

Experimental Investigation of L/D Ratio and Machining Parameters on Surface Roughness of Part Turned on CNC Lathe

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Abstract— Surface roughness is important parameter in all industrial products as it can affect life and working of the product. Researches have been carried out to investigate effect of machining parameters on surface roughness but L/D ratio which is also an effective parameter is not considered in most researches. In this work, experimental investigation was done to analyze effect of L/D ratio, speed, feed and depth of cut on surface roughness of mild steel cylindrical part. The parameters were analyzed for getting better surface roughness by turning on CNC lathe. Taguchi method was used in the work.

Keywords: Surface roughness, Taguchi, Design of Experiment, dry turning

1. INTRODUCTION

Surface roughness is important parameter from functional point of view, rough surface may be reason of failure of part sometimes. It has remained an important parameter and many researches have been carried out to find ways to obtain desired level of surface roughness. Machining of parts can be done either using coolants or without using it. Machining which is carried out without use of coolant is called “dry machining”.

Turning operation has been most widely used method for machining, researches show that with less lead time good surface quality can be obtained by turning [1], [2]. Process parameter optimization for turning operation is very significant.

Dr. C. J. Rao *et al* [3] analyzed influence of machining parameters on cutting force and surface finish, they used Taguchi L-27 design for the purpose. They concluded that feed rate has significant effect on surface roughness and cutting force both. Mustafa Günay *et al* [4] applied taguchi method to optimize surface roughness of high alloy white cast iron.

N.Satheesh Kumar *et al* [5] carried out experiments to analyze effect of spindle speed and feed rate on surface roughness of carbon steel in CNC turning, the conclusion of the work was better surface finish could be achieved by low feed rate. Ilhan

Asilturk [6] obtained optimum values of cutting parameters for better surface finish using Taguchi method and ANOVA. Researches have been carried out to analyze effect of machining parameters but mostly in all research effect of L/D ratio is not studied. In this work experiments were carried out to check effect of different L/D ratio together with machining parameters on surface roughness of part in dry turning of mild steel cylindrical part.

2. DESIGN OF EXPERIMENT

Experiments can be effectively designed by Taguchi method. Taguchi developed a method for designing experiments to investigate effect of different parameters on mean and variance of a process performance characteristic that define how well the process is functioning. Experiment time decreases and significant factors can be found in shorter time. Signal to Noise(S/N) ratio is used to check level of signal (desired) to level of noise (undesired).

In this work L16 orthogonal array was used to design experiment using 4 parameters.

Table 1: Machining Parameters

Level	L/D ratio	Feed mm/sec	Speed rpm	Depth of cut mm
1	17.9	0.15	1200	0.5
2	15.4	0.18	1350	1
3	13.5	0.21	1500	1.5
4	7.7	0.24	1650	2

3. EXPERIMENTAL SETUP

HMT STARTURN CNC lathe was used to turn the work pieces. Work pieces with different diameters were taken to introduce different L/D ratio.

Turning of all the work pieces was carried out by the parameters set which was designed by L16 orthogonal array. Surface roughness of all the work pieces was measured by surface roughness indicator.

Table 2: Experiment Layout

Sr. No.	L/D ratio	Feed mm/sec	Speed rpm	Depth of cut mm
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	1	4	4	4
5	2	1	2	3
6	2	2	1	4
7	2	3	1	4
8	2	4	3	2
9	3	1	3	4
10	3	2	4	3
11	3	3	1	2
12	3	4	2	1
13	4	1	4	2
14	4	2	3	1
15	4	3	2	4
16	4	4	1	3



Fig. 1: HMT STARTURN CNC Lathe used for experiments

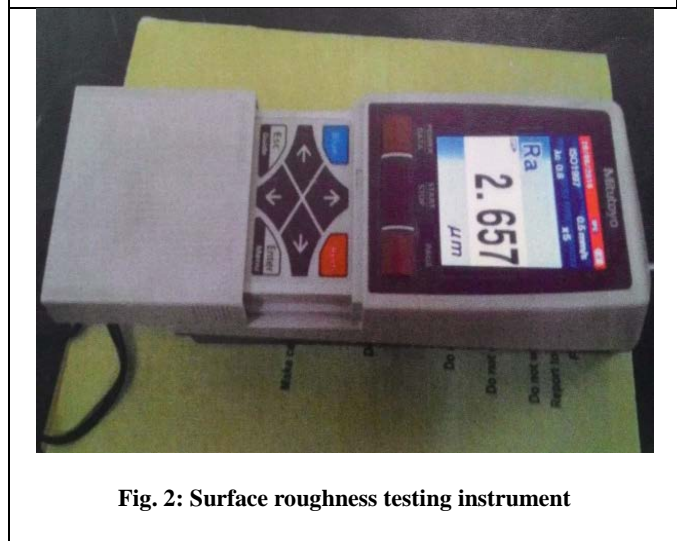


Fig. 2: Surface roughness testing instrument

4. RESULTS AND DISCUSSION

Results of the experiments are shown in Table III. Analysis of results was done using Minitab16.

Table 3: Results

Sr. No.	L/D ratio	Feedmm/s	Speed rpm	Depth of cut mm	Surface roughness	SN ratio
1	1	1	1	1	1.698	-4.59875
2	1	2	2	2	2.319	-7.30601
3	1	3	3	3	2.922	-9.3136
4	1	4	4	4	3.092	-9.80479
5	2	1	2	3	2.842	-9.07248
6	2	2	1	4	2.325	-7.32846
7	2	3	1	4	2.716	-8.6786
8	2	4	3	2	2.657	-8.48783
9	3	1	3	4	2.595	-8.28275
10	3	2	4	3	2.273	-7.13199
11	3	3	1	2	2.132	-6.57574
12	3	4	2	1	1.799	-5.10062
13	4	1	4	2	2.775	-8.86526
14	4	2	3	1	2.933	-9.34624
15	4	3	2	4	2.652	-8.47147
16	4	4	1	3	2.358	-7.45088

S/N ratio is the criteria to analyze the results using Taguchi method, smaller the better method was selected to get optimum response. Fig.3 shows main effect plot for S/N ratios with smaller is better method. Minimum roughness was obtained for L/D ratio 13.5, depth of cut 1.5mm, spindle speed 1200 rpm, feed rate 0.15 mm/rev.

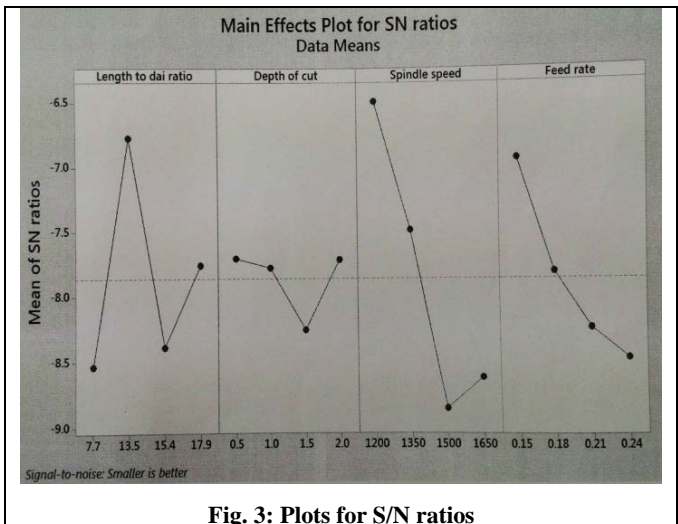


Fig. 3: Plots for S/N ratios

It was noted that good surface finish is obtained by low speed and low depth of cut. Chattering may be the reason. It was also noted that for smallest L/D ratio high surface roughness was obtained as L/D ratio increases to 13.5 better surface finish was obtained which again reduces with further increase in L/D ratio.

Analysis was done to find most influential parameter. The effect of a factor level is defined as the deviation it causes from overall mean. Hence as a first step, overall mean value of η was calculated. After that ratio of sum of square of parameter to total sum of square is taken and is represented in percentage. Parameter with the highest percentage is the most influential parameter.

Table 4: Influence of parameters

PARAMETER	%INFLUENCE	RANK
L/D ratio	27.09	2
Depth of cut	2.99	4
Spindle speed	50.45	1
Feed rate	19.46	3

5. CONCLUSIONS

Experiments were conducted to analyze effect of speed, feed, depth of cut and L/D ratio in dry turning of mild steel on CNC lathe. Taguchi method was used to design experiment and analyze results. Sixteen experiments were conducted using L16 orthogonal array.

- Optimum surface roughness was obtained at L/D ratio 13.5, depth of cut 1.5mm, spindle speed 1200 rpm, feed rate 0.15 mm/rev.
- Most effective parameter was spindle speed
- High L/D ratio creates bending of cylindrical part which creates vibrations and results into poor surface roughness.

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