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Measurement of Cutting Forces While Turning Different Materials by Using Lathe Tool Dynamometer with Different Cutting Tool Nomenclature

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ABSTRACT: The measurement of cutting forces in metal cutting is essential to estimate the power requirements, to design the cutting tool and to analyze machining process for different work and tool material combination. Although cutting forces can be measured by different methods, the measurement of cutting forces by a suitable dynamometer is widely used in industrial practice. Mechanical and strain gauge dynamometer are most widely used for measuring forces in metal cutting. The principle of all dynamometers is based on the measurement of deflections or strain produced from the dynamometer structure from the action of cutting force.

In this experimental study, a lathe tool dynamometer is used to measure cutting force, feed force and thrust/Axial force by using strain gauge accelerometer. The dynamometer is a 500kg force 3-component system. The dynamometer is connected to a data acquisition system. As the tool comes in contact with the work piece the various forces developed are captured and transformed into numerical form system. In this experimental work three forces of aluminum, brass and stainless steel materials have been noted down. In this study **single point cutting tools with different rake angles**, are used to measure forces on these materials with variation in speeds and depth of cut. Graphs were drawn on how these forces vary due to variation in speed and rake angles.

KEYWORDS: Lathe tool dynamometer, Aluminum, brass, stainless steel, single point cutting tools with different rake angles.

I. INTRODUCTION

The metal cutting is done by a relative motion between the work piece and the hard edge of a cutting tool. Metal cutting could be done either by a single point cutting tool or multi point cutting tool. There are two basic types of metal cutting by a single point cutting tool. They are orthogonal and oblique metal cutting. If the cutting edge of the tool is at 90° to the direction of the tool travel, then the cutting action is called as orthogonal cutting. If the cutting face of the tool is inclined at less than 90° to the path of the tool then the cutting action is called as oblique cutting.

A machine-tool dynamometer is a multi-component dynamometer that is used to measure forces during the use of the machine tool. Empirical calculations of these forces can be cross-checked and verified experimentally using these machine tool dynamometers.

With advances in technology, machine-tool dynamometers are increasingly used for the accurate measurement of forces and for optimizing the machining process. These multi-component forces are measured as an individual



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component force in each co-ordinate, depending on the coordinate system used. The forces during machining are dependent on depth of cut, feed rate, cutting speed, tool material and geometry, material of the work piece and other factors such as use of lubricants during machining.



Fig 1. single point cutting tools with different rake angles

II. EXPERIMENTAL PROCEDURE

The work piece is held in the chuck and facing operation is performed to make the end face of the work piece flat. The work piece is centre drilled to provide tapered hole which can then accommodate and be supported by a running centre in the tail stock. Undercutting operation is done to provide a groove on the work piece in order to have a reference point, sensing unit of the dynamometer is placed on lathe tool post and clamped rigidly. With the help of cable provided, cable is connected on sensing unit to socket on back plate of Force Indicator Unit. Force Indicator is connected to 230 V, single phase supply and switch on power supply. Waited for 5 to 10 minutes to balance the channels to get zero readings on display with tare pots on the panel. Mounted solid work – piece in the chuck. Selected the speed by engaging the levers to a suitable combination to get the specified speed and start the Machine. Fed the tool manually to start cutting and then automatically. Waited to stabilize the output of the bridges and measured the maximum output for thrust, feed & radial forces. Noted down the reading and repeated the same procedure for various speeds, by using different single point cutting tools of different rake angles.



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Fig 2. Turning with single point cutting tool with different rake angles

2.1. ALUMINIUM

Aluminum is a chemical element in the boron group with symbol Al. It is a relatively soft, durable, lightweight, ductile and malleable metal with appearance ranging from silvery to dull gray, depending on the surface roughness. The following figure shows the Aluminum before and after machining





Fig 3. Aluminum rod before and after turning

It is nonmagnetic and does not easily ignite. A fresh film of aluminum serves as a good reflector of visible light and an excellent reflector of medium and far infrared radiation. The yield strength of pure aluminum is 7–11 MPa.

2.2. BRASS

Brass is an alloy made of copper and zinc; the proportions of zinc and copper can be varied to create a range of brasses with varying properties. It is a substitution alloy: atoms of the two constituents may replace each other within



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the same crystal structure. It is used for decoration for its bright gold-like appearance. The following figure shows the Brass before machining and after machining.





Fig 4. Brass rod before and after turning

By varying the proportions of copper and zinc, the properties of the brass can be changed, allowing hard and soft brasses. Because brass is not ferromagnetic, it can be separated from ferrous scrap by passing the scrap near a powerful magnet. Brass scrap is collected and transported to the foundry where it is melted and recast into billets. Billets are heated and extruded into the desired form and size.

2.3. STINLESS STEEL

In metallurgy, **stainless steel**, also known as **inox steel**, and it is a steel alloy with a minimum of 10.5% chromium content by mass. Stainless steel does not readily corrode, rust or stain with water as ordinarywater as ordinary steel does however, it is not fully stain-proof in low-oxygen, high-salinity, or poor air-circulation environments. There are different grades and surface finishes of stainless steel to suit the environment the alloy must endure. Stainless steel is used where both the properties of steel and corrosion resistance are required.



Fig 5. Stainless Steel rod before and after turning



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	AI	LUMINUM]	BRASS		STAIN	LESS S	TEEL
RAKE ANGLE	SPEED(rpm)	C.F	F.F	T.F	C.F	F.F	T.F	C.F	F.F	T.F
	400	4	3	2	2	2	8	11	5	15
3 ⁰	630	2	2	1	2	2	6	5	4	11
	1000	3	4	2	1	4	4	5	2	11
	400	2	1	1	2	1	4	4	2	5
4 ⁰	630	1	2	1	1	1	2	4	2	3
	1000	1	2	2	1	1	1	5	1	1
	400	2	1	2	5	1	3	5	2	5
6 ⁰	630	1	2	1	3	1	1	9	5	2
	1000	1	2	2	2	1	1	6	3	1
	400	2	1	1	5	1	12	5	3	6
7 ⁰	630	2	1	2	2	1	5	4	1	1
	1000	2	1	1	1	1	4	5	1	4
	400	2	2	1	1	1	4	3	1	3
8 ⁰	630	1	1	1	1	1	2	1	1	4
	1000	2	2	2	1	2	1	2	2	4
	400	3	3	1	4	1	5	8	4	10
9 ⁰	630	2	1	2	2	1	3	6	4	4
	1000	1	2	1	2	1	1	4	1	1
C.F: CUTTING	FORCE in Kgf,		F.F:FEI in k	ED FOF Kgf	RCE in 1	Kgf,		T.F:TH	RUST F	ORCE

III. RESULTS

The various forces such as cutting force, feed force and the axial force have been found out with the variation in depth of cut for different materials. Graphs are drawn on how these forces vary with the variation in the depth of cut for different materials.

Rake angle: 3 ⁰	Material: aluminum	ı
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Rake		cutting	feed	thrust
angle	speed	force	force	force
	400	4	3	2
3	630	2	2	1
	1000	3	4	2





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Rake angle: 9⁰ Material: aluminum

rake		cutting	feed	thrust
angle	speed	force	force	force
	400	3	3	1
9	630	2	1	2
	1000	1	2	1

Rake angle:40 Material: stainless steel

Rake angle	speed	cutting force	feed force	thrust force
	400	4	2	5
	630	4	2	3
4	1000	5	1	1





Rake angle: 6⁰ Material: stainless steel

Rake angle	speed	cutting force	feed force	thrust force
10	400	5	2	5
	630	9	5	2
6	1000	6	3	1





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Rake angle: 9⁰ Material: brass

Rake angle	speed	cutting force	feed force	thrust force
	400	4	1	5
8 2	630	2	1	3
9	1000	2	1	1



Rake angle: 8⁰ Material: brass

4 +		
3.5 +		
3 -	 	
2.5 +		Series1
2 +		Series2
1.5 +	 	 Series3
1 +		
0.5 +		
0 +		

Rake angle	speed	cutting force	feed force	thrust force
	400	1	1	4
	630	1	1	2
8	1000	1	2	1



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IV. CONCLUSION

In this experimental work the various forces such as cutting force, feed force and the axial force have been found out with the variation in speed and rake angle for different materials like aluminum, brass and stainless steel. From the results we can conclude that as the rake angle increases cutting force increased at all speeds in aluminum material where as cutting fore & thrust forces increased in brass and stainless steel metals at all speeds. Less Feed force is observed at 7^0 rake angle at all speeds for all three metals. At $3^0 \& 8^0$ rake angles three forces increased in aluminum material. At 6^0 , $7^0 \& 9^0$ rake angles three forces increased in brass material. At $3^0 \& 9^0$ rake angles three forces increased in stainless steel material.

REFERENCES

 Indrajith Mukharji, Pradip Kumar Ray(2006) 'A review of optimisation techniques in metal cutting process' Computers and Industrial engg. 50, 15-34.

2. G.Boothroyd,'Fundamentals of machining and machine tools' 1sted,Scrapta Book Company'.

3. W. E. Biles, James J. Swain, "Optimization and industrial experimentation", 1980, John Wiley & sons, New York.

4. Muammer Nalbant, Hasan Gokkaya, and Ihsan Toktas 2007. Comparison of Regression and Artificial Neural Network Models for SurfaceRoughness Prediction with the Cutting Parameters in CNC Turning. *Modelling and Simulation in Engineering*. pp. 1-14,doi:10.1155/2007/92717.

5. Oktem. H., Erzurumlu. T., Kurtaran. H., 2005. Application of response surface methodology in the surface roughness. J. Mater. Process. Technol. Vol.170, pp. 11–16 optimization of cutting conditions for

6. Abouelatta. O.B. and Madi. J. Surface roughness prediction based on cutting parameters and tool vibration in turning operations", Journal of Materials Processing Technology, 118, 2001, pp.269-277.

7. L. Andren, L. Hakansson, A. Brandt, I. Claesson, —Identification of motion of cutting tool vibration in a continuous boring operation correlation to structural properties!, Mechanical Systems and Signal Processing 18 (2004) 903–927, 29 September 2003.

BIOGRAPHY



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