Indian Journal of
Advances in Chemical Science

Article

Optimization of Turning Parameter for Roundness Investigation using V-block Method

S. Raghu[1]*, T. G. Mamatha[1], M. Vishnoi[1], G. Moona[2], R. Sharma[2]

[1]Department of Mechanical Engineering, JSS Academy of Technical Education, Noida, Uttar Pradesh, India, [2]Department of Length, Dimension and Metrology, CSIR-National Physical Laboratory, New Delhi, India

ABSTRACT

Roundness or circularity is a very important surface characteristic that can effect on the performance and behavior of machined parts. This paper introduces experimental investigations on the effect of turning parameters on roundness error of turned specimens using 90° V-block method and analysis of variance techniques. For the study, the turning parameters such as cutting speed and depth of cut were chosen. Aluminum 6061 specimens are used for experimental investigations. The results of the investigation indicate that depth of cut and cutting speed are interrelated and have significant effects on roundness error. This optimized design was minimized the roundness error.

Key words: Roundness, V-block, Cutting speed, Turning and circularity.

1. INTRODUCTION

The dimensional accuracy and surface quality of a machined part are of primary importance in the turning process. Measurement is involved in every aspect of our daily life and supports societal also. “Once accurate measurement is worth a thousand expert opinions,’ ‘said Grace Murray Hopper. Quality control actually depends on the information about the characteristics and process control of the product. Quality assurance defined on some parameters such as designed specification, expected outputs, and customer satisfaction. In the manufacturing industry, this information obtained by authentic and real-time dynamic measurements with a good working environment. Some time, simple measurement mistakes in science and technology cause big consequences. The entire life cycle of the product is supporting by accurate and precise dimensional measurement and associated procedure. National metrology institutes establish national measurement systems, as shown in Figure 1, to maintain and disseminate measurement standards for base units and metrological capability by providing traceable calibration and testing services along with significant research outcomes to the nation’s economic growth and ascertain that measurements done are fit for purpose.

Alloys composed mostly of aluminum have been very important in aerospace manufacturing since the introduction of metal-skinned aircraft. Aluminum-magnesium alloys are both lighter than other aluminum alloys and much less flammable than alloys that contain a very high percentage of magnesium Taguchi methods are statistical methods developed by Genichi Taguchi to improve the quality of manufactured goods. More recently, this method is being applied to engineering, biotechnology, marketing, advertising, etc. Analysis of variance (ANOVA) is a collection of statistical models used to analyses the differences between group means and their associated procedures such as “variation” among and the main objective of the present research is to study the effect of some important turning parameters on machined out-of-roundness and to build a database for predicting surface roundness by selecting suitable cutting parameters for aluminum materials.

It is the simplest method for roundness measurement of the different artifact. V-block method consisting of the surface table, V-block, Vernier caliper, steel rule, etc. In an assembly of circular parts, only the dimensional tolerance on diameter will not fulfill the requirements but it is the geometrical accuracy that is most frequently needed. Roundness or circularity is defined as the radial uniformity of the work surface measured from the centerline of the workpiece. The error of circularity or out of roundness is defined as the radial distance between the minimum inscribing circle and the maximum inscribing circle, which contain the profile of the surface at a section perpendicular to the axis of the rotation. There may be so many reasons for out-of-roundness that may include clamping distortion, spindle runout, presence of dirt and chips on clamping surface, poor bearing in the spindle, inadequate lubrication, poor alignment of centers, excessive feeds, and vibrations types of measurement of out-of-roundness. The most commonly used methods of the measurement of roundness are: (1) Traditional V-block method with dial gauge and (2) coordinate measuring machine [1]. Rotational datum method most advanced technique. Roundness is a major parameter in dimensional metrology that is affected by the machining parameters [2]. Nowadays, turning parameters majorly spindle speed, feed rate, and depth of cut influences the production rate and performance of the component [3]. We have used aluminum (Al6061) component. It is good strength, lightweight, and widely used aerospace application [4]. The experiment performed using 90-degree-block method [5]. Many papers, we have studied roundness affected by the speed, feed, and depth of cut [6]. Initially, workpiece selected based on the literature survey and turned into different machining

***Corresponding author:**
E-mail: raghu4gk@gmail.com

ISSN NO: 2320-0898 (p); 2320-0928 (e)
DOI: 10.22607/IJACS.2020.801006

Received: 09th November 2019;
Revised: 15th December 2019;
Accepted: 30th December 2019

conditions [7]. Al6061 it was good mechanical properties and corrosion resistance [8]. To find the optimum and accurate machining parameters ANOVA technique is used [9]. Taguchi method applied and determined the optimum solution to enhance the performance of the component [10]. Initially, turned part placed on the v-block and dial indicator touches the surface and collecting the corresponding measuring points [11]. After collecting measured points and draw the polar plot, find the roundness error [12,13]. Orthogonal array applied with a specific condition, as shown in Figures 3-5.

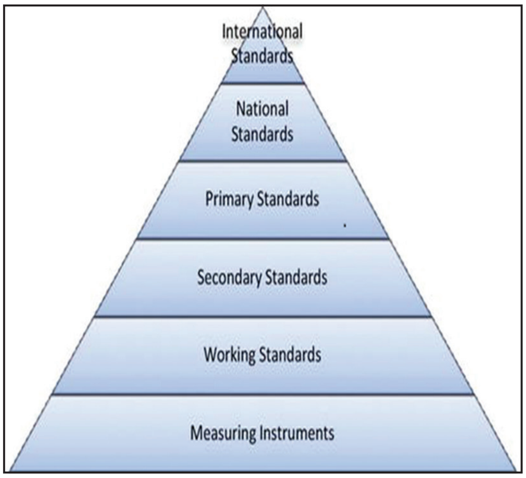

Figure 1: Hierarchy of measurement traceability pyramid.

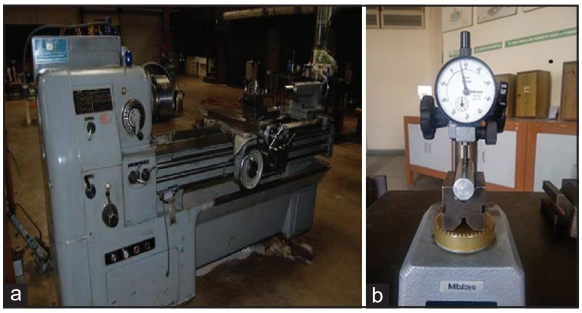

Figure 2: (a) Turning operation using lathe machining, (b) roundness measurement using V-block measurement.

Figure 3: Al6061 workpiece before turning.

2. EXPERIMENTAL

Figure 2 shows the experimental setup used in the present work. Al6061 workpieces of diameter 20 mm and length 55 mm were used in the experiments. Figure 3 shows the sample workpieces machined. The process parameters such as cutting speed, feed, and depth of cut were chosen with each parameter having three levels, as shown in Table 1. Circularity is defined as radial deviation between the circumscribed and inscribed circle. Usually roundness measured by difference in dial indicator reading gives the out of roundness error. In polar graph method is given the actual roundness error but sometimes lobes come into picture, lobes are the peak and valley structured seen on the surface called lobe. When ring or rod subjected to turning, it is hold by three jaw chuck. When stress exerted on the surface, during turning resulting lobes are generated. If we are using the four-jaw chuck increases the out of roundness error due to position of chuck, spindle speed, feed and depth of cut. In an assembly of circular parts, only the dimensional tolerance on diameter will not fulfill the requirements but it is the geometrical accuracy that is most frequently needed. Out-of-roundness, that may AQ2

Table 1: Chemical composition of 6061 aluminum.

Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti
0.4–0.8	0.7	0.15–0.4	0.15	0.8–1.2	0.04–0.35	0.25	0.15

Table 2: The levels of the variable used in the experiment.

Control variables	Low	Medium	High
Coding	−1	0	+1
Spindle speed (rpm)	500	630	800
Depth of cut (mm)	0.4	0.6	0.8

Table 3: Material removal rate for Al6061 specimens.

Samples	Initial weight in grams	Final weight in grams	MRR in g/s
Sample 1	58.210	56.640	0.0635
Sample 2	59.100	56.530	0.0903
Sample 3	62.334	61.210	0.0390
Sample 4	58.230	57.860	0.0119
Sample 5	60.110	58.240	0.0603
Sample 6	57.910	55.340	0.0829
Sample 7	52.190	50.350	0.0593
Sample 8	60.120	57.800	0.0748
Sample 9	62.330	60.540	0.0577

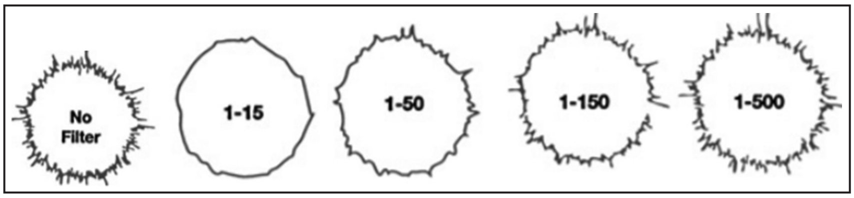

Figure 4: Representation of different UPR ranges of roundness profile.

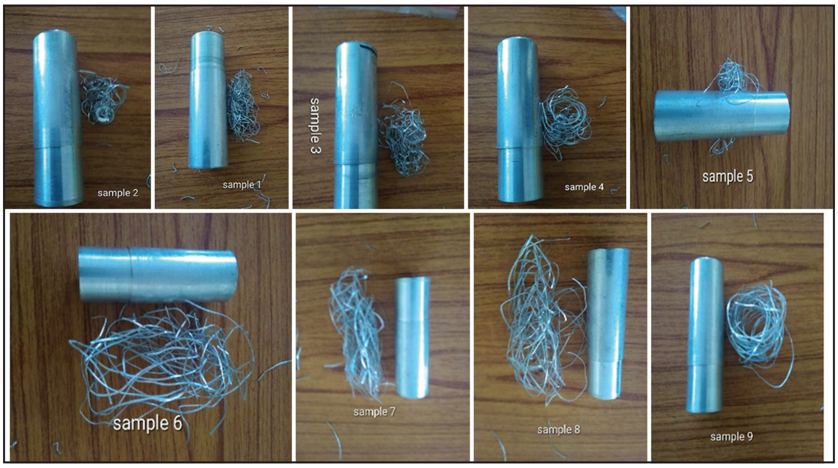

Figure 5: Orthogonal array of Al6061 workpiece with different speed, depth of cut.

include, clamping distortion, spindle run out, presence of dirt and chips on clamping surface, poor bearing in the spindle, inadequate lubrication, poor alignment of centers, excessive feeds, method of measurement using V-block and dial indicator. (1) Place the V-block on the surface plate, and the work to be checked is placed on it. (2) Equally spaced 12 markings at angle of 30° are made on the face of the work piece to be measured. (3) A sensitive dial indicator is firmly fixed in a stand and its feeler made to rest against one of the points on the surface of the work. (4) The dial indicator records any variation in dimensions due to out-of-roundness. (5) The work is rotated so that the dial indicator should make contact with the next point on circumference, the reading of dial indicator is noted down. (6) The readings of the dial indicator are noted down for all the markings. (7) The procedure is repeated at four positions on the work. (8) The polar graph is then plotted. (9) Draw the polar graph with selecting suitable scale. We have use dimension all in mm 10. Initially, mark the workpiece with 12 equal parts and then placed on the 90° V-block in proper position. (11) After dial indicator touch on surface, we start to rotating the workpiece with uniform RPM and corresponding reading note down. (12) The measured data points are collected and draw polar charts. (13) In graph maximum area out of the circle indicates the peak and minimum area departure called valley. (14) The LS method is giving the accurate result and sum of the radial deviation of peak and valley.

When component subjected to residual stress, it caused the development of the different lobes on the measured profile. The lobes in the component indicate that peaks and valley of the surface texture. The sum of the highest peak to the lowest valley, i.e., called least square deviation.

2.1. Tip Diameter Selection

The stylus tip diameter should also be taken into consideration when measuring roundness. A larger diameter stylus tip will have a greater mechanical filtering effect than a smaller diameter tip. The size of the component will also have an effect, smaller the ratio of component diameter to stylus diameter, the greater the filter effect. This parameter helps to produce the precise dimensional manufactured product.

$$R=\pi D/24 \quad (1)$$

Where R=Stylus tip radius D=Part diameter

ISO 12180-2 further information

(This formula to use according to component size ISO-12181-2)

Workpiece Día 19.5 mm, Speed=500 rpm and Depth of cut=0.4

$$UPR=\frac{\pi D}{0.8} \quad (2)$$

Where d=diameter of measured workpiece.

(This formula to use according to component size ISO-12181-2)

i.e. $UPR=\frac{\pi * 19.5}{0.8}$

UPR=76.53 upr.

Tip diameter selection

$$R=\pi * 19.5/24$$

R=2.55m
D=5.10 mm

2.2. Material Removal Method

The concept of material removal rate in the turning operation is a very important parameter, it assessed by volume of material removed per unit time. When achieved the productivity of machining process, MRR plays an important role. If increase MRR more productivity achieved, MRR is given by

$$MRR = W_I - W_f/\rho t \ mm^3/min$$

Where W_i = Initial weight of the specimen
W_f= Final weight of the specimen
T = Time taken for material removal
ρ = Density of the Al6061 material.

3. RESULTS AND DISCUSSION

On the other hand, the results of the experimental run are given in Tables 2-4. In this way, nine experiments were carried out with different combinations; each treatment was run randomly, the control variables were encoded. The roundness of the turned bar was measured used an indicator dial model MITUTOYO.

On the other hand, Figure 6 outlines the effect of interactions of cutting speed and depth of cut on roundness, according to the graph, when the cutting speed is high and the depth of cutting is low then the roundness is low. Finally, the model was optimized, the results were: Cutting speed equal to 800 rpm, and depth of cut equal to 0.6 mm. Therefore, the minimum roundness of the cylindrical bar is equal to 0.029 mm.

Figure 7 shows that we have to increase the spindle speed from 500 to 800 rpm and depth of cut from 0.4 to 0.8 mm and corresponding roundness error is given by 0.029–0.140 mm, respectively.

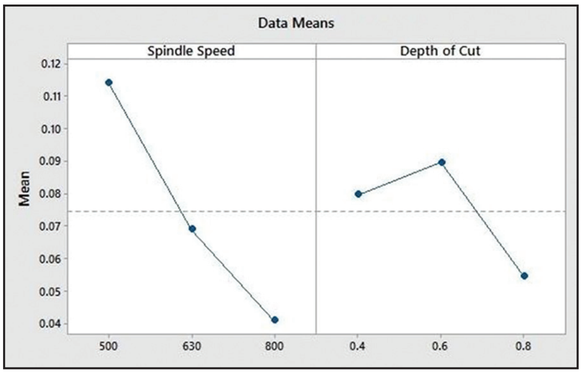

Figure 6: Effect of the mean plot of on roundness.

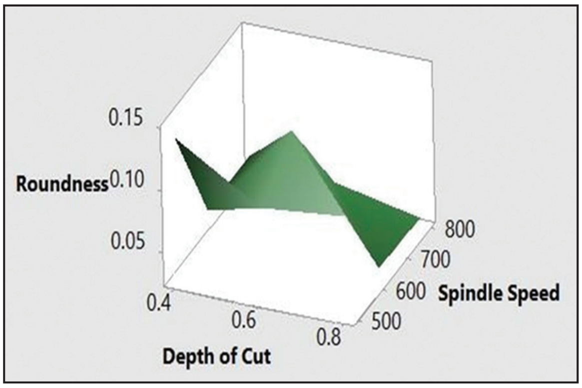

Figure 7: Effect of roundness on the surface plot.

Table 4: Result of the orthogonal experimental run.

Roundness error in mm	Spindle speed in rpm	Depth of cut in mm
0.140	500	0.4
0.098	500	0.6
0.104	500	0.8
0.049	630	0.4
0.127	630	0.6
0.031	630	0.8
0.050	800	0.4
0.044	800	0.6
0.029	800	0.8

4. CONCLUSION

1. This work to findings the experimental investigation of the effect of spindle speed, and depth of cut on the roundness in turning for AA 6061 the following conclusions are made.
2. The cutting speed significantly affects the roundness. The interaction cutting speed-depth of cut significantly affects the roundness of the cylindrical bar.
3. For further works, it is recommended to analyses the effect of other parameters on the roundness of cylindrical bar with other materials of the workpiece.
4. Precise dimensional metrology plays an important role in assuring that the manufactured product meets design specification and perform as per the requirement.
5. Dimensional metrology is a crucial factor in industrial application thus adequate attention is to be paid to precise measurement needs and also precision dimensional metrology kept under higher priority.
6. Here minimum roundness error achieved with maximum spindle speed and maximum depth of cut and maximum MRR rate obtained with decreased spindle speed and depth of cut.

5. REFERENCES

1. J. R. Davis, editor, (1993) ***ASM Specialty Handbook: Aluminum and Aluminum Alloys***, Cleveland, Ohio, United States: ASM International.
2. J. E. Hatch, (1984) ***Aluminum: Properties and Physical Metallurgy***, Cleveland, Ohio, United States: ASM International.
3. G. H. Kissen, (1986) Anodic coatings on aluminum. In: W. H. Safranek, editor. ***The Properties of Electrodeposited Metals and Alloys: A Handbook***, 2nd ed., United States: American Electroplaters and Surface Finishers Society, p29-34.
4. N. V. Parthasarathy, (1989) Electroplating on aluminum and its alloys. In: ***Practical Electroplating Handbook***, Upper Saddle River: Prentice Hall, p138-147.
5. B. Rajendra, D. Deepak, (2016) Optimization of process parameters for increasing material removal rate for turning Al6061 using S/N ratio. ***Procedia Technology***, **24**: 399-405.
6. P. G. Bernardos, G. C. Vosniakos, (2002) Prediction of surface roughness in CNC FACE milling using neural networks and Taguchi´s design of experiments, ***Robotics and Computer-Integrated manufacturing***, **18**: 343-354.
7. Y. Qin, A. Brockett, Y. Ma, A. Razali, J. Zhao, C. Harrison, W. Pan, X. Dai, D. Loziak, (2010) Micro-manufacturing: Research, technology outcomes and development issues, ***International Journal of Advanced Manufacturing Technology***, **47**: 821-837.
8. G. N. Peggs, (2001) ***Transactions on Engineering Sciences***, United Kingdom: WIT Press.
9. H. N. Hansen, K. Carneiro, H. Haitjema and L. De Chiffre, (2006) Dimensional micro and nano metrology, ***CIRP Annals***, **5**: 721-743.
10. G. Wilkening, H. Bosse, (2005) Nano and micro metrology state of-the-art and future challenges, ***MAPAN Journal of Metrology Society of India***, **20**: 125-151.
11. Y. Zhao, X. Xu, T. Kramer, F. Proctor, J. Horst, (2011) Dimensional metrology interoperability and standardization in manufacturing systems, ***Computer Standards and Interfaces***, **33**: 541-555.
12. A. K. Srivastava, (2013) Role of NPL-India in nanotechnology and nanometrology, ***MAPAN Journal of Metrology Society of India***, **28**: 263-272.
13. T. J. B. Janssen, D. Roy, (2013) Nano-science and nanometrology for societal benefits, ***MAPAN Journal of Metrology Society of India***, **28**: 237-238.

***Bibliographical Sketch**

Mr. Raghu S is obtained M Tech degree from Dr. APJ Abdual Kalam Technical University Lucknow. His research interests are Dimensional Metrology, Nano surface, advance manufacturing, and 3D printing technology. Currently, he has working as Technical staff at JSS Academy of Technical Education, Noida. He has research student from October 2018 to March 2019 at CSIR National Physical Laboratory, New Delhi. He has published two articles in the International and National conferences.

Author Query???
AQ2:Please review the sentence for more clarity.