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Studying The Effect of Tool Nose Radius on Workpiece Run Out and Surface Finish

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Abstract

Tool geometry play an important role in mechanical machining and surface finish of workpiece. So there are many parameters such as cutting speed ,feed rate ,and tool nose radius that are known to have a large impact on surface quality,however there are many more parameters that have an effect on the surface roughness . this paper fouced on effect of tool nose radius on surface roughness and run out which causes tool chatter, the experments prove that high values of nose radius causes rough surface with high value of run out also in this paper use seven different values of nose radius of cutting tool were(0.3,0.4, 0.5. 1 , 1.5, 2, 2.5mm) under different of cutting conditions (such as feed rate ,cutting speed , depth of cut) Results show that good surface finish at nose radius (0.4, 0.5)mm which lead to reduce tool chatters, work run out during machining another calculations were done theoritically for arithmetic roughness which have a small difference with experimentally tests and increasing of roughness and run out at values less than (0.3mm).

Keywords: nose radius, run out, surface finish

دراسة تاثير مقدمة قطر العدة على الانحراف عن المركز والخشونة السطحية

الخلاصة

يلعب الشكل الهندسي للعدة القاطعة دوراً مهماً في عملية التشغيل الميكانيكي والأنهاء السطحي للمشغولة كما أن هنالك عوامل عديدة لها تأثير كبير على نوعية السطح المشغل كسرعة القطع ومعدل التغدية , نصف قطر أستدارة مقدمة العدة أو مايعرف (nose radius) وقد ركز هذا البحث على تأثير نصف قطر أستدارة مقدمة العدة على خشونة السطح والأنحراف عن المركز أو مايعرف (Run out) والدي يؤدي الى أهتزاز العدة القاطعة . التجارب أثبتت أن القيم العالية لنصف قطر أستدارة المقدمة تؤدي الى الحصول على خشونة عالية في السطح مع قيم عالية من الأنحراف عن مركز دوران المشغولة و في هذا البحث تم أستخدام(7) قيم مختلفة من نصف قطر أستدارة المقدمة (0.3,0.4, 0.5. 1 , 1.5,2,2.5mm) وتحت ظروف قطع مختلفة من(معدل التغذية , سرعة القطع ,عمق القطع) والنتائج قد بينت أنه يمكن الحصول على سطح ناعم عند مقدمة قلم قطع (0.4, 0.5 mm) والذي يؤدي الى تقليل الأنحراف عن المركز و الأهتزازات الناتجة أثناء التشعيل ,حسابات نظرية أخرى أنجزت للخشونة بينت أختلاف بسيط مع النتائج العملية فيما تزداد الخشونة والأنحراف عند القيم التي أقل من (0.3 mm).

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Introduction

The tool nose radius is very critical part of the cutting edge since it produces the finished surface, if the nose is made to a sharp point the finish machined surface will usually be unacceptable and the life of the tool will be short[1]. if other factors such as the work material, the cutting speed , and cutting fluids are not considered large nose radius will give better surface finish and will permit a faster feed rate to be used .[2]

Machinability tests have demonstrated that increasing the nose radius will also improve the tool life or allow faster cutting speed to be used. For example high speed steel tools were used to turn an alloy steel in one series of tests where complete or catastrophic tool failure was used as a criterision for the end of a tool life .

Avery large nose radius can often be used but a limit is some times imposed because the tendency for chatter to occur is increased as the nose radius is made larger prove that most cutting conditions , experimental and theoretical (Ra) values mach very well, except at low value of feed .Also one of the structural modes of the machine tool – workpiece system is excited by cutting forces initially.away surface finish left during the previous revolution in turning is removed during the succeeding revolution which also leaves a wavy surface owing to structural vibrations[3,4]

This paper involves a theoretical study in addition to experimental work .

Theoritical procedure

The quality of surface finish is commonly specified along linear and geometric dimension then metal cutting is inherently cyclic ,cutting forces built up as the tool pentrates the material and deflect the tool.even if slightly , when repture or shear occurs to form the chip and the forces momentarily drop, the tool springs back .[2] vibration increase when the cutting forces get out of phase with the tool forces that incease the relative speed between the cutting edge and workpiece and the cutting force drop.Actully many more factors such as cyclic vibration in depth of cut ,properties of materials, friction force and rubbing of the tool nose effect vibrations.chatter may become quite noisy and obnoxious, can damage tools and machines , and defaces work surfaces with patterns called chatter marks .[5,6] surfaces generated by hard turning are nominally defined by the geometry of the cutting process- primarialy by the feed rate and nose radius of the cutting tool . the arithmetic centerline average roughness Ra can be calculated by equation (1) , , it can also be approximated by equation where f is the feed / revolution and r is the nose radius of the cutting tool.[7,8,9]

$$Ra = f^2 / 32 .r \text{----------------} (1)$$

Then for each nose radius(r) and according to above equation Arithmetic roughness can be calculated As in table (1).

Expermental work

Currently a total of (14) different cutting conditions have been tested as shown in table (3) .

3-1 Turning. Machine was used model (Harrison M300) .

3-2.Workpiece materials was carbon steel and chemical composition as shown in table(2) .

3-3 Cutting tool used in experiment was High speed steel (HSS) with different nose radius (0.3,0.4, 0.5,1,1.5,2, 2.5mm) and depth of cut = 0.5mm ,Cutting speed 80 m/min as shown in tables (3)

Then another test has been don to calculate the runout of workpiece during mechanical machining as follow in table (3). .

3-4. Roughness appratus measurement for surface was used (Talysur),it is produced by (Rank Taylor Hobson)

English company.as shwn in Figure(1)

3-5 .Run out measurement was done by indicater device..

Result and Discussion

The test conditions in table (3)are divided into three conditions .the divisions are based on the nose radius of cutting tool ,although the first related with nose radius and the second was related with run out ,third was related with surface roughness , figure (2) shows that the positively relation ship between the nose radius and the surface roughness that's mean increasing nose radius of cutting tool lead to increase the surface roughness according to points shown in diagram at nose radius (0.5,1,1.5,2, 2.5) , Except the point at small nose radius 0.3 give high value of roughness because of sharp nose was generated so Figure (3) refers to the same relation between run out and surface roughness also increasing run out during machining causes high roughness because generated un equal surface along the workpiece so this lead to fact that The effect of nose radius is more than the effect of cutting angles on surface roughness except the value of run out 0.2 which clear at line below then Figure (4) shows anew relation ship between the nose radius and the run out of the workpiece during machining this mean chatter was happened in cutting tool because of roughness was generating and transmitted to cutting tool at maximum nose radius(2.5mm) when run out was 0.2 mm

Conclusions

Tool geometry is one of an important parameters which play important role in surface roughness and dimensional accuracy of workpiece during mechanical machining by using a suitable tool nose radius then the conclusion of this study was

1-Increasing nose radius refers to increase surface roughness but not less than 0.4 mm. .

2-Maximum roughness value was (Ra=4.1 µm) when nose radius = 2.5mm and good surface finish at nose radius = 0.4 mm when Ra=0.5 µm.

3- Expermental worke proved that small difference between arithmetic roughness values and experimental values according to table (1) and table (3).except nose values (1,5 ,2,2.5mm).

4-Anew relationshipe was found between nose radius and run out according to tool chatter occurs during turned workpiece surface.

5-Maximum run out occurs at high research recomanded use suitable value of nose radius=2.5 mm and surface roughness= 4.1µm.

6- In order to reduce tool chatter nose radius such as (0.4, 0.5mm) .

7-Also a suitable nose radius for run out was(0.4, 0.5 mm) to get good surface finish (0.5 , 1.2 µm).

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Table (1) Arithmetic Roughness(Ra)

No	Nose radius mm	Arithmetic Roughness Ra µm
1	0.3	41
2	0.4	31
3	0.5	25
4	1	12
5	1.5	8
6	2	6
7	2.5	5

Table (2) Chemical composition (1020)

Metal	C%	Mn%	P%	S%	Rem
Carbon steel(1020)	0.2	0.3	0.04	0.05	Fe

Table (3) Cutting conditions

No	Cutting speed m/minl	Feed rate mm/min	Nose radius mm	Run out mm	Roughness Ra µm
1-	80	0.2	0.3	0.2	1.7
2-	80	0.2	0.4	0.01	0.5
3-	80	0.2	0.5	0.03	1.2
4-	80	0.2	1	0.05	2
5-	80	0.2	1.5	0.07	2 .3
6-	80	0.2	2	0.15	2.8
7-	80	0.2	2.5	0.19	3.1

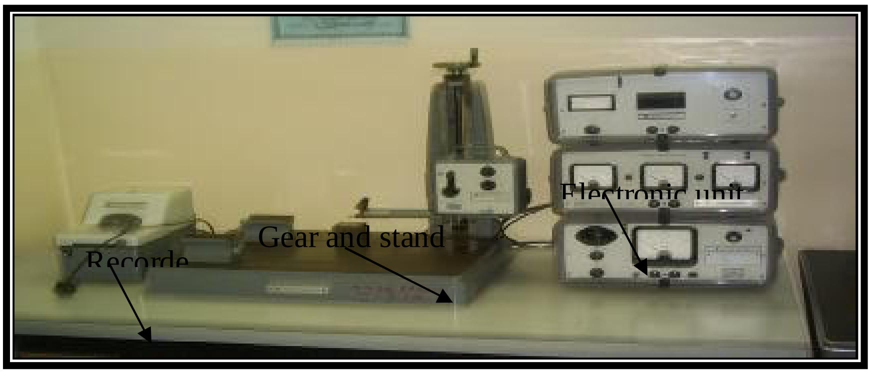
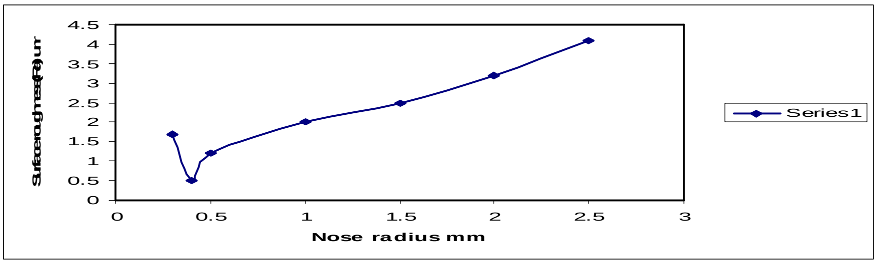


Figure (1) Roughness appratus measurement



Figure(2) Influence of nose radius on surface roughness

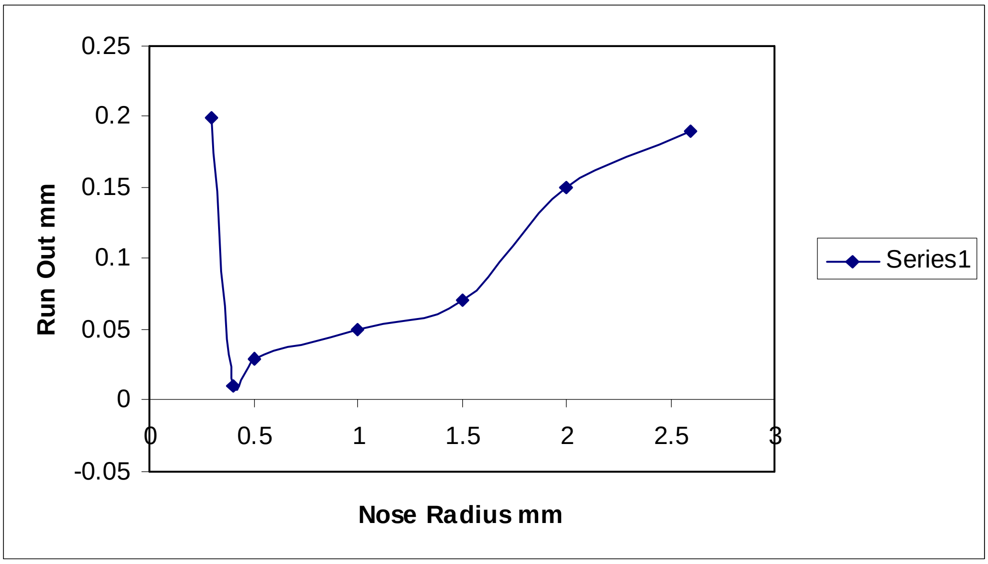


Figure (3) Influence of nose radius on run out mm

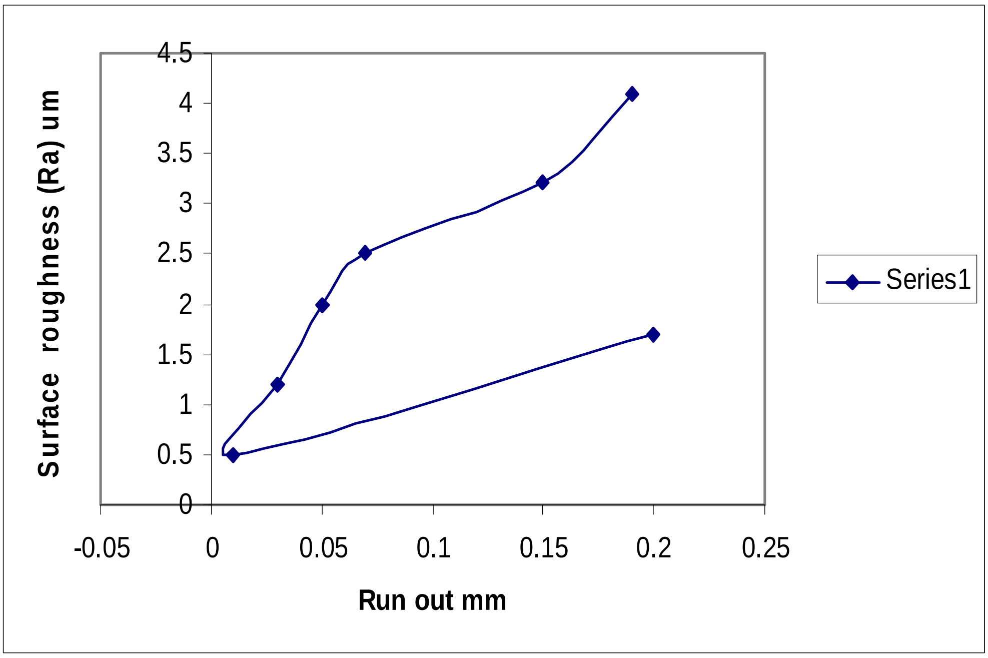


Figure (4) Relationship between Run out and surface roughness