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Finding Cutting Forces While Turning Aperation on Lathe Machine at Different Depth of Cut of Different Metals

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ABSTRACT: In this study, a lathe tool dynamometer that can measure cutting force, feed force and also thrust/Axial force by using strain gauge accelerometer has been Studied and used. The dynamometer used in this project 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 project various forces for four different materials have been noted down and the materials used in this project are aluminum, brass, mid steel & nylon. The forces on these materials with variation in depth of cut are studied. Graphs are drawn on how these forces vary due to variation in depth of cut.

KEYWORDS: Depth of cut, Cutting speed and cutting force

I . INTRODUCTION

A. METAL CUTTING

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 a 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 face of the tool is at 90^o to the direction of the tool travel the cutting action is called as orthogonal cutting. If the cutting face of the tool is inclined at less than 90^o to the path of the tool then the cutting action is called as oblique cutting. The differences between orthogonal and oblique cutting is given below

B. DYNAMOMETER

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 component force in each co-ordinate, depending on the coordinate system used. The forces during machining are dependent on depth of

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cut, feed rate, cutting speed, tool material and geometry, material of the work piece and other factors such as use of lubrication/cooling during machining.

C. NEED FOR MEASURING FORCES

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 in based on the measurement of deflections or strain produced from the dynamometer structure from the action of cutting force.

II. OPERATING 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 Place the sensing unit of the dynamometer on lathe tool post and clamp rigidly. With the help of cable provided, carefully connect cable on sensing unit to socket on back plate of Force Indicator Unit .Connect Force Indicator to 230 V, single phase supply and switch 'ON' supply. Wait for 5 to 10 minutes and then balance the channels to get zero readings on display with tare pots on the panel. Mount solid work – piece in the chuck .Adjust the speed & feed of the Lathe Machine and start the Machine. Feed the tool manually to start cutting and then feed it automatically .Wait to stabilize the output of the bridges and measure the maximum output for thrust, feed & radial forces. The Vertical, Horizontal & radial forces on the dynamometer should not exceed the limit 300 kg. Note down the reading and change depth of cut & repeat the same procedure. The following figure shows the operating procedure.

Fig.1. Aluminium rod during machining

A. ALUMINIUM

Aluminium 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 Aluminium before machining and after machining.

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Fig2: Aluminium before machining

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

Fig 3 : Aluminium rod after several operation

B. 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 substitutional alloy: atoms of the two constituents may replace each other within 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 machining

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.

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Figure 5: Brass rod after machining operation

C. MILD STEEL

Mild steel, also called as plain-carbon steel, is the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications, more so than iron. The following figure shows the Mild steel before machining, machining and after machining

Fig 6: Mild steel rod before machining

Low-carbon steel contains approximately 0.05–0.3% carbon making it malleable and ductile. Mild steel has a relatively low tensile strength, but it is cheap and malleable; surface hardness can be increased through carburizing. It is often used when large quantities of steel are needed, for example as structural steel.

Figure 7: Mild steel rod after machining

D. NYLON

Nylon is a thermoplastic silky material, Solid nylon is used in mechanical parts such as machine screws, gears and other low- to medium-stress components previously cast in metal. Engineering-grade nylon is processed by extrusion, casting, and injection moulding. The following figure shows the Nylon before machining, machining and after machining

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Fig8: Nylon rod before machining

Variation of luster: nylon has the ability to be very lustrous, semi-lustrous or dull.

Durability: its high tenacity fibers are used for seatbelts, tire cords, ballistic cloth and other uses. High elongation Excellent abrasion resistance Highly resilient (nylon fabrics are heat-set)

Figure 9: Nylon rod after machining

III . GRAPHS AND TABULAR COLUMNS

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 Aluminium. Graphs are drawn on how these forces vary with the variation in the depth of cut for aluminium. It has been observed.

Speed: 630rpm **Material: Aluminium**

Table 1: Tabular column of variation of forces with variation in depth of cut

Depth of cut	Cutting force(f_c)	Feed force(f_f)	Thrust force(f_t)
0.25	2	0	2
0.5	5	1	3
0.75	8	4	3
1	10	5	4
1.25	11	7	6

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1.5	12	9	6
1.75	14	10	7

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 Brass. Graphs are drawn on how these forces vary with the variation in the depth of cut for Brass. It has been observed.

Speed: 630rpm **Material: Brass**

Table 2: Tabular column of variation of forces with variation in depth of cut

Depth of cut	Cutting force(F_c)	Feed force(F_f)	Thrust force(F_t)
0.25	1	0	1
0.5	3	0	1
0.75	4	1	1
1	5	2	2
1.25	6	2	2
1.5	8	3	2
1.75	9	3	1

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 Mild Steel. Graphs are drawn on how these forces vary with the variation in the depth of cut for Mild Steel. It has been observed.

Speed: 630rpm **Material: Mild steel**

Table 3: Tabular column of variation of forces with variation in depth of cut

Depth of cut	Cutting force(F_c)	Feed force(F_f)	Thrust force(F_t)
0.25	2	1	3
0.5	6	2	3
0.75	10	4	3
1	13	7	4
1.25	15	9	7
1.5	19	11	8
1.75	21	12	8

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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 Nylon. Graphs are drawn on how these forces vary with the variation in the depth of cut for Nylon. It has been observed.

Speed: 630 rpm **Material: Nylon**

Table 4: Tabular column of variation of forces with variation in depth of cut

Depth of cut	Cutting force(F_c)	Feed force(F_f)	Axial force(F_t)
1	0	0	0
1.50	0	0	0
2	1	0	0
2.50	1	0	0
3	1	1	1
3.50	2	1	1

IV. RESULT & CONCLUSION

In this project 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 like aluminium, brass, mild steel & nylon. Graphs are drawn on how these forces vary with the variation in the depth of cut. For aluminium and mild steel, It has been observed that with the increase in depth of cut, there is a linear increase in all the three forces. Whereas in case of brass and nylon there is uniform step increase in the forces with variation in depth of cut. And in this project we have studied, how a dynamometer works .And also learnt about various elements involved in metal cutting process.

For the further enhancement of this project a thermocouple if connected can be used to find the temperature developed during the machining process.

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