

An Experimental Study on Burr Formation in Turning

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ABSTRACT: Burrs are undesirable extended surface over a workpiece. In turning operation, burrs are mainly formed at the side of the workpiece where the tool loses contact with the workpiece. Burr removal processes are costly and time consuming, so it is desirable to remove burrs at the initial stage. However, it is impossible to remove burr completely, therefore efforts are on to minimize it. In turning, process parameters affect burr heights to a large extent. A proper combination of process parameters can lessen burr height. The present experimental work studies the variation of burr height in turning of aluminium workpiece with respect to the change in process parameters, viz. feed, cutting velocity and depth of cut. The experimental work is carried out in CNC lathe and the burr heights are measured with a profile projector. It is observed that generally burr height increases with feed, cutting velocity and depth of cut. However, the ranges of feed and cutting velocity used also affect the trend of increasing or decreasing burr height. A proper combination of all these parameters for burr minimization is proposed. Additionally, surface roughness for each cutting condition is also observed.

KEYWORDS: Burr, turning, feed, depth of cut, cutting velocity, surface roughness.

I. INTRODUCTION

In turning operation, unwanted projections of material beyond the workpiece surface are termed as burrs. Burrs extend over actual and intended workpiece surfaces. Burr forms as a result of plastic deformation and mainly depends on the ductility of the material. In turning operation, burrs are mainly formed at the side of the cylindrical workpiece where the turning process ends. Machado *et al.* [1] categorizes burr on the face of the workpiece in turning operation into two different types: leaned burr and sideflow burr. Formation of burrs during turning is a severe problem which affects surface quality thereby reducing the product durability, dimensional accuracy, precision, and safety of handling of the product. Moreover, deburring involves costly and time consuming additional burr removal processes. Therefore, it is desirable to minimize burr formation during machining stage itself.

Effect of process parameters on burr formation in drilling and milling are widely studied as evident from the extensive works found in the literature. However, efforts to study the effect of process parameters on burr formation in turning operation are sparse. Various parameters that affect burr formation in turning are material properties, process parameters and tool geometry as found from the literature. Machado *et al.* [1] performed an experimental study on turning carbon steel and observed that burr height increases with increase in feed, cutting velocity and depth of cut. Nakayama and Arai [2] studied burr formation in orthogonal cutting of brass and classified burrs into various types. They observed that burr size can be reduced by selecting optimal cutting conditions that limits the shear strain of the chip, which is achieved by using cutting fluid and high cutting velocity. Toropov *et al.* [3] observed from an experimental study on turning aluminium alloy that the change of burr size with feed is affected by tool rake angle. The authors are of the view that for a zero degree tool rake angle, burr dimensions grow almost linearly with feed. However, for a tool rake angle of around

International Journal of Innovative Research in Science, Engineering and Technology

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20 degree, the stresses in the chip formation zone decreases, the burr becomes thin and goes off the workpiece. For higher tool rake angle, burr height decreases with increase in feed. They suggested that general trend of burr size is increasing with increase in depth of cut. However, for a lower value of lead angle, this increase in burr size is low. Niknam *et al.* [4] observed that more the ductility of the material, the more is the burr formation. The authors noted that using very low feed rates on aluminium alloys (with high ductility) generally lead to higher burr size. An important contribution in burrs in metal cutting is by Aurichet *et al.* [5] where the authors presented a detail study of burr formation mechanism in different machining processes, types of burrs, burr control and removal methods.

In view of the need for more research efforts in the study of burr formation in turning operation, the present experimental study is devoted to find the effect of feed, cutting velocity and depth of cut on the formation of burr in turning of aluminium workpiece. Additionally, the effect of the above process parameters on the surface roughness of the aluminium workpiece is also observed for each cutting condition.

II. EXPERIMENTAL PROCEDURE

The turning operation is carried out in a CNC lathe (manufacturer: M/S Ace designers Ltd., Model No: LT 16XL) with the capacity of maximum diameter and length of workpiece as 270 mm and 400 mm respectively, and accuracy up to 0.01mm. Single point carbide insert cutting tool is used for machining. The variations in the burr height and surface roughness are observed by varying the process parameters, *viz.* cutting velocity, feed and depth of cut. Figure 1 shows the experimental setup of the turning operation.

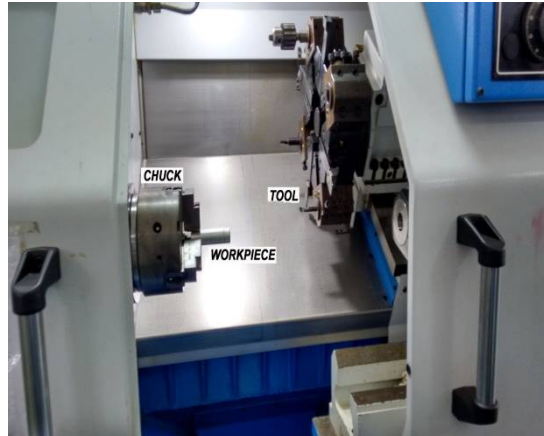


Fig.1: Experimental setup of turning operation

Commercially available aluminium is selected as workpiece material for the experiments. The diameter and length of the workpiece are 25 mm and 80 mm respectively. Figure 2 shows the aluminium workpieces after the turning operations.



Fig. 2: Aluminium workpieces after turning operation

Figure 3 shows the leaned burr and sideflow burr as projected in the profile projector. It is observed from Figure 3 that the height of the leaned burr formed during the experiments is bigger than that of the sideflow burr. Therefore, the heights of the leaned burrs are considered in this work for burr analysis and its minimization. The burr heights are measured in profile projector (M/S Radical Scientific Equipment Pvt. Ltd.; Model No. RPP-3000) using 100x zoom. The surface roughness (R_a values) of the workpiece is measured using stylus probe type roughness tester.

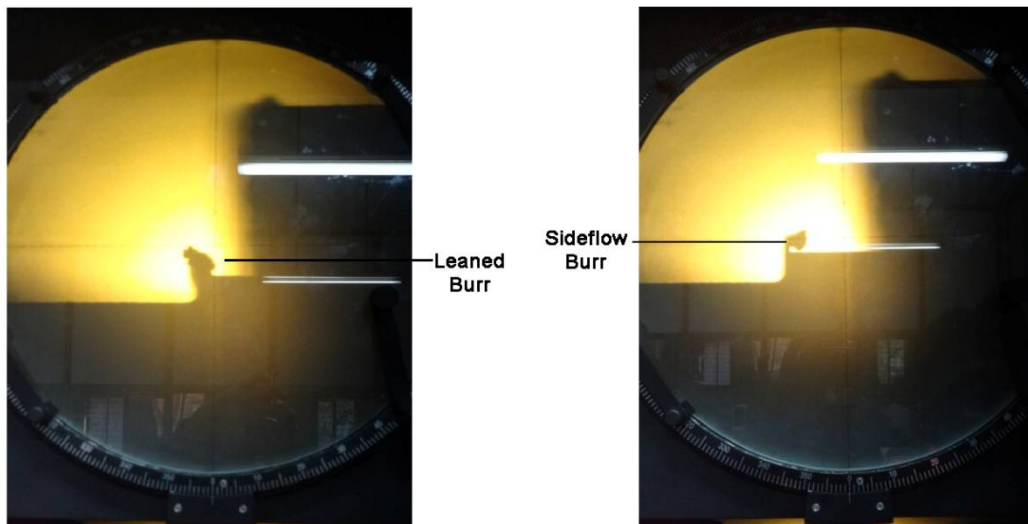


Fig. 3: Leaned burr and sideflow burr as projected in profile projector

III. RESULTS AND DISCUSSIONS

As the height of the leaned burr is more than the height of the sideflow burr during the turning operation, the burr heights of leaned burr are measured and considered for analysis. Table 1 shows the maximum burr heights of leaned burr and surface roughness (R_a values) values of the workpiece for varying values of cutting velocity and feed. It is observed from Table 1 that for high cutting velocity, increase in burr height is proportional to feed. However, for low cutting velocity, burr height decreases with feed. Surface roughness increases proportionately with feed.

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Table 1: Burr height and surface roughness for turning of aluminium for varying feed and cutting velocity (At constant DOC of 2 mm and same tool geometry)

Sl. No.	RPM & Cutting velocity (m/min)	Feed (mm/rev)	Maximum Burr Height(mm)	Surface Roughness, R_a (μm)
1	$N_1 = 3000$ $V_1 = 235.50$	0.2	1.156	2.103
		0.4	1.304	4.024
		0.6	1.449	4.795
		0.8	1.592	5.065
2	$N_2 = 2500$ $V_2 = 196.25$	0.2	1.524	2.197
		0.4	1.662	4.329
		0.6	1.453	4.510
		0.8	1.130	5.215
3	$N_3 = 2000$ $V_3 = 157.00$	0.2	1.685	2.388
		0.4	1.671	4.504
		0.6	1.242	4.697
		0.8	1.113	5.553
4	$N_4 = 1500$ $V_4 = 117.75$	0.2	1.875	2.896
		0.4	1.773	4.290
		0.6	1.154	4.573
		0.8	1.101	5.080

Table 2 shows the variation in burr height and surface roughness with the change of depth of cut (DOC) keeping other parameters constant. Both burr height and surface roughness show increasing trend with increase in DOC thus supporting similar observations found from the literature.

Table 2: Burr height and surface roughness for turning of aluminium for varying depth of cut (At 0.2mm/rev feed, 235.5 m/min cutting velocity and same tool geometry)

Sl. No.	DOC (mm)	Maximum burr height (mm)	Surface roughness, R_a (μm)
1	1	0.683	1.897
2	1.5	0.962	2.209
3	2	1.156	2.103
4	2.5	1.498	3.273

Figure 4 shows variation of burr height with feed for four different cutting velocities. Feed is varied from 0.2 mm/rev to 0.8 mm/rev for four different cutting velocities in the range 117.75–235.50 m/min, at constant 2mm depth of cut. It is observed from Fig. 4 that the burr height decreases with increase in feed when the cutting velocity is below 196.25 m/min at 2500 rpm spindle speed. For cutting velocity higher than 196.25 m/min, the burr height increases with the increase in feed. From the present experimental study of burr formation in turning operation, it is observed that high cutting velocity with low feed and low cutting velocity with high feed favours lower burr height.

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Vol. 5, Issue 3, March 2016

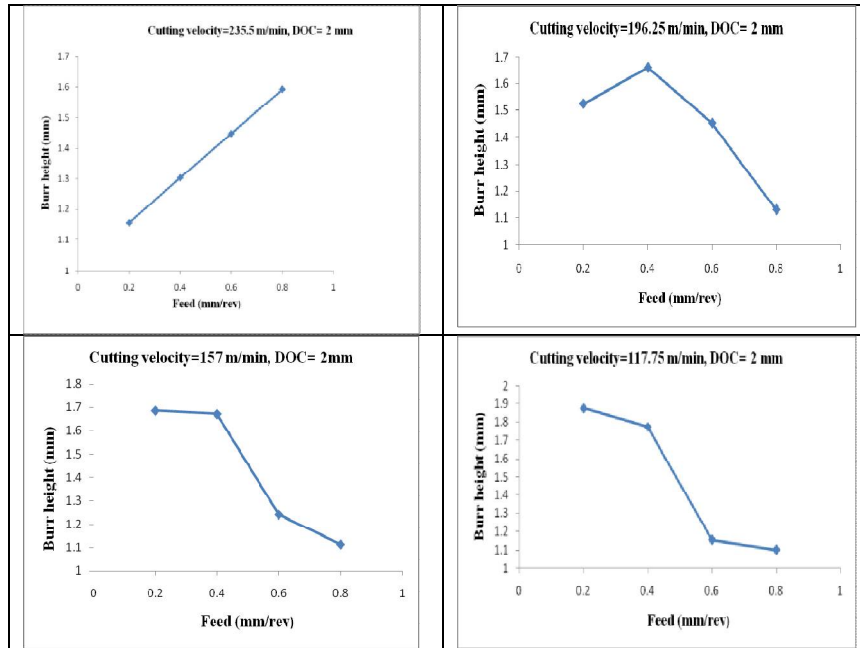


Fig. 4: Variation of burr height with feed for different cutting velocities

Figure 5 shows variation of burr height with cutting velocity for four different feeds. It is observed from figure 5, when feed is 0.2 mm/rev and 0.4 mm/rev, burr height decreases with the increase in cutting velocity and when feed is 0.6 mm/rev and 0.8 mm/rev, burr height increases with the increase in cutting velocity. Therefore, it is observed that burr height is decreasing with the increase in the cutting velocity for lower values of feed and burr height is increasing with the increase in cutting velocity for higher values of feed.

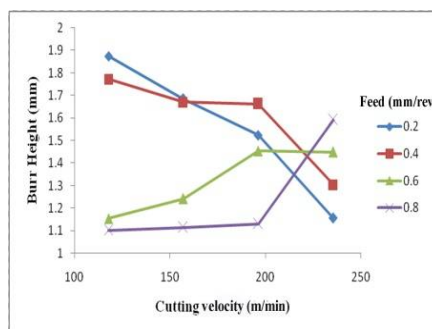


Fig. 5: Variation of burr height with change in cutting velocity for different feeds

In Fig. 6, the variation of burr height with depth of cut at constant cutting velocity (235.5 m/min) and constant feed (0.2 mm/rev) is shown. It is observed from Fig. 6 that burr height increases linearly with increase in depth of cut for constant cutting velocity, feed and tool geometry. The general trend of burr size is increasing with increase in depth of cut. It is an established fact as found from the literature in burr formation in turning [1][3].

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 5, Issue 3, March 2016

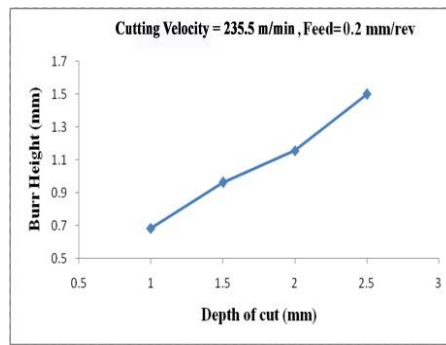


Fig.6: Variation of burr height with depth of cut

The surface roughness of the workpiece was measured for each cutting condition and Figure 7 shows the variation of surface roughness (R_a value) with feed for different cutting velocities. It is observed that the surface roughness increases with the increase in feed for all cutting velocities which is an established fact. Feed is the most affecting parameter for increasing surface roughness as found from the abundant literature on effect of process parameters on surface quality in different machining processes.

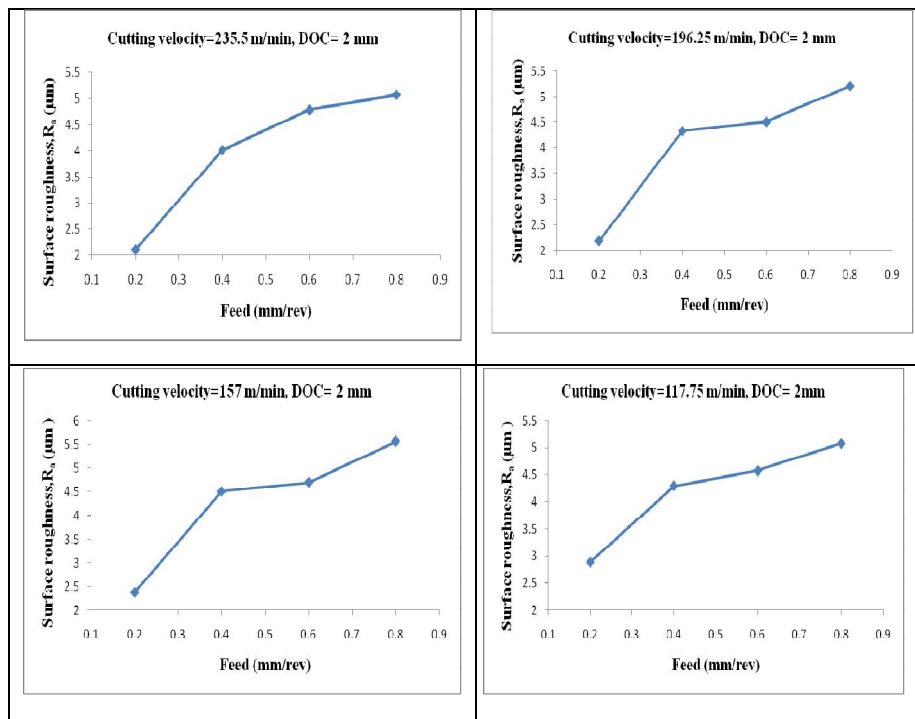


Fig. 7: Variation of surface roughness with feed for different cutting velocity

Figure 8 shows the variation of surface roughness value (R_a value) with depth of cut at constant cutting velocity (235.5 m/min) and constant feed (0.2 mm/rev). It is observed from Figure 8 that the surface roughness of the workpiece increases with the increase of depth of cut for constant cutting velocity and feed. It follows similar trend as found from literature.

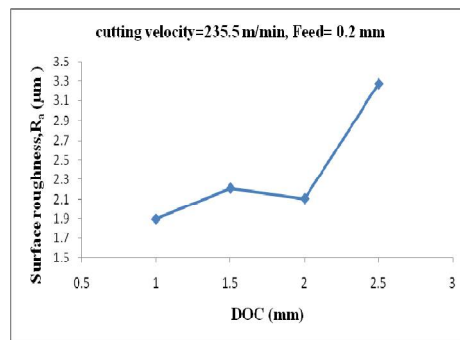


Fig. 8: Variation in surface roughness with depth of cut

IV. CONCLUSION

Following conclusions are drawn from the results obtained from the set of experiments carried out in the present work:

- Some important factors that affect burr formation in turning operation are feed, cutting velocity and depth of cut.
- For the given range of process parameters, burr height decreases with the increase in feed, the effect is more predominant when the cutting velocity is not more than 196 m/min.
- Burr height increases with the increase in cutting velocity for the feed range 0.6 to 0.8 mm/rev and burr height decreases with the increase in the cutting velocity for the feed range 0.2 to 0.4 mm/rev.
- Burr height increases linearly with increase in depth of cut.
- Surface roughness increases with increase in feed and depth of cut keeping other parameters constant.

From the present experimental study of burr formation in turning operation, two favourable conditions for minimum burr can be obtained. It is observed from the results that high cutting velocity with low feed and low cutting velocity with high feed favours decreasing burr height. However, with increase in feed the quality of the surface deteriorates. On the other hand, low feed rate and low cutting velocity increases the machining time which ultimately increases machining cost. In this era of high speed machining, high cutting velocity with low feed will be preferred for burr minimization. Optimum values of feed, cutting velocity and depth of cut for burr minimization in every machining condition will depend on machining environment, machine capability, tool-workpiece combination, the desired degree of precision needed, machining cost, and many related factors. Optimal combination of process parameters is to be selected judiciously for burr minimization. Other parameters affecting burr formation also need more attention. Minimization of burr is a very important aspect for applications involving precision work and high quality surface finish. Therefore need arises for more research work in the field of machining for burr minimization.

ACKNOWLEDGEMENT

The authors wish to acknowledge Micro Small and Medium Enterprise, Amingaon, Guwahati for allowing us to carry out the experimental work in their enterprise.

REFERENCES

- [1] Machado, A. R., Kaminise, A. K., Silva, M. B. and Ariza, R. G., "Study on Burr Formation in Turning", 17th International Congress of Mechanical Engineering, Sao Paulo, 2003.
- [2] Nakayama, K. and Arai, M., "Burr Formation in Metal Cutting", Annals of CIRP, Vol. 36, pp. 33–36, 1987.
- [3] Toropov, A., Ko, S. L. and Kim, B. K., "Experimental study of burrs formed in feed direction when turning aluminium alloy A16061-16", International Journal of Machine Tools and Manufacturing, Vol. 45, pp. 1015–1022, 2005.
- [4] Niknam, S. A., Zedan, Y. and Songmene, V., "Machining Burrs Formation & Deburring of Aluminium Alloys", INTECH, Chapter 5, 2014.

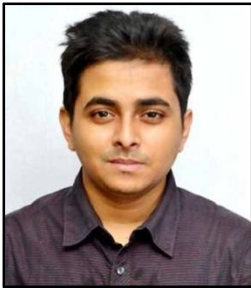
International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 3, March 2016

- [5] Aurich, J.C., Dornfeld, D., Arrazola, P.J., Franke, V., Leitz, L. and Min, S., "Burrs–Analysis, control and removal", CIRP Annals - Manufacturing Technology, Vol. 58, pp. 519–542, 2009.

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