INVESTIGATE THE EFFECT OF TOOL NOSE RADIUS ON TOOL CHATTER IN METAL CUTTING PROCESS

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Abstract

This study aims to investigate the effect of tool nose radius on tool chatter in turning of EN19 steel. Speed, feed and depth of cut are the selective parameter and tool vibration is the responses. The machining time, tool nose radius of 0.4, 0.8 and 1.2 mm variation and speed are the proportionalityof tool vibration. The tool vibration has been minimum 50m/min speed and 0.4 nose radius insert. The result revealed that the significant parameter of speed with nose radius is dominated parameter of tool vibration.

Keywords—Tool chatter;Nose radius; Spindle speed;

INTRODUCTION

Spindle speed variation and tool nose radius is the parameter of control tool chatter.The machining of the system proposed criterion for selecting the Spindle speed variation frequency is based on how fast the regenerative energy is dissipated. The chatter frequency and spindle speed is the proposed criteria are suitable for on-line Sinusoidal spindle speed variation programming since the only requirement is knowledge of the chatterEmad Al-Regib et al [1**].**Cutting edge geometry, workpiece hardness, feed rate cutting speed and depth of cut are affect the machining process Turgrul O et al [2].S.Kebdani et al [3]. Tool nose radius is affecting the machining process. A large nose radius tool insert is suitable for ultrasonic elliptical vibration cutting. Extremely tool nose radius may again destroy the chatter suppression dynamics due to quick increase in maximum cutting edge angle and increase in thrust force, which result is higher cutting force, higher wear and worst surface finish Chandranath et al [4].Variable spindle speed machining to reduce chatter in turning process using method of a fast tool servo-assisted noncircular process. Noncircular cross-sections is able by controlling the position of the radial cutting tool in the direction normal to the surface of a workpiece Dan Wun and KenChen [5]. The regenerative chatter stability was focused on the Sinusoidal Spindle Speed Variation, but the consideration was more generally extended to the vibration level and cutting force. Work piece length and workpiece diameter is increase, natural frequency is also increase. Spindle speed variation depends on the workpiece diameter and workpiecelengthAlebertelli et al. [6].M.Siddhpura et al. [7]. Variable spindle speed machining is to suppress the chatter during turning. It has been concluded that the production can be increased by applying variable spindle speed machining process without any adverse effect. The temporarily increase in amplitude of vibration and high level of acceleration can be minimized by stabilizing capability of spindle speed variation Andreas otto and GnterRadons [8].Vladimir Aleksandrovichrogov et al. [9]. A tool life is also influenced by vibration. Severe acoustic noise in the working environment frequently results as a dynamic motion between the cutting tool and the work piece. The machining quality of titanium alloy workpiece surface can be significantly improved by increasing theamplitudeandvibration frequency G.M.Sayeed Ahmed [10].

The Vibration parameters are not the only factors to affect the machining quality. In fact, many other elements, such as the precision ofthe tool dimension parameters, machine tool, and the clamping system rigidity, can also have great effect on the titanium alloy machining quality and on the wear of diamond tools Yuanlian Zhang et al [11].The effect of machining parameter on surface quality is established and the optimum cutting condition for minimizing the surface roughness using S/N ratio. From the result it is known that feed is the influential parameter followed by cutting speed nose radius and the depth of cut. The workpiece material used for experiment is a titanium alloy (Ti-6Al-4V). The machining experiment has been carried out all geared lathe using Taguchi’s orthogonal array. In this paper concluded that by using Taguchi’s method the effect of machining parameter on the surface roughness has been evaluated and optimal machining conditions would be arrived to minimize the surface roughness, flank wear and investigated K.R Kottaiah and J.Srinivas [12]. J.Nithyanandam et al [13].Effect of Depth of Cut, Cutting Speed and Work-piece Overhang on Induced Vibration and Surface Roughness in the Turning of 41Cr4 Alloy Steel. The effect of turning parameters on work surfaceandinduced vibration roughness of 41Cr4 alloy steel was experimentally studied. It also shows that the induced vibration and surface roughness of workpiece is directly proportional to the work piece overhangdepth of cut, and cuttingspeedC.O.Izelu et al [14].Cutting speedsandhigher feed rates resulted in higher cutting forces in both conventional turning condition and vibration assisted turning.Also the results showed that by increasing the feed rate is the decreasing of surface quality. The increase in the cutting speed results in different development of surface roughness change in vibration assisted turning and conventional machining process S.Amini et al [15].The surface roughness was increased with increasing depth of cut and feed rate, whereas, with an increase in the feed rate from 0.15 to 0.2 mm/rev, the surface roughness approximately kept constant. The surface roughness had no direct relation to the lathe spindle speed, but cutting speed had excessive effect on it. The general trend of the surface roughness was decreased and then cutting speed is increased with increasing Ping Zou et al [16].

EXPERIMENTAL DETAILS

A. Work Material

Mild steel also known as plain-carbon steel, is now the most common form of steel because its price is comparatively low while it provides material properties that are satisfactory for many applications. Low-carbon steels endure from yield-point run out where the material has two yield points.EN19 steel is using for this machining process. High production industrial applications such as casting, metal forming, machining and sintering. The multi response optimization technique for predict and select the optimal setting of machining parameters while machining Chemical composition and mechanical properties of EN19 steel as shown in figure 1.

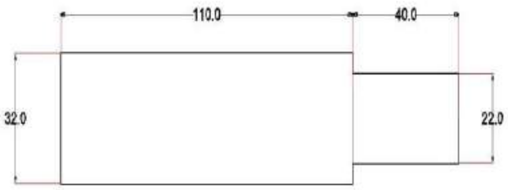


Fig 1. Work material

The chemical composition of the work material as investigates in table 1. It deals with the composition various metal and other particles.

Table 1. Chemical composition of EN19 Steel in percentage

C	Si	Mn	S	P	Cr	Mo	Ni	Fe
0.4	0.15	0.6	0.03	0.02	1.3	0.3	1.3	Balance

The mechanical properties of work piece listed in table 2. This table is used to identify the tensile, yield strength, bulk, shear modulus, poisson ratio and vicker hardness.

Table 2: Mechanical properties of EN19

Properties	***Units in metric***
Tensile Strength	745 MPa
Yield Strength	470 MPa
Bulk Modulus	140 GPa
Shear Modulus	80 GPa
Poisson ratio	0.27
Vicker hardness	228

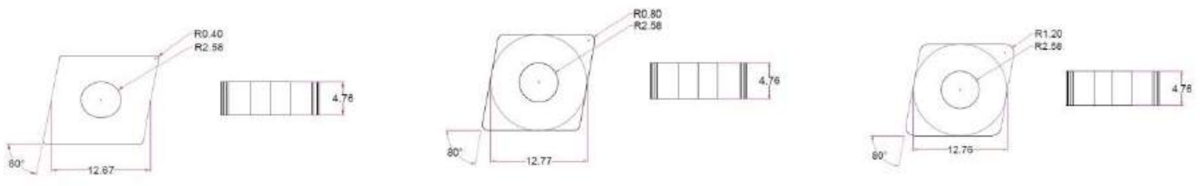
B.Tool Material

A cutting tool is any tool that is used to remove material from the workpiece by means of shear deformation. Cutting may be accomplished by single point tools are used in turning, shaping, planning and similar operations, and remove material by means of one cutting edge. Cutting tools must be made of material harder than the material which is to be cut, and the tool must be able to withstand the heat generated in the metal cutting process. Also the tool must have a specify geometry with clearance angles designed so that the cutting edge can contact the workpiece the rest of the tool dragging on the workpiece surface. The angle of the cutting face also important, as is the flute width, number of flutes or teeth and margin size. In order to have a long workpiece life, all of the above must be optimized, plus the speed and feed at which tool is run.Carbide inserts are used in the machining process to obtain good surface finish. The carbide tool single point cutting tool is used of make SANDVIK.

This selection of tool insert depends on many factors like workpiece hardness and tool life required the operation condition etc. The selected insert CNMG 1204 SMR H13 a different nose radius tool. The nose radius of the tool insert is should be an optimum value for between 0.4, 0.8 and 1.2 mm Chatter and surface finish depends on tool nose radius. The product details as shown in table 3.

Table 3: carbide insert product data

Product data	
Operation type	***Medium***
Insert size and shape	CN1204
Inscribed circle diameter	12.7
Insert Shape code	C
Cutting edge effective length	8.5mm
Corner radius	0.4, 0.8 and 1.2
Grade	H13A
Coating	Uncoat
Clearance angle	0 deg
Weight of item	0.01kg



(a) (b) (c)

Fig 2. (a) 0.4 mm Nose Radius; (b) 0.8 mm Nose Radius; (c) 1.2 mm Nose Radius

C.Machining details

In Absolute programming the end point of a motion is programmed with reference to the program zero point. Coordinates are specified as X, Z. X coordinate is the diameter of the part. In Incremental programming the end point is specified with reference to the current tool position. Coordinates are specified as U, W. U is the incremental diameter of the part.

Table 4: Batliboi lathe specification

Main specification	***Sprint 16TC***
Swing over bed	400mm
Turning diameter	225mm
Turning length	300mm
Power chuck	165mm
Spindle speed	30-5000 rpm
Spindle motor	5.5-7.5kw
z-axis stroke	325mm
x-axis stroke	125mm
Max. No. of tools in turret	8
Rapid transverse	20m/min
Tail stock	Hydraulic

Spindle rotation is started by specifying a spindle direction command and a spindle speed command. This command specified an M command. The tool change command includes the tool number and the tool offset number of the commanded tool. When the command is executed, the tool changer causes the commanded tool to come to the cutting position. The specification of CNC lathe machine shown in table 4.

D. Vibration measurement

In this vibration Absorber is used to calculate the vibration frequency. This absorber sensor is connected with tool holder. This instrument system connected with laptop and using Data log software to calculate the vibration frequency in turning process.

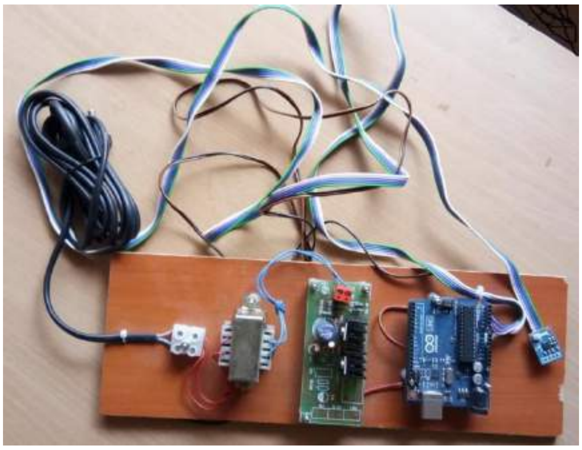


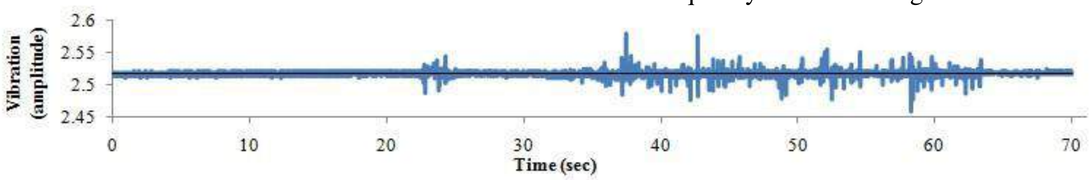
Fig 3. Vibration measuring Instrument

Carbide insert nose radius 0.4, 0.8 and 1.2 is used for the machining process. Input parameter four different speeds 500, 750, 1000 and 1250 rpm, feed (0.3mm) and depth of cut (0.3) mm respectively. In this process all cutting operations frequency are measured in feed, radial and tangential direction.

Fig 4. Machining arrangement

RESULT AND DISCUSSION

The vibration measurement is used to collect the data from CNC lathe. The sensor is attached from the tool holder. 0.4 nose radius carbide insert is mounted on the tool holder. Then the speed, feed and depth of cut is input from the CNC lathe. 0.4 nose radius carbide insert is to machined and the frequency is shown in figure 6.



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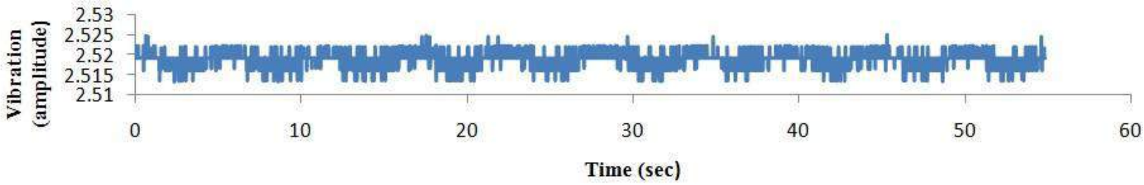

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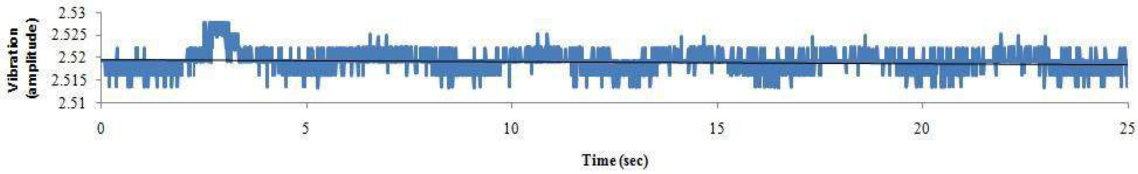

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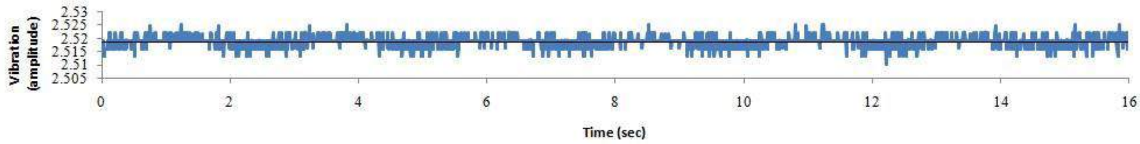
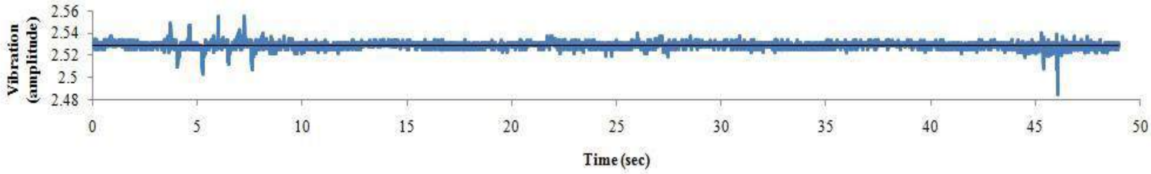


(d)

.Fig 5. Vibration in 0.4 radius (a) 500, (b) 750, (c) 1000 and (d) 1250 rpm.

In this vibration frequency are based on nose radius 0.4mm and different spindle speed (500, 750, 1000 and 1250 rpm). The feed rate is 0.3 and depth of cut is 1mm. Average vibration frequency of 0.4 nose radius 2.5172, 2.5189, 2.5190 and 2.5191 amplitude is the minimum speed to maximum speed.

The comparison of same nose radius and different speed are calculated in percentage. First 0.4 nose radius are taken. 500 and 750 variation is 0.17%. 750 and 1000 variation is 0.01%. 1000 and 1250 rpm variation are 0.01%.



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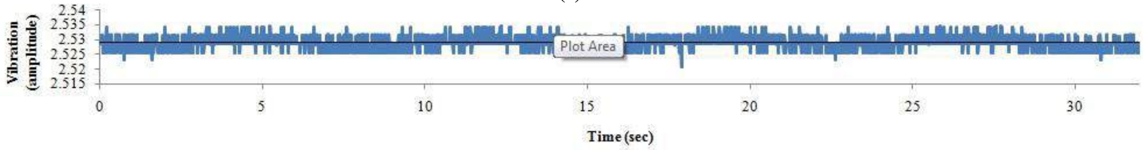

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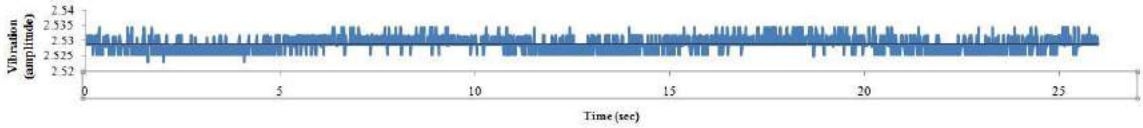

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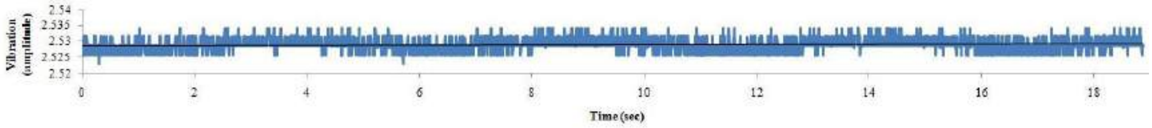
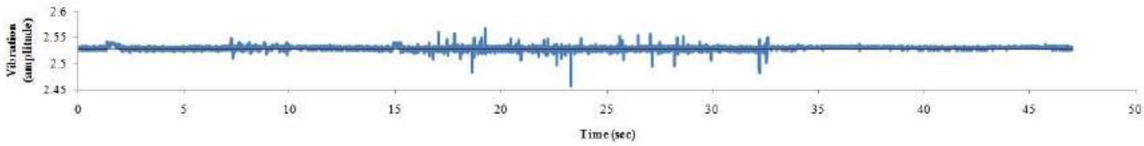


(i)

Fig 6. Vibration in 0.8 nose radius (e) 500, (f) 750, (g) 1000 and (e) 1250 rpm

In this vibration frequency based on the nose radius 0.8 mm. and the different speed rate. The speed is mentioned above the 0.4 nose radius. Feed rate and depth of cut all are same as above. Average vibration frequency of 0.8 nose radius is 2.5289, 2.5290, 2.5291 and 2.5292 amplitude is for minimum speed to maximum speed.

Next 0.8 nose radius 500 and 750 variation is 0.01%, 750 and 1000 variation is 0.01%. 1000 and 1250 variation is 0.01%.



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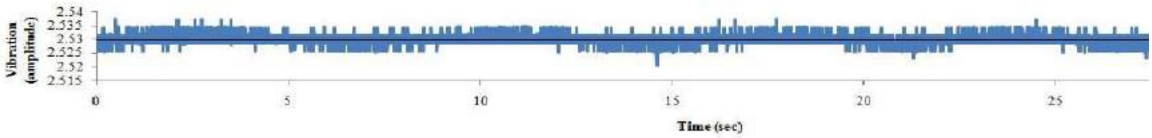

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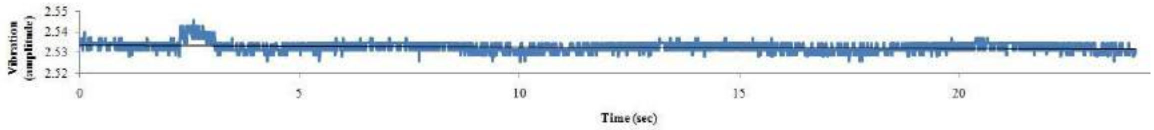

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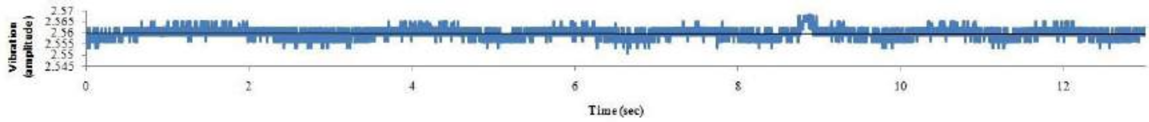

(l)

Fig 7. Vibration in nose radius 1.2 (i) 500, (j) 750, (k) 1000 and (l) 1250 rpm

In this vibration frequency is based on the nose radius 1.2 mm. And the different speed rate. The speed is mentioned above the 0.4 nose radius. Feed rate and depth of cut all are same as above. Average vibration frequency of 1.2 nose radius is 2.5293, 2.5299, 2.5327 and 2.5598 amplitude is for minimum speed to maximum speed.

And the final nose radius is 1.2 and comparison of 500 and 750 is 0.34%. 750 and 1000 variation is 0.28%. 1000 and 1250 variation is 2.71%.

Table 5: Average vibration

Nose Radius(mm)	*Speed (rpm)*	*Feed (mm)*	*Depth of cut (mm)*	*Average vibration (amplitude)*
0.4	500	0.3	1	2.5172
0.4	750	0.3	1	2.5189
0.4	1000	0.3	1	2.5190
0.4	1250	0.3	1	2.5191
0.8	500	0.3	1	2.5289
0.8	750	0.3	1	2.5290
0.8	1000	0.3	1	2.5291
0.8	1250	0.3	1	2.5292
1.2	500	0.3	1	2.5293
1.2	750	0.3	1	2.5299
1.2	1000	0.3	1	2.5327
1.2	1250	0.3	1	2.5598

The percentage difference between the nose radius 0.4, 0.8 and 1.2 and same speed 500 rpm. The percentage difference of 0.4 and 0.8 is 1.17%, 0.8 and 1.2 is 0.04%, and 0.4 and 1.2 percentage difference is 1.21%. The next is speed is 750 rpm. Compare for three nose radius. 0.4 And 0.8 is 1.01%, 0.8 and 1.2 is 0.09% and the 0.4 and 1.2 is 1.1%. Next is speed 1000 rpm percentage difference 0.4 and 0.8 is 1.01%. 0.8 And 1.2 is 0.3%. And 0.4 and 1.2 is 1.37%. Next speed is 1250 rpm. And 0.8 variation is 1.01%, 0.8 and 1.2 is 3.06% and 0.4 and 1.2 is 4.07 variation of vibration.

In this russelt is shown that tool chatter in spindle speed variation and tool nose radius. Speed 500, 750, 1000 and 1250 rpm, depth of cut 1mm and feed rate are 0.3mm. Frequency is measured in tangential, feed and radial direction. Russelt are calculating in this frequency. This russelt are shown in graph at frequency and speed. X axis column are vibration in amplitude. Y axis column are speed. Three different nose radius 0.4, 0.8 and 1.2 are using for machining process. In this nose radius frequency are used for the russelt graph is shown in figure 8.

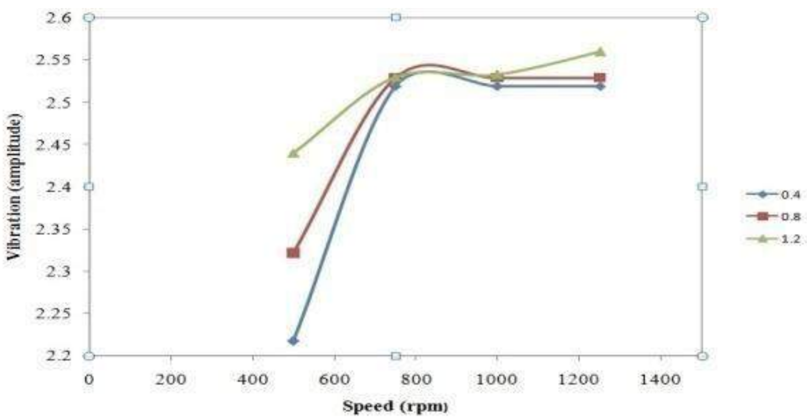

Fig 8. Russeltent graph

CONCLUSION

Tool Vibration was conducted based on the tool chatter equipment and investigate the parameter of identify the minimization of tool vibration with respect tool nose radius and speed. The result obtained from the investigation is as follows.

1. The nose radius of 0.4 mm cutting tool carbide insert with 50 m/min, 75 m/min, 100 m/min and 125 m/min speed were machined the values of variation 500 and 750 rpm variation is 0.17%. 750 and 1000 rpm variation is 0.01%. 1000 and 1250 rpm variation is 0.01%.
2. The nose radius of 0.8 mm cutting tool carbide insert with 50 m/min, 75 m/min, 100 m/min and 125 m/min speed were machined the values of variation 500 and 750 rpm variation is 0.01%, 750 and 1000 rpm variation is 0.01%. 1000 and 1250 rpm variation is 0.01%.
3. The nose radius of 0.8 mm cutting tool carbide insert with 50 m/min, 75 m/min, 100 m/min and 125 m/min speed were machined the values of variation 500 and 750 rpm is 0.34%. 750 and 1000 rpm variation is 0.28%. 1000 and 1250 rpm variation is 2.71%.

Thus we can conclude that the nose radius of cutting tool insert are considerably improves the vibration resistance moderate speed for light duty application.

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