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A Graphical Approach to Establish the Relevancy between Weight before and after Machining Vs. Surface Roughness and Chip Thickness in CNC Lathe

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Abstract: A CNC lathe is a standard machine-tool in the modern manufacturing industry, and turning is one of its important machining processes, among many other processes of a CNC lathe. So, studying and comparing different parameters of machining in the CNC lathe is important in order to have a more in-depth understanding of the different criteria affecting the machining process and to have a more desirable output from the CNC lathe. The authors have taken an approach to find-out if the weight of the aluminium work-piece before and after machining is related to the surface roughness and chip thickness. If so, then how in practice? The authors have employed a CNC lathe, using a carbide tip HSS tool, and have machined an aluminium work-piece and tested, measured, and noted down different aspects of the work-piece. For this approach, initially, a L_9 Taguchi Orthogonal Array, with three sets of input constraints (Speed, Feed, and Depth of Cut), was formed with the help of Minitab software.

In this experiment-based work, a comparative study is done between the difference in weights before and after machining, surface roughness, and chip thickness on a CNC lathe for aluminium work-piece. This study was conducted to find-out how these parameters are related to each other in practice. For this, three levels of spindle speed (rpm), depth of cut (mm), and feed rate (mm/min) were used as input constraints, and surface roughness, chip thickness, and weight before and after machining were taken as output parameters and were measured. As already stated before, we have taken an approach to find out if the weight of the aluminium work-piece before and after machining is related to its surface roughness and chip thickness. In theory, if the difference between weights before and after machining is high, that means a huge amount of material is removed, which implies a high surface roughness value and greater chip thickness, but through our practical experiment, the difference in weight before and after machining is connected with surface roughness and chip thickness. In the initial machining process, a high difference in weight before and after machining is desirable for aluminium work-piece machining as it drastically improves the surface roughness while at the same time giving a low chip thickness. To conduct the comparative study, a graph was created using these data.

Keywords*:* Surface roughness, Chip thickness, Weight before and after machining, Taguchi Orthogonal Array, Aluminium work-piece.

I. INTRODUCTION

CNC lathe is a standard machine tool in modern manufacturing industry and turning is one of its important machining processes among many other processes of CNC lathe. So, studying and comparing different parameters of machining in the CNC lathe is important in order to have a more in-depth understanding of different criteria affecting the machining process in order to have a more desirable output from the CNC lathe. In this experiment-based work, we have taken an approach to find out if the weight of the aluminium workpiece before and after machining is related to its surface roughness and chip thickness. If yes, then how in practice. For this, we have employed a CNC lathe, using a carbide tip HSS tool and have machined an aluminium workpiece and tested, measured and noted down different aspect of the aluminium workpiece.

A. Literature review:

Kesarwani et al. [1] have prepared three Aluminum Metal Matrix composite (AMC) by stir casting technique-AMC with eggshell (6% wt, 104 µm), AMC with boron carbide (6%wt, 104 µm) and hybrid AMC(6%wt egg shell+6%wt B_4C, 104 µm). After preparation of composites, they have conducted CNC turning at fixed process parameters of cutting speed 500 rpm, feed rate 0.1 mm/rev and depth of cut 0.5 mm. After the experiments, the responses such as material removal rate (MRR), surface roughness, residual stress and temperature between tool-work piece interfaces are recorded and evaluated.

Chaturvedi et al. [2] have applied Taguchi Method for getting optimum parameters settings for Surface roughness and Metal Removal Rate (MRR) in case of turning AlMg3 (AA5754) in CNC Lathe machine, which is an aluminum alloy having diameter 20 mm and length 100 mm.

Singh et al. [3] have conducted an examination concerning the utilization of Taguchi Parameter Design for upgrading surface roughness produced by a CNC lathe machine.

Karmakar et al. [4] have conducted an experiment, taking three levels of Spindle Speed (RPM), Depth of Cut (mm), Feed Rate (mm/min) as input constrain and surface roughness, materials removal rate and chip thickness were taken as output parameters and were measured.

II. THEORETICAL AND EXPERIMENTAL METHODS

In this experimental process, 9 different combinations of spindle speed (rpm), depth of cut (mm), and feed rate (mm/min) is used (applying the Taguchi orthogonal array concept). The three specific values of each parameter is in Table [I].

A. The Procedure Is As Follows:

i)A 100mm cylindrical aluminium job is cut with the help of Hacksaw and it is weighted. The value was noted down.
ii) Next, the job was set in a three-jaw universal chuck in a CNC lathe and an initial point was set on the job using the CNC program.
iii) Then, in the control panel X and Z axes are selected and fixed using CNC programming commands.
iv) Next, value of Depth of Cut (mm),Feed rate (mm/min), and Spindle speed (rpm) are entered in the CNC program and in the CNC lathe respectively.
v) Lathe operation is started.
vi) When the lathe operation is finished the job is taken out.
vii) The job is again weighted. Its chip thickness is measured using a digital vernier caliper and surface roughness was measured after machining using a Talysurf surface roughness tester. The values are noted down.
These steps are repeated for 9 different combinations of spindle speed (rpm), depth of cut (mm), and feed rate (mm/min).

III. RESULTS AND DISCUSSION

The result of lathe operation on the job for 9 different combinations of spindle speed (rpm), depth of cut (mm), and feed rate (mm/min) is included in the Table [II]. Comparisons between a few parameters are made via table and graph.
Difference Of Weights Before And After Machining Vs. Surface Roughness And Chip Thickness: Here we are comparing the experimental result from Table [III], Table [IV] and Fig. [1], Fig. [2].

A. Discussion:

In Fig.[1] and Fig. [2] we are comparing difference in weight before and after machining, surface roughness, and chip thickness. The data can be divided into two-parts in both cases, the first part we can call initial machining from 1-4 and the later part from 5-9 after initial machining. In the first part, we can observe that the difference in diameter before and after machining is increasing gradually in Fig. [2].

From 1 to 4 surface roughness is starting from an initial high point and then dipping down then increasing in 3 and again dipping in 4 which is in most part opposite to chip thickness which is starting from a low initial point increasing then dipping and end up lower than the initial point, which could be a result of a high difference in weight before and after machining in 4 but as we move to later part of machining from 5 to 9 we can observe in 5 and 6 surface roughness keeps decreasing then in 7 to 9 it follows the initial machining data pattern where it hit a peak in one then goes down and again hit a peak mirrored by the chip thickness. So there is a linear relationship between the data sets.

In theory, if difference between weights before and after machining is high means a high amount of material is removed which implies high surface roughness and high chip thickness but through our practical experiment we can observe for aluminium in practice the things are more relative in initial machining process a high difference of weight before and after machining is a better way to get better surface roughness early in machining process but later in the machining process as surface roughness go below the average surface roughness of entire machining process and we have a better surface roughness, aluminium becomes more sensitive toward a high difference of weight before and after machining and fall in line with theory.

IV. FIGURES AND TABLES

TABLE I DESIGN OF EXPERIMENT

Parameters	Level 1	Level 2	Level 3
Speed (rpm)	750	1000	1250
Feed (mm/min)	50	75	100
DOC (mm)	0.05	0.075	0.1

TABLE 2 OBSERVATION TABLE

Sl no.	Spindle Speed (rpm)	Depth of cut (mm)	Feed rate (mm/min)	Weight before machining (g)	Weight after machining (g)	Surface roughness (µm)	Chip thickness (mm)
1	750	0.05	50	75.5	75.3	1.42	0.41
2	750	0.075	75	75.3	75	1.03	0.85
3	750	0.1	100	75	74.5	1.38	0.44
4	1000	0.05	75	74.5	73.5	0.62	0.32
5	1000	0.075	100	73.5	73	0.53	0.35
6	1000	0.1	50	73	72.5	0.45	0.19
7	1250	0.05	100	72.5	72	0.66	0.25
8	1250	0.075	50	72	71.5	0.47	0.27
9	1250	0.1	75	71.5	71	0.74	0.18

TABLE 3 WEIGHT BEFORE AND AFTER MACHINING VS. SURFACE ROUGHNESS AND CHIP THICKNESS

Weight before machining (g)	Weight after machining (g)	Surface Roughness (µm)	Chip thickness (mm)
75.5	75.3	1.423	0.41
75.3	75	1.039	0.85
75	74.5	1.383	0.44
74.5	73.5	0.623	0.32
73.5	73	0.539	0.35
73	72.5	0.454	0.19
72.5	72	0.668	0.25
72	71.5	0.472	0.27
71.5	71	0.741	0.18

TABLE 4 SURFACE ROUGHNESS, CHIP THICKNESS VS. DIFFERENCE IN WEIGHT BEFORE AND AFTER MACHINING

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Surface Roughness(µm)	Chip thickness (mm)	Difference in weight before and after machining (g)
1.423	0.41	0.2
1.039	0.85	0.3
1.383	0.44	0.5
0.623	0.32	1
0.539	0.35	0.5
0.454	0.19	0.5
0.668	0.25	0.5
0.472	0.27	0.5
0.741	0.18	0.5

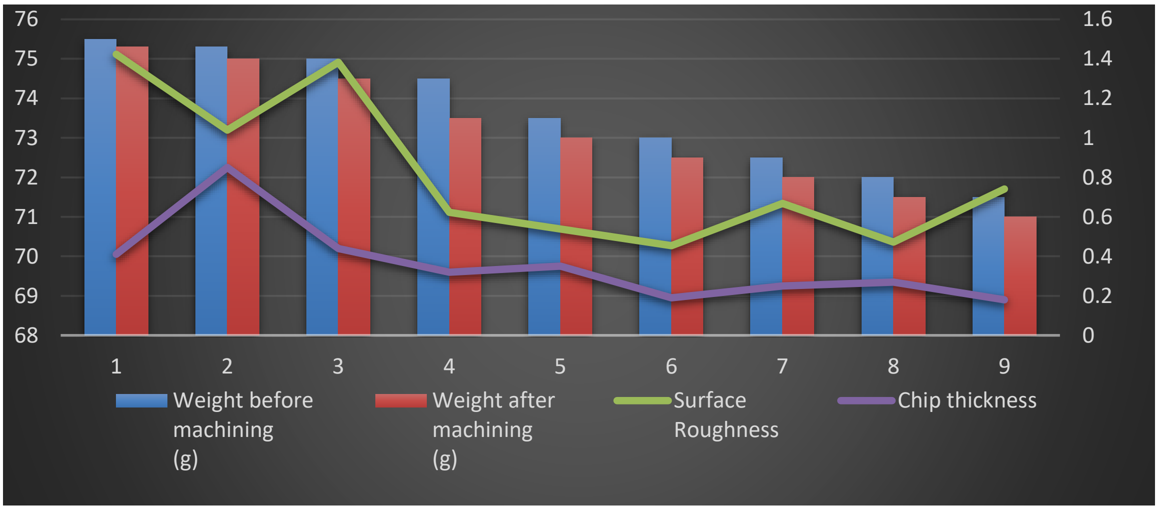

Fig. 1 Weight Before and After Machining Vs. Surface Roughness And Chip Thickness

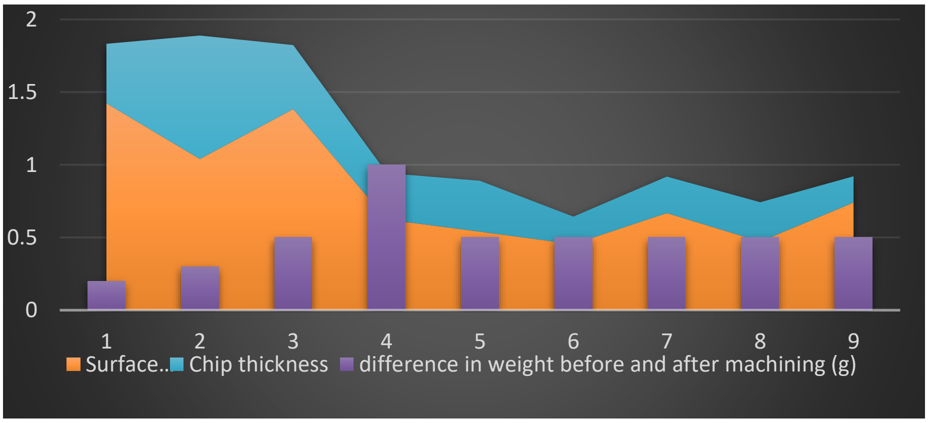

Fig. 2 Surface Roughness, Chip Thickness Vs. Difference In Weight Before and After Machining

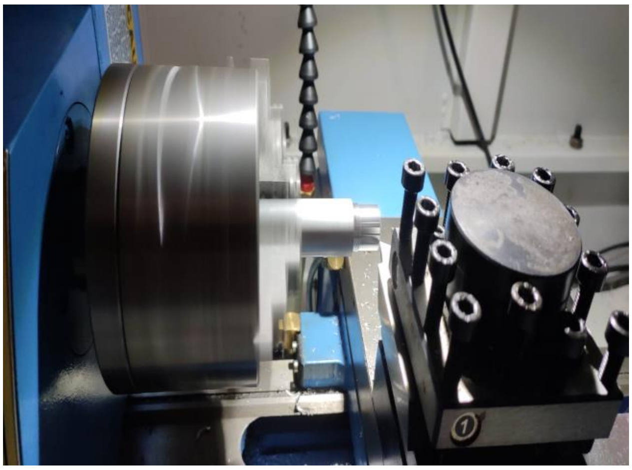

Fig. 3 Turning operation performed in CNC Lathe

Fig. 4 Aluminiun workpiece after turning operation

V. CONCLUSION

In this research paper we have done a comparative study between difference of weights before and after machining vs. surface roughness and chip thickness. We can conclude

- Difference of weight before and after machining is connected with surface roughness and chip thickness.
- In initial machining process high difference of weight before and after machining is desirable for aluminium machining as it drastically improve the surface roughness at the same time give low chip thickness.
- Later stage of machining when a below average surface roughness is achieved aluminium surface become sensitive toward same difference in weight before and after machining as we see peaks and dips of surface roughness and chip thickness when there is a constant difference in weight of the job before and after machining.

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