented in taguchi analysis process.
9. s/n ratio graphs are drawn in MINITAB software.
10. Results are analyzed and compared.

3.2. Work piece preparation

Aluminum was selected as the work piece material of Plate of 50mm x 50mm x 20mm, then drilling operation were performed on that work piece on M1TR milling machine. [7] [8] [9]

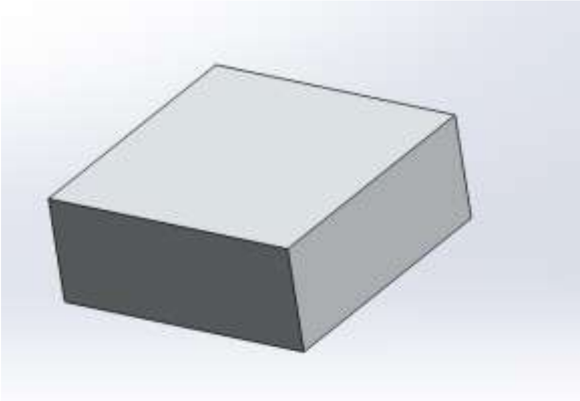


Figure 2**:** Workpiece

Table 1: Parameters used in drilling operation

Factors	**Parameters**	**Level**		
		1	2	3
A	Cutting dia (mm)	5	10	15
B	Cutting speed (rpm)	500	1000	1500
C	Feed rate (mm/rev)	0.012	0.014	0.016

4. RESULTS AND DISCUSSION

4.1. Experimental result

For three different drill diameters of 5mm, 10mm and 15mm, optimization results were obtained for different combinations of the feed rate and cutting speeds. Material Removal Rate, Surface roughness, Single to noise ratio and the means for each combination of the characteristics parameters are noted down in table below. [10]

Table 2: Experiment result

S.No.	Drill Dia(mm)	Cutting Speed(rpm)	Feed Rate	MRR	Surface Roughness	S/n ratio	Mean
1	5	500	0.012	117.804	0.35	-38.3871	59.077
2	5	1000	0.014	276.846	0.75	-45.8109	138.798
3	5	1500	0.016	471.216	0.97	-50.4362	236.093
4	10	500	0.014	549.733	1.73	-51.7654	275.7315
5	10	1000	0.016	1256.624	2.11	-58.9592	629.367
6	10	1500	0.012	1413.702	3.12	-59.9777	708.411
7	15	500	0.016	1413.712	2.45	-59.9819	708.081
8	15	1000	0.012	2120.568	3.99	-63.5024	1062.279
9	15	1500	0.014	3710.994	4.01	-68.3701	1857.502

Response Table for Signal to Noise Ratios

The table and the graphs below show the response ratios of the different characteristics of the machining process.

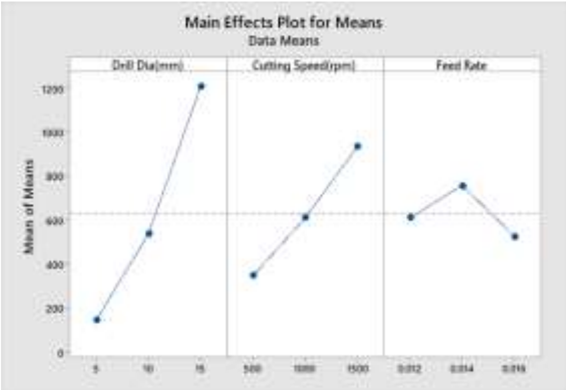
Nominal is best (-10×Log10(s^2)) criteria has been used.

Table 3: Response table for s/n ratio

Level	Drill Dia(mm)	Cutting Speed(rpm)	Feed Rate
1	-44.88	-50.04	-53.96
2	-56.90	-56.09	-55.32
3	-63.95	-59.59	-56.46
Delta	19.07	9.55	2.50
Rank	1	2	3

Table 4: Response Table for Means

Level	Drill Dia(mm)	Cutting Speed(rpm)	Feed Rate
1	144.7	347.6	609.9
2	537.8	610.1	757.3
3	1209.3	934.0	524.5
Delta	1064.6	586.4	232.8
Rank	1	2	3



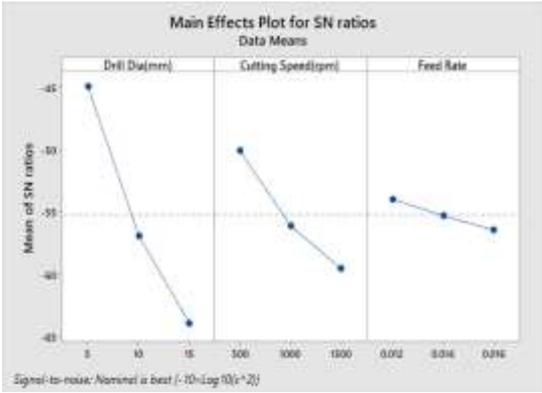


Figure 3**:** main effects plot for (a) means; and (b) SN ratios

The drill diameter is observed to be the most affected parameter in the graphs above with greater response ratio, followed by the cutting speed and the feed rate. Hence, the drill diameter is ranked no. 1 parameter, to be considered during the drilling process and that would affect the surface roughness and the S/N ratio the most. According to that analysis it is obtained that drill diameter should be at 10 mm cutting speed at 1000 rpm and feed rate should be at 0.014 mm/rev for obtained better results with less damage of work piece surface.

4.2. Result validation

The results have been validated from the paper of **C. Manickam.**

Table 5: result comparison

Base Paper value (C. Manickam)		**Experiment value**	
MRR	**Surface roughness**	**MRR**	**Surface roughness**
169.460	0.7566	117.804	0.35
402.123	1.86	276.846	0.75
785.398	1.61	471.216	0.97
170.421	1.63	549.733	1.73
326.230	1.25	1256.624	2.11
800.235	1.84	1413.702	3.12
155.236	1.44	1413.712	2.45
311.124	1.65	2120.568	3.99
902.101	0.90	3710.994	4.01

5. CONCLUSION

Drilling test is performed on an aluminium slab on M1TR milling machine. Surface roughness is tested and taguchi method is used to analysis the quality of drill and which parameters are better for drilling.

- According to that analysis it is obtained that drill diameter should be at 10 mm cutting speed at 1000 rpm and feed rate should be at 0.014 mm/rev for obtained better results with less damage of work piece surface.
- According to response table it can be observed that drilling diameters found on rank 1 which means diameter of drill is a most important factor which should be analysed appropriately according to drill requirement.
- Cutting speed is at rank 2 in response table which affects surface roughness a lot. And for better finishing of work piece surface, it should be maintained according to the requirements.
- Optimum MRR and surface roughness is attained because of using ‘nominal is best’ criteria.

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