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ANALYSIS OF VARIOUS FORCES ON RDM BY INOVATIVE DESIGN AND DEVELOPMENT OF A TOOL DYNAMOMETER

[1]Kiran B. Gore, [2] Vinaykumar C. Jadhav, [3] Karan K. Sharma
[1] Assistant Professor, [2] Assistant Professor, [3] Assistant Professor
[1] Department of Mechanical Engineering
SNJB'S K. B. Jain College of Engineering, Chandwad

Abstract: In this exploration work, the two principle goals initially is to grown a particularly test arrangement by which we measure torque and radial thrust directly and second target is to research apparatus quality on different materials. The new review comprises of experimentations, parametric investigation utilizing Visual fundamental programming lastly numerical demonstrating utilizing programming. Experimentation for the most part indicates the machining of Copper, Brass and Aluminum example on Radial boring machine. The Objective of this exploration work is to set up push and force model of boring cycles for developing openings, in view of fluctuating calculation and cuttings such models are possibly valuable in a worldwide boring interaction recreation of hardware movement and the age of surface geology for a simultaneous designing plan framework. Such work is unquestionably required for meeting resistance necessity, measure arranging and framework checking**.**

***Index Terms* – RDM, Copper, Brass, Aluminium.**

I. INTRODUCTION

A machine oversees ability to achieve an assignment. A portion of its genuine instances are a mechanical framework, a registering framework an electronic framework, and a sub-atomic machine. In like manner utilization, the importance is that of a gadget having parts that perform or help with playing out a work. A straightforward machine is a gadget that changes the course or greatness of a power. All things considered, a gadget required moving parts to arrange as a machine; notwithstanding, the appearance of hardware innovation has prompted the advancement of gadgets without moving parts that many allude to as machines, like a PC, radio, and TV

Machine configuration is a significant piece of designing applications, yet what is a machine? Machine is the devise that involves the fixed parts and moving parts joined together to produce, change or use the mechanical energy. Every one of the machines are comprised of components or parts and units. Every component is a different piece of the machine and it might need to be planned independently and in gathering. Every component thus can be a finished part or comprised of a few little pieces, which are combined by riveting, welding and so on A few machine parts are gathered into one place to frame what we call as complete machine.

II. PROBMEM FORMULATION

In this exploration work, the two principle goals initially is to grown a particularly test arrangement by which we measure torque and radial thrust directly and second target is to research apparatus quality on different materials. The new review comprises of experimentations, parametric investigation utilizing Visual fundamental programming lastly numerical demonstrating utilizing programming. Experimentation for the most part indicates the machining of Copper, Brass and Aluminum example on Radial boring machine.

2.1 Objectives

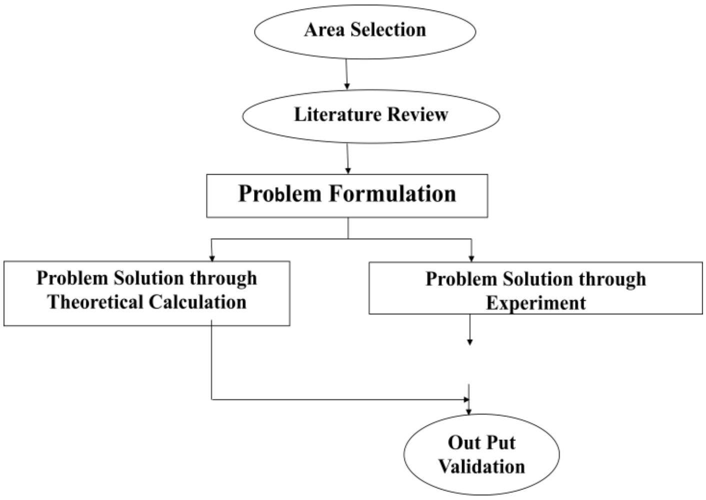
The Objective of this examination work is to set up thrust and torque model of drilling processes for enlarging holes, based on varying geometry and cuttings such models are potentially useful in a global drilling process simulation of tool motion and the generation of surface topography for a simultaneous designing plan framework. Such work is certainly required for meeting tolerance requirement, process planning and system monitoring. According to the powerful perspective, the proposed thrust and torque models should be able to reflect variations of the thrust and torque due to change of the drill geometry. (See figure 3.1)

The following two aspects must be included in this research work:

(1) The drill force varies with the change of cutting parameters for example feed rates, spindle speeds and work piece materials.

(2) The drilling force changes with the deflection of the drill structure.

III. RESEARCH METHODOLOGY



3.1Area Determination

Drilling is the one of the most essential machining tasks performed by engineers. The cycle is utilized to make opening by first fixing a drill to the furthest limit of a turning axle, and afterward drilling an opening through a fixed work piece. Drills are effectively worm by erosion, heat, and so on and now and then break when exposed to cut off cutting powers at the lips, which are the really cutting districts and the most fragile pieces of the drill. By indicating the work piece materials, working conditions, and drill calculations, the push and force model are utilized to anticipate the comparing cutting powers and machining execution.

3.2 Literature Review

An audit of the writing relating to the advancement of push and force models of boring cycles for opening development is isolated into four areas: machining framework displaying, models of boring constructions, models of push and force, and motivation behind the review. The principal area presents an all around created model to progressively describe a machining framework, a few applications and proceeded with advancement. The subsequent area incorporates an overview of the created hypothetical models of penetrating designs and an exploratory strategy for primary distinguishing proof. In the third area, the previous exploration work is examined and the cutting power in two-dimensional cutting is considered

3.3 Problem formulation

Thrust force during drilling can be characterized as the force acting along the axis of the drill during the cutting process. Cutting forces help to assist tooling wear, since forces increases with tool wear. Trust force is additionally used to monitor tool wear and, thusly, monitor tool life. Instrument disappointment can happen if apparatus wear isn't observed. Other than being a significant factor in the observing of hardware wear, push power is viewed as the significant giver of delaminating during penetrating. Impressive exploration has been done to demonstrate that there is a basic pushed power that causes delaminating, and push power beneath that will oblige or dispose of delaminating during penetrating.

3.4 Problem Solution through Theoretical Calculations

The mathematical investigation of a drill is exceptionally complicated, on the grounds that, the tendency point, the ordinary rake point and the viable rake, shift profoundly as we go from the inward most piece of the bleeding edge to the external part. The place of the drill might be considered as comprising of two sections: the bleeding edges and the etch edge. The etch edge doesn't cut in the standard sense, but instead dislodges the metal sideways as though we were playing out the hardness test. The all out force and push would thus be able to be isolated into two parts:

(i) Due to cutting edge

(ii) Due to chisel edge.

The contribution of chisel edge to total torque is just small but to total thrust is considerable. The depth of cut'd' in drilling from the solid metal is one-half the drill diameter. The feed '*f*' is the movement of the drill along its axis in mm per revolution. The type of drill selection for a particular task depends upon several factors. As shown in following fig. 3.1.

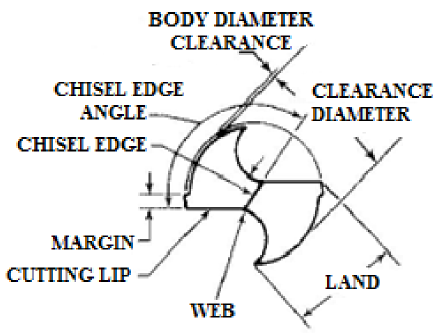


Figure 3.1 Tool Geometry

The chip thickness, t is

$$t = \left(\frac{f}{2}\right) \times \sin \alpha_p \quad \text{...... (1)......[1]}$$

And, the width of the cut, *b* is

$$b = \frac{D}{2 \sin \alpha_p} \quad \text{......(2).....[1]}$$

Where,

D = Drill diameter

$2\alpha_p$ = The point angle of the drill.

Figure shows the torque force acting on the cutting edges

$$F_P = \sigma_C \times \text{Chip Cross-section} = \sigma_C \times \frac{f}{2} \times \frac{D}{2} \quad \text{.....(3).....[1]}$$

$$= \sigma_C \times b \times t \quad \text{........ (4) ....[1]}$$

where σ_C is the contact stress, equal to Brinell hardness H_B. The moment due to two forces, F_P separated by half the drill diameter is

$$M = \frac{\sigma_c \times D^2 \times f}{8} = \frac{H_B \times D^2 \times f}{8} \quad \text{...... [1]....... (5)}$$

The thrust force T_1 due to cutting edges can be estimated if the mean make angle is known. However, the effective rake angle goes from a positive value near the outer radius to a negative value near the chisel edge.

Taking

$$\frac{F_t}{F_p} = 0.05 \text{ to} 1.0 \quad \text{...................... (6)}$$

$$T_1 = (0.5\text{to}1.0) \times 2 \times \sin \alpha_p \times \left(\frac{D}{2}\right) \times \left(\frac{f}{2}\right) \times \sigma_c \quad \text{... .... (7)}$$

.... (7)

For $2\alpha_p = 118^0$

$$T_1 = (0.21 \text{ to } 0.42) \times \sigma_c \times D \times f \quad \text{.............. (8)}$$

From equation (7) and (8)

$$T_1 = (1.7 \text{ to} 3.5) \times \frac{M}{D} \quad \text{......................... (9)}$$

It is difficult to estimate T_2 (thrust due to chisel edge) as it is very difficult ascertain area of contact between the chisel edge and metal. To a very crude approximation, the shaded contact area is taken as 10 to 20% of the area of a circle inscribed with in the web. The web thickness w is,

$$w = 0.2D \text{ for } D < 3.2\text{mm}$$

$$w = 0.1D \text{ for } D > 25.4\text{mm}$$

As mentions above, the cutting action of chisel point is very similar to a hardness test.

So, $$T_2 = (0.1 \text{ to } 0.2) \times \frac{\pi}{4} w^2 \times H_B \quad \text{.......... (10)}$$

$$\text{Total Thrust } (T) = (1.7\text{to}3.5) \times \frac{M}{D} + (0.1\text{to}0.2) \times \frac{\pi}{4} w^2 \times H_B$$

[1]…….(11)

Hardness of material is play an important role for determine the twisting moment in our experiment. For determine twisting moment and drilling thrust, we take a different material like Aluminum, Copper and Brass. Hardness of materials is determined by conducting Brinell hardness test on hardness testing machine.

Brinell Hardness (H_B) of Material is determining by following formula;

$$H_B = \frac{2 \times P}{\pi \times D\left[D - \sqrt{D^2 + d^2}\right]}$$ **…… [2]….. (12)**

Where,

P = Load Selected (*kgf*) = 187.5 kg for 20 Sec. for each material

D= Diameter of Ball (*mm*) = 2.5mm,

d = Diameter of Indentation (*mm*) (depend upon material**)**

Theoretical calculation

For Drill diameter D= 5mm

a) For Copper Material			b) For Brass Material			c) For Aluminum Material		
Feed	Thrust	Moment	Feed	Thrust	Moment	Feed	Thrust	Moment
1.96	175.77	439.16	3.40	438.40	1095.83	1.44	112.430	280.83
4.16	372.95	932.10	4.92	634.40	1585.73	3.96	309.01	772.29
6.20	548.61	1371.26	6.80	876.80	2191.66	4.48	348.28	870.47
7.96	699.18	1747.68	7.60	979.90	2449.50	5.72	446.31	1115.54
10.08	889.10	2222.70	9.76	1258.00	3145.67	6.76	525.49	1313.48
11.72	1036.10	2590.16	12.04	1552.00	3880.52	7.88	612.53	1531.08
13.60	1211.08	3029.32	13.64	1758.00	4396.21	9.24	718.24	1795.36
15.00	1330.10	3325.08	15.92	2052.00	5131.06	9.72	755.54	1888.62
17.20	1563.10	3907.65	18.16	2341.00	5853.02	10.00	777.54	1943.63
19.44	1742.40	4355.77	20.80	2681.00	6703.90	11.2	876.79	2191.73
20.12	1803.30	4508.13	23.28	3001.00	7503.21	12.36	963.83	2409.35
21.54	1949.40	4873.33	25.92	3341.00	8354.09	13.56	1057.10	2642.52
23.10	2070.70	5176.56	29.00	3738.00	9346.79	14.48	1128.60	2821.28
23.56	2111.60	5278.91	30.92	3986.00	9965.61	15.64	1218.76	3046.67
24.15	2164.50	5411.10	31.12	4012.00	10030.0	16.84	1315.13	3287.60

3.5 Problem Solution through Excremental Calculations

Figure 5.2 Experimental Setup

3.5.1 Experimental readings

For Drill diameter D= 5mm

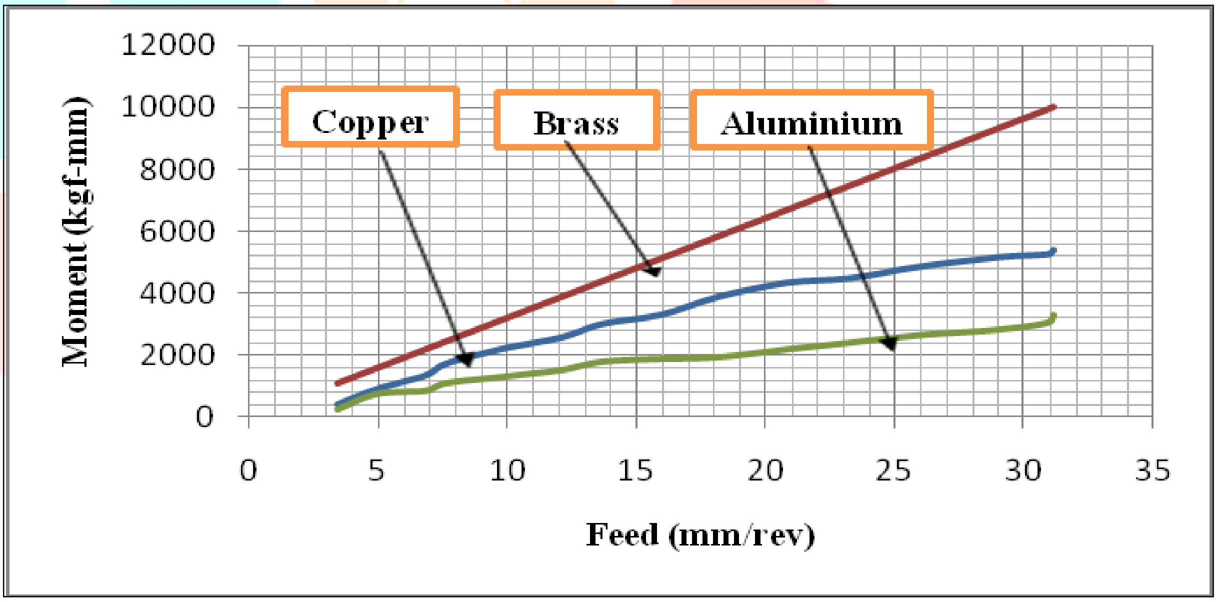
a) For Copper Material			b) For Brass Material					
Feed	Thrust	Moment	Feed	Thrust	Moment	Feed	Thrust	Moment
1.96	17.16	439.16	3.40	15.64	1095.83	1.44	10.56	280.83
4.16	13.92	932.10	4.92	15.08	1585.73	3.96	22.68	772.29
6.20	10.60	1371.26	6.80	16.2	2191.61	4.48	18.96	870.47
7.96	12.12	1747.68	7.60	15.52	2449.50	5.72	16.16	1115.54
10.08	10.20	2222.70	9.76	16.96	3145.67	6.76	23.24	1313.48
11.72	12.44	2590.16	12.04	18.12	3880.52	7.88	19.36	1531.08
13.60	17.76	3029.32	13.64	17.68	4396.21	9.24	15.92	1795.36
15.00	22.96	3325.08	15.92	18.28	5131.06	9.72	16.84	1888.62
17.2	8.44	3907.6	18.16	17.80	5853.02	10.00	18.32	1943.63
19.44	10.60	4355.77	20.80	20.32	6703.90	11.20	13.20	2191.73
20.12	12.24	4508.13	23.28	20.24	7503.21	12.36	17.08	2409.35
21.54	14.28	4873.33	25.92	22.12	8354.09	13.56	12.44	2642.52
23.10	12.11	5176.56	29.00	22.28	9346.79	14.48	14.76	2821.28
23.56	10.28	5278.91	30.92	14.48	9965.61	15.64	12.20	3046.67
24.15	16.10	5411.10	31.12	16.47	10030.0	16.84	11.00	3287.60

IV. Result and Discussion

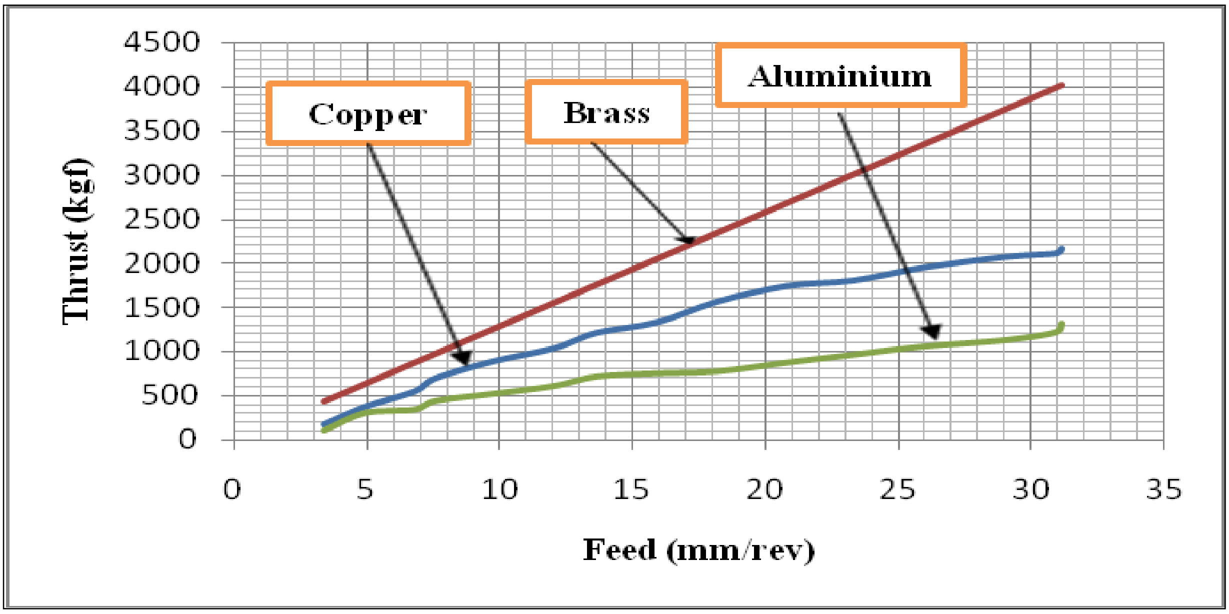
Here combine graphs are plot between Fees Vs Moment and Feed Vs Thrust for Copper, Brass and Aluminum for 5mm drill diameter.

4.1 Based on theoretical reading

4.1.1 Feed Vs Moment for 5mm drill diameter:-

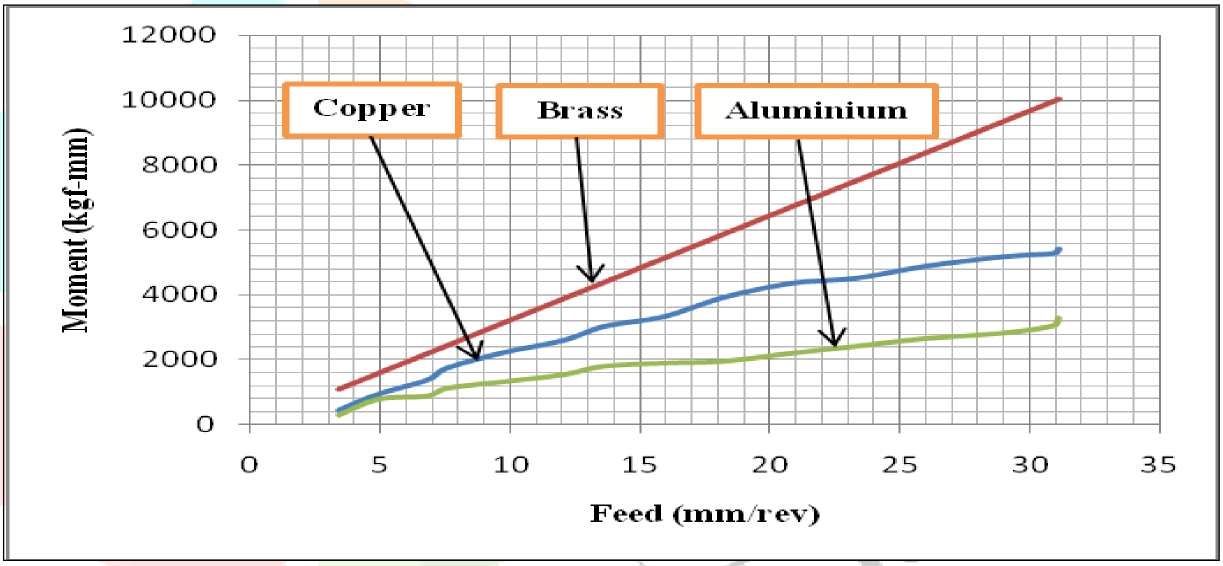


4.1.2 Feed Vs Thrust for 5mm drill diameter:-

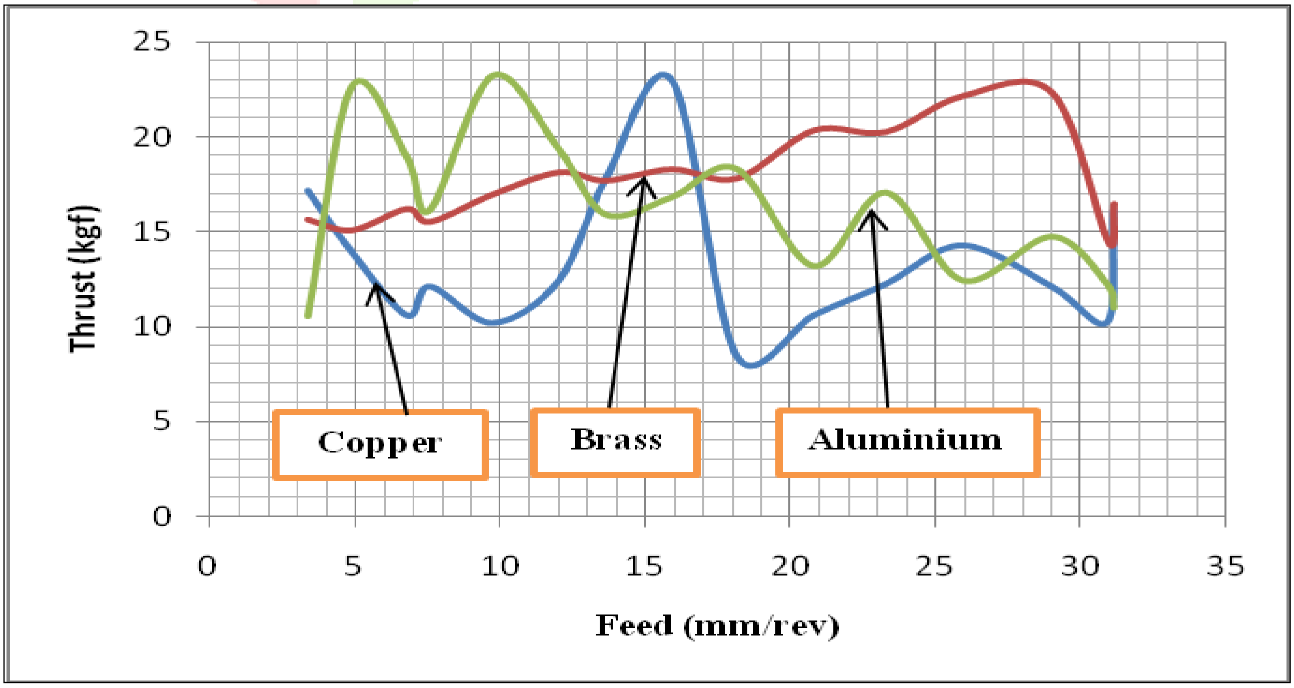


4.2 Based on Experimental Readings

4.2.1 Feed Vs Moment for 5mm drill diameter:-



4.2.2 Feed Vs Thrust for 5mm drill diameter:-



4.3. Result and conversation

4.3.1 Thrust: - Thrust is more achieve by the experimental setup.

4.3.2 Moment: -

- Moment of copper material is 1.56 times more than the aluminium material for 5mm drill diameter.
- Moment of copper material is 1.33 times more than the aluminium material for 7mm drill diameter.

4.3.3 Feed: - Feed is directly measure by 10k revolution pot, which is connected to PCB. So feed can read directly on Computer due to the Visual basic software.

4.3.4 Hardness:-Brinell hardness is measure by Brinell hardness Testing Machine.

4.3.5 Economy: - Lot product- Low price
Individual product- High

4.3.6 Risk: - Component of PCB and USB is very delicate, so prevent from coolant and take care to handle the box.

V. Conclusion

In the present study, the investigation of thrust and torque generated during drilling processes is summarized into four aspects; analytical mathematical models, drill structure identification, drilling dynamometer development, and cutting parameters effects estimation.

(1) The mathematical models have been developed for thrust and torque predation based on the drill geometry and the cutting parameters. An orthogonal cutting plane has been found in oblique cutting processes, which is applied to the cutting force analysis along the cutting edge of a drill.

(2) The drill structure is identified through model testing the predicted response based on the identified model parameters is at a reasonable accurate level compared to the measured response during vibration test.

(3) The prototype drilling dynamometer is designed and constructed the measured dynamic signals revel that the fundamental natural frequency of the dynamometer is higher than the lowest natural frequency of the drill structure. The stiffness of whole drilling system does not decrease due to the built dynamometer which guarantees the reliability of the built dynamometer.

(4) By utilizing the dynamometer, the cutting parameters effects on the thrust and torque are assessed. The combination of a low feed rate and high spindle speed is found to be the most proficient strategy for decreasing or controlling the thrust force while keeping a comparable machining usefulness.

VI. Future enhancement

Based on the present study, the following future work in this area are made

(1) The cutting mechanism of the web and the cutting edge near the drill centre is proposed to be examined for acquiring more complete mathematic models.

(2) Finite element method can be used to simulate the drill structure and Rayleigh-Ritz method can be used to model the structure theoretically.

(3) Semiconductor strain gauges could be valuable in satisfying the high affectability necessity.

(4) Development of a model to predict the optimal thrust force necessary for drilling of composites without delimitation since a very low thrust force is known to cause the fibers pull out and other defects during drilling.

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