Effect of Nose angle on surface texture while profile turning – An Experimental approach.

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ABSTRACT

The secondary manufacturing process involves turning operation including profile turning operations. Cutting tools for metal cutting have many shapes, each of which are described by their angles or geometries. Every one of these tool shapes has a specific purpose in metal cutting. Different tool signatures of the cutting tool are used for different operations. The primary machining goal is to achieve the most efficient separation of chips from the workpiece. For this reason, the selection of the right cutting tool geometry is critical. This paper presents an experimental investigation on the cutting tools having varied nose angles, its strength and suitability on profile turning application. Different Nose angle tools were taken for turning profile on a 58CrV4 material. A Carbide Tip Brazed cutting tools with 90⁰, 60⁰, 30⁰ nose angles were used for the turning test under dry conditions. The surface finish of the component was measured using mitutoyo make portable surface roughness tester of model SJ201P. The micro chipping and macro chipping if any on the cutting tool were recorded using a tool makers Microscope. The cutting edge strength against Micro chipping and Macro chipping were monitored after every pass. The results indicated that the surface finish obtained when 60⁰ nose angle tools was used for profile turning at 0.05 mm feed per revolution**.**

Key words: Nose angle, feed per revolution, dry machining, surface finish.

1.0 INTRODUCTION

A tool intended for high production machining process should be amply strong and rigid, it should have optimum geometry for the given process in terms of strength, be keenly sharpened should produce acceptable surface finish and convenient to use. The cutting tool consists of various angles which are important when introducing the cutting tool edge into a rotating work piece. These Cutting Tool Nomenclature and Nose angle is shown in Figure 1 and the tool signature preferred while turning profiles are tabulated in Table 1.

Table 1: Tool signature preferred while turning profiles

Back rake angle	Side rake angle	End cutting edge angle	Side cutting edge angle	End clearance angle	Side clearance angle	Tool nose radius in mm	Nose angle
$-6^{o}$to$+6^{o}$	$-6^{o}$to$+6^{o}$	5^{o}to20^{o}	5^{o}to20^{o}	25^{o}	25^{o}	0.4-3.2	35^{o}-120^{o}

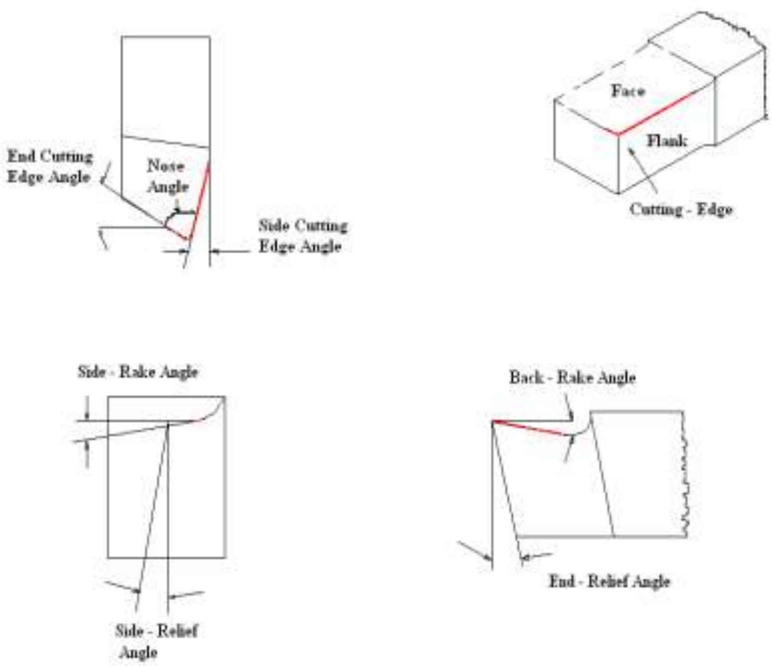

Fig 1: Cutting Tool Nomenclature

Machining at higher feed rates is opted during turning in order to achieve high production. Components manufacturing includes both roughing and finishing operation. During roughing high depth of cut and high feed rates are preferred in order to reduce cycle time. For finishing operation lower feed and depth of cut are selected.

Literature review: 58CrV4 material is the most versatile engineering material used for manufacturing machine parts and carrier bodies since 58CrV4 material can be heat treated in order to obtain desired properties such as hardness, wear resistance, strength, stiffness, toughness. For profile turning on a 58CrV4 material, a carbide tip brazed cutting tools with varied nose angles were used for the turning test under dry conditions. The research work carried by different researchers are Engr. Kaisan Muhammad Usman [1] studied in his paper on the effect of tool rake angles on tool life and he has considered between 0^{o} to 20^{o} for his research work, he has used 8 degree clearance angle to turn bright mild steel on the lathe machine and Mustafa G¨unay et al [2] investigated the effect of cutting tool rake angle on main cutting force, while machining AISI1040 steel decreasing trend of cutting force was observed with increase in rake angle. Jadhav J.S. et al [3] investigated the effect of cutting tool on forces and surface roughness in their article titled 'Experimental study of Effect of Cutting Parameters on Cutting Force in Turning Process' and they found that the Cutting Speed has no significant effect on the cutting force as well as the surface roughness. K. V. Santha Kumari et al [4] investigated the effect of cutting tool in their article titled 'effects of tool setting on tool cutting angle on turning operation' that centre height, deviation of tool when set, then what change in angle of tool should be set to get the correct result, where adverse effect on tool and work-piece will not occur. Thus we can get the greater accuracy of job/ work in turning operation. Masood Atahar Khan et al [5] investigated the effect of cutting tool in their article titled 'Study and Analysis of Effect of Cutting Parameters on Cutting Forces and Surface Roughness' they found that surface roughness is continuously improved with the increase in cutting speed, but increase in feed rate and rake angle leads to deterioration of the surface.

However, not much research work is done on effect of nose angle on surface roughness. Hence the present research works the effect of nose angle of the cutting tool on surface roughness on the specimen profile is done.

2.0 EXPERIMENTAL STUDIES

2.1 Cutting Tool and Machining Parameters:

Cutting tools of various nose angles were selected for the experimentation. The cutting tools selected are conforming to ISO P30 grade, brazed carbide tools. The following are the cutting tool parameters used during the test.

Table 2: Machining parameters and nose angles used for turning profiles

Description	Measured values
Cutting speed	150 m/min
Depth of cut	1.0 mm
Feed rate per revolution	0.1 mm, 0.15 mm, 0.2 mm.
Nose angles used	90º , 60º, 30º
Nose radius	Sharp

2.2 Raw Material Used.

The chemical composition of 58CrV4 material used for the experimentation is shown in table3.

Table No. 3: Chemical Composition of work material.

C ≤	Si ≤	Mn ≤	P ≤	S ≤	Cr	V
0.55-0.62	**0.15-0.40**	**0.7-1.10**	**0.035**	**0.035**	**0.9-1.2**	**0.1-0.2**

2.3 The cutting tool Used.

Brazed carbide cutting tools of ISO grade P30 is used for the experiment which is shown in the Figure 2 shown below.

Fig No. 2: Influence of feed on surface roughness

2.4 The machine tool Used.

The machine tool used for the experiment was the ACE Designers make Jobber XL CNC lathe and the profile machined is shown in the Figure 3:

Fig No. 3: Influence of feed on surface roughness

2.4 Steps followed to conduct the experiment:-

1. 58CrV4 material of diameter 32 mm and a length of 100 mm was selected for the experimentation.
2. After skinning the material, cutting tools with different nose angles were fastened on the turret.
3. Each tool were used for machining as mentioned in table 2 and then observed for cutting tool edge condition.
4. The surface roughness of the specimens was measured.

3.0 RESULTS AND DISCUSSIONS

The following Table No. 4 shows the data pertaining to the tool life at various nose angles and feed rates. The corresponding edge conditions at the various nose angles and the feed rate are also recorded.

Table No. 4: Experimental Results.

Sl.No.	Feed/Rev	Nose angle	Ra , in microns
1	0.05 mm	30^o	0.34
2	0.05 mm	60^o	0.42
3	0.05 mm	90^o	0.48
4	0.10mm	30^o	0.46
5	0.10 mm	60^o	0.69
6	0.10 mm	90^o	1.12
7	0.15 mm	30^o	0.92
8	0.15 mm	60^o	1.16
9	0.15 mm	90^o	1.35

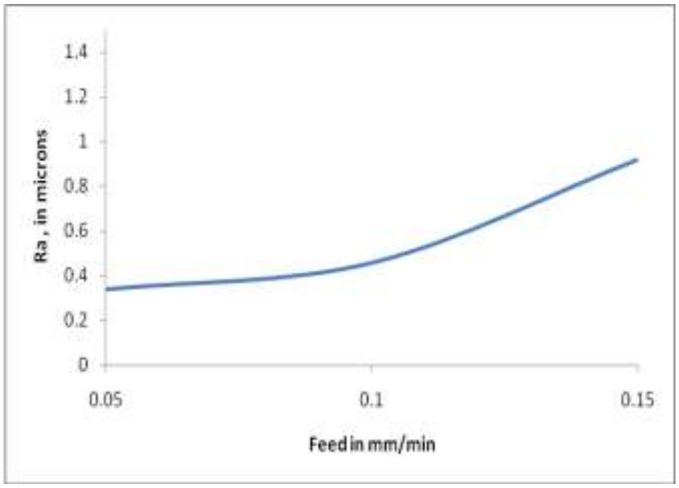

Fig No. 4: Influence of feed on surface roughness when 30⁰ nose angle tool is used.

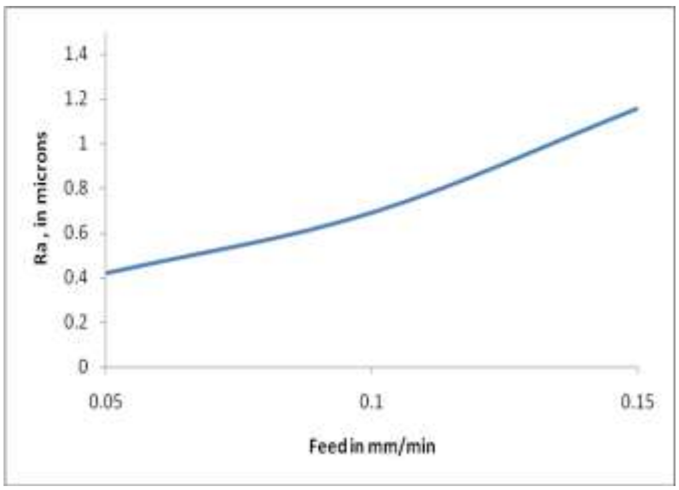

Fig No. 5: Influence of feed on surface roughness when 60⁰ nose angle tool is used.

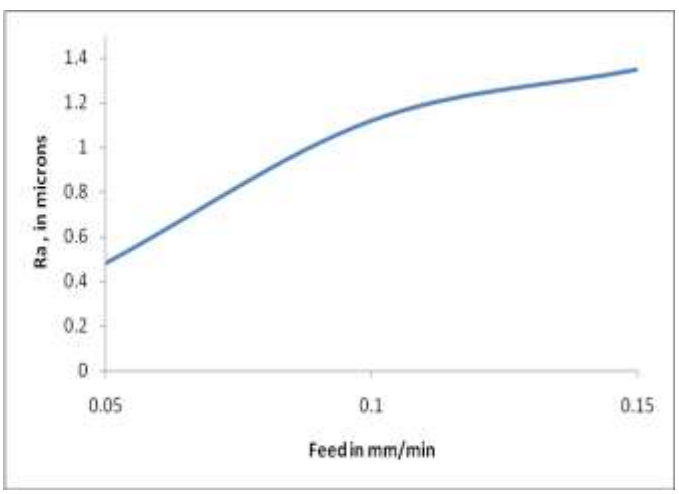

Fig No. 6: Influence of feed on surface roughness when 90° nose angle tool is used.

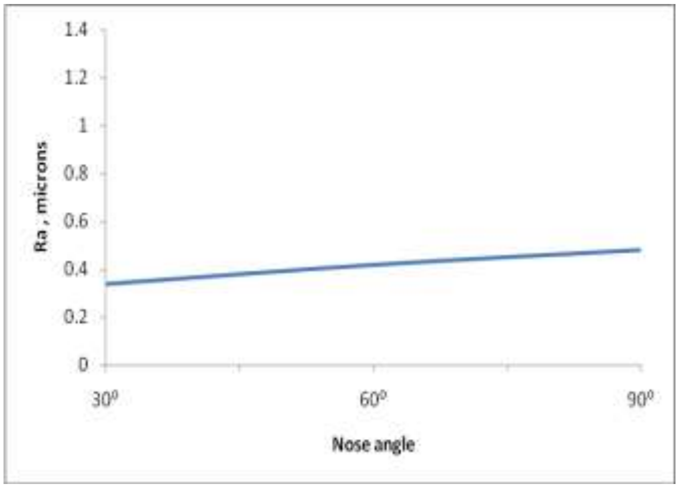

Fig No. 7: Influence of nose angle on surface roughness when 0.05mm feed is used

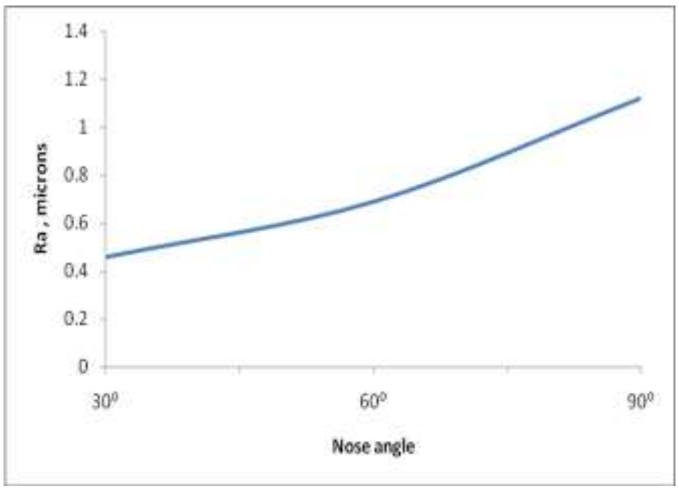

Fig No. 8: Influence of nose angle on surface roughness when 0.1mm feed is used

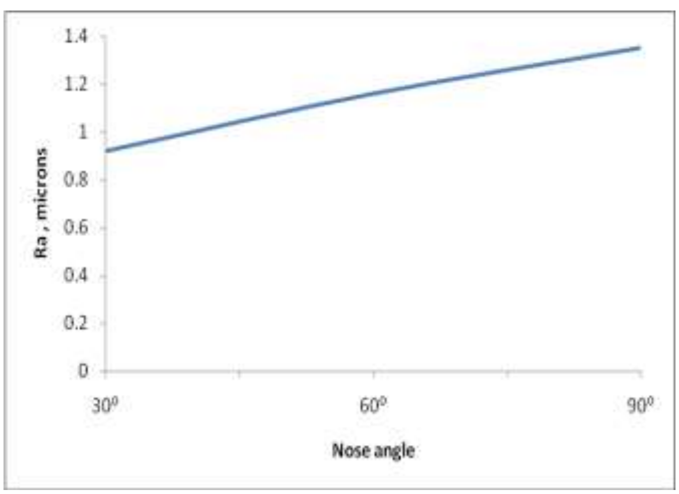

Fig No. 9: Influence of nose angle on surface roughness when 0.1mm feed is used

From the Table No. 4 and Figs 4-9, it is observed that at lower feed rates nose angle is found insignificant as pertaining to surface finish, at higher feed rates cutting tool with 30^0 nose angle performed better than the other two cutting tools that is tool with 60^0 and 90^0 nose angles.
However, the cutting tool with 30^0 nose angle failed, due to chip entangling problem (premature failure). Hence from the above experimentation we can conclude that cutting tool with 60^0 nose angle is ideal for profile turning applications. For stock removal applications higher nose angles may be preferred.

4.0 CONCLUSIONS:

Based on the work carried out at different nose angles and at varied feed rates the following conclusions are drawn:

1. At lower feed rates, nose angle is found insignificant as pertaining to surface roughness.
2. At higher feed rates cutting tool with 300 nose angle performed better than the other two cutting tools.
3. Hence, we can conclude that cutting tool with 600 nose angle is ideal for profile turning applications.
4. It is also observed that as the chip cross section increases, spalling of cutting edge observed due to chip entangling.

Acknowledgements:
The authors acknowledges the support and encouragement received from the management of Global academy of Technology, Bangalore 98.

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