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RESEARCH ARTICLE

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MACHINING PARAMETERS OPTIMIZATION OF DRILLING FOR MMC BY USING TAGUCHI DESIGN AND S/N RATIO ANALYSIS

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ABSTRACT

The Research work conducts on hybrid metal matrix composite of different ratios Al+Mg + SiC+ graphite of sample plates. As required machining parameters bring to samples drilled by using vertical milling machine with the help of HSS drill tool diameter 10mm. Here select to applied machine parameters are spindle speed, feed and depth of cut. In the 3 parameters and 3 levels are taguchi designed as L9 orthogonal array. Then the 9 trials of machining experiments implement on the all sample plates. Surface roughness of S/N ratio was selected to smaller the better mode. It was considered as minimize the roughness by improve the quality of work along from obtained the optimum machining parameters.

Keywords: Drilling, Surface Roughness, Optimization, ANOVA, Spindle Speed, Feed, Depth of Cut.

1. INTRODUCTION

The L9 design of Machining parameters offers a systematic approach (Taguchi) for optimization of various parameters with regard to performance quality and cost. Design optimization for quality was carried out and signal to noise ratio and analysis of variance were employed using experiment result to confirm effectiveness of this approach. The signal to noise ratio in taguchi methodology was used to find optimal parameter for surface roughness in drilling operation based experimental results done on hybrid MMC work piece and HSS tool. Machining parameters of selected as spindle speed 1 (357), 2(520), 3(727) in rpm, feed (slow, medium, fast) in mm/min, and depth of cut 1(3), 2(5), 3(7) in mm of drilling operations. Minitab-17 software utilized to taguchi L9 orthogonal array of experimental planning for drilling operation.

2. Experimental Details:

2.1 Work Piece Material: In the drilling operation performed on hybrid MMC (Al+Mg+SiC+graphite). The composite material ingredients of combination have to be various ratios of 4 samples. First sample ratio was 60%+20%+10%+10%, Second sample ratio was 50%+25%+10%+15%, Third sample ratio was 70%+10%+10%+10%, and Fourth sample ratio was 60%+30%+5%+5%. In the all sample plates sizes like as 100×100×12 mm to machined.

2.2 Machine Setup: Drilling operation performed for using vertical milling machine with the help of 10 mm diameter sized HSS drill. Herewith selection parameters of spindle speed, feed, depth of cut are 3 levels by 9 experiments conduct with various changed parameters operations performed (using L9 orthogonal array of process parameters).

2.3 Surface Roughness Testing Setup

Figure 1: Calibration of Surface Roughness Testers

Probe calibration of Surface roughness tester for before testing by using for a standard specimen (Ra 2.7µm). Then the Diamond Probe head by leveling for using the spirit level. Work piece obtained holes axies is parallel to the probe movement for setting the work by clamp. Start button on as final SR value (µm) taken from the indicator screen.In the same procedure follow to each hole measuring.

Thus the Surface roughness values obtained from L9 design of machining parameters along bydrilling hole for each sample.

Figure 2: Leveling of SR Probe

Figure 3: Drilling Hole Surface Roughness Measurement

Figure 4: Final image of 4 Sample pieces

Table 1: Design of Experimental Parameters & Levels

Control Parameter	Level 1	Level 2	Level 3
Speed (RPM)	357	520	727
Feed (mm/min)	Slow	Medium	Fast
DOC (mm)	3	5	7

3. DESIGN OF EXPERIMENTS

Machining parameters arranged for L9 orthogonal array design of drilling machining parameters is used. The milling machine was adapted to drilling process and HSS tool with diameter of 10mm was used. The Surface Roughness (Ra) is essential part of a product in any drilling machining operation. In the array having a three control parameter and three levels are shown in table1. In the study spindle speed, feed rate and depth of cut have been selected as design factor. This experimental focuses the observed values of SR and each experimental trial was performed with three simple replications at each set value. Then the optimization of the observed values obtained from taguchi approach.

Table 2: L9 Orthogonal Array of Machining Parameters

TRIALS	SPEED (RPM)	FEED (mm/min)	DOC (mm)
1	357 (1)	S (1)	3 (1)
2	357 (1)	M (2)	5 (2)
3	357 (1)	F (3)	7 (3)
4	520 (2)	S (1)	5 (2)
5	520 (2)	M (2)	7 (3)
6	520 (2)	F (3)	3 (1)
7	727 (3)	S (1)	7 (3)
8	727 (3)	M (2)	3 (1)
9	727 (3)	F (3)	5 (2)

Table 3: Surface Roughness (SR)

Trial No	Surface Roughness (Ra)			
	I	II	III	IV
1	7.749	1.017	3.779	1.544
2	7.581	1.814	1.221	2.820
3	8.487	1.423	2.668	3.163
4	6.244	3.763	8.507	1.329
5	5.229	1.896	6.555	2.256
6	5.773	1.330	5.037	1.186
7	8.161	3.412	7.366	2.267
8	4.842	2.528	1.698	2.567
9	6.694	7.199	2.505	3.345

Table 4: SR – Signal to Noise Ratio

Trial No	S/N Ratio of Surface Roughness			
	I	II	III	IV
1	-4.856	-0.146	-11.548	-3.773
2	-17.595	-5.173	-1.734	-9.005
3	-18.575	-3.064	-8.524	-10.002
4	-15.909	-11.511	-18.596	-2.471
5	-14.368	-5.557	-16.332	-7.067
6	-15.228	-2.477	-14.043	-1.482
7	-18.235	-10.660	-17.345	-7.109
8	-13.701	-8.056	-4.599	-8.189
9	-16.514	-17.145	-7.976	-10.488

Taguchi Design: MINITAB Analysis

Taguchi Analysis of Response versus Speed(A),Feed (B), Depth of Cut (C)

Table 5: I-Sample Response for Signal to Noise Ratios (Smaller is Better)

Level	SPEED	FEED	DOC
1	-17.98	-16.77	-15.57
2	-15.17	-15.22	-16.67
3	-16.15	-17.31	-17.06
Delta	2.82	2.09	1.49
Rank	1	2	3

Main Effects Plot for S/N Ratios

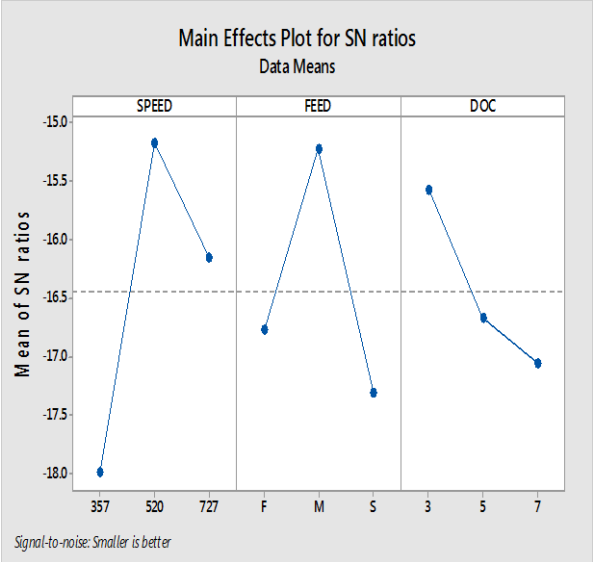

Figure 5: Sample I - S/N Ratios

Table 6: II-Sample Response for Signal to Noise Ratios (smaller is Better)

Level	SPEED	FEED	DOC
1	-2.794	-7.562	-3.560
2	-6.515	-6.262	-11.276
3	-11.954	-7.439	-6.427
Delta	9.159	1.301	7.717
Rank	1	3	2

Main Effects Plot For S/N Ratios

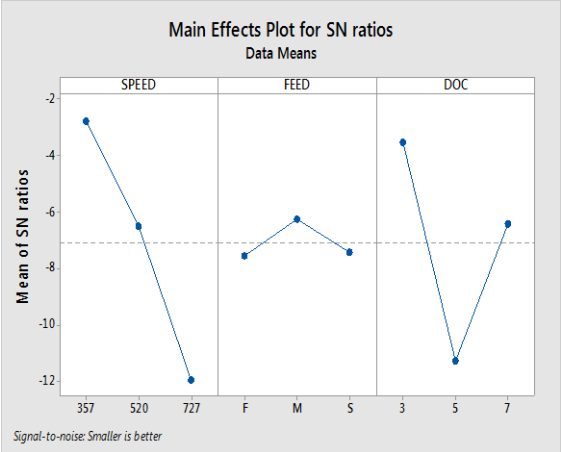

Figure 6: Sample II - S/N Ratios Graph

Table 7: III-Sample Response for Signal to Noise Ratios (Smaller is Better)

Level	SPEED	FEED	DOC
1	-7.269	-10.181	-10.063
2	-16.323	-7.555	-9.435
3	-9.973	-15.829	-14.067
Delta	9.055	8.274	4.631
Rank	1	2	3

Main Effects Plot for S/N Ratios

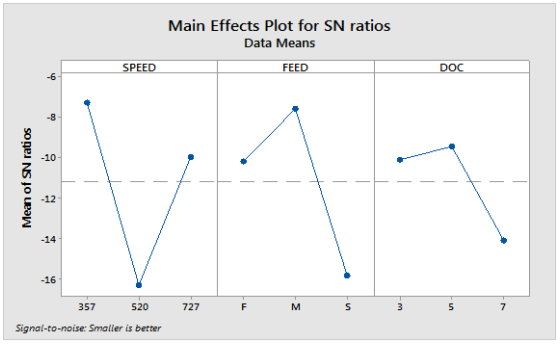

Figure 7: Sample III - S/N Ratios Graph

Table 8: IV-Sample Response for Signal to Noise Ratios (Smaller is Better)

Level	SPEED	FEED	DOC
1	-7.593	-7.324	-4.481
2	-3.673	-8.087	-7.321
3	-8.595	-4.451	-8.059
Delta	4.922	3.636	3.578
Rank	1	2	3

Main Effects Plot for S/N Ratios

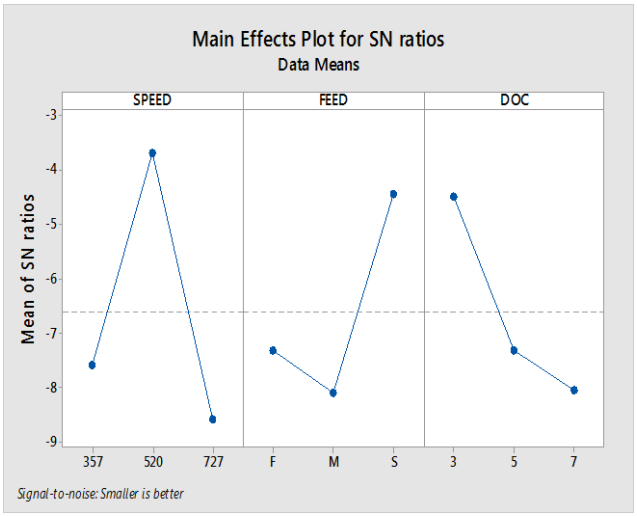

Figure 8: Sample IV - S/N Ratios Graph

4. Results & Discussion

Surface Roughness value minimize in the first sample for obtained machining parameters from graph results of speed 2 (520 rpm), feed 2 (Medium), and Depth of cut 1 (3mm). Second sample for obtained machining parameters of speed 1 (357 rpm), feed 2 (Medium), Depth of cut 1 (3mm). Third sample for obtained machining parameters are speed 1 (357 rpm), feed 2 (Medium), Depth of cut 2 (5mm) and IVth sample has to be the speed 2 (520 rpm), feed 3 (slow), Depth of cut 1 (3mm).

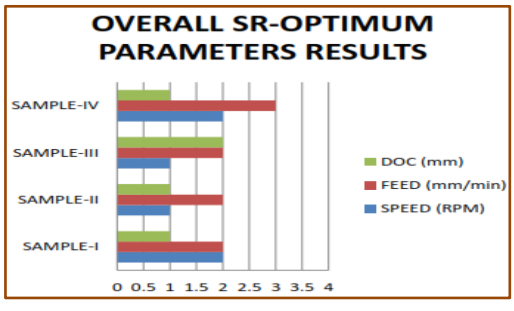

Figure 9: Optimum Parameters Results

5. Conclusion

Metal matrix composite of 4 specimens brought to the drilling operation as L9 orthogonal array of machining parameters in taguchi approach. Surface roughness (µm) of significant machining parameters for the sample I, II, III, & IV was speed. In the main reason for all samples of S/N ratio analysis results obtained in first rank. Optimum machining parameters of speed, feed, depth of cut respectively for first sample of 2 (520 rpm), 2 (medium), 1 (3mm); second sample of 1 (357 rpm), 2 (medium), 1 (3mm); third sample of 1 (357 rpm), 2 (medium), 2 (5mm); and fourth sample of 2 (520 rpm), 3 (slow), 1 (3mm).

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