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# THE APPLICATION OF SIMPLE STRAIN GAUGE DYNAMOMETER IN LEARNING STYLE ON CUTTING LATHE

Wenny Marthiana [1,*], Suryadimal [2] Edi Septe [3] Duskiardi [4], and [5] Andika

[1,2,3,4,5] *Mechanical Engineering, Faculty of Industrial Technology University of Bung Hatta* , Indonesia

**ABSTRACT:** One of the characteristics in the production process using a lathe machine is to know the magnitude of the cutting force and cutting Power Cut of any kind of cutting materials. the magnitude of the actual cutting forces can be determine by measuring it using Dynamometer. Unfortunately, now days the Dynamometer price is still quie expensive.That is for, through this research aims to design a simple dynamometer that can be used as a means of supporting the learning process on analysis turning cutting forces at Lathe machine.

*Dynamometer* designed consists of four octogonal rings which made by alumina material. The top surface of the ring is made flat to put a *strain gauge* measuring instrument with 350 Ohm resistance value. When the cutting tool cut the cutting material will cause deformation on the octagonal rings then the material will produce a change of resistance whose value is proportional to the deformation of the ring shape. The change in resistance of four *strain gauge* connected to form a *Wheatstone* bridge will cause imbalance resulting in differing voltages at both inputs.

The result of the result is the Dynamometer wit The spesification Overall dimension is 150 mm x 100 mm x 100 mm;Number of strain gauge being used are four. Strain gauge were posisitioned on alumina octagonal ring surface ; *Strain gauge* resistance value is 350 Ohm; Wheatstone bridge type is full bride; Strain Amplifier of 1.000 gain; Data acuisision type is Jmida MF 126.

**Keywords:** Cutting Force, Cutting power, *Dynamometer*, Strain gauge

## 1. INTRODUCTION

One of the important process parameters of the production process, especially in the lathe process, is the Cutting Force. The cutting force becomes quite important because since it is very influential on the lathe process, such as if the cutting force increases, it is influence to the increasing of the friction that occurs between the workpiece and cutting and the increasing in vibrations that occur in the process as well. The increasing of the friction and vibration value may result in non-achievement of appearance (the surface roughness for example) on the cutting field.

The Cutting force valuev could be obtained in two ways, first it could be obtained through analytically mathematically, its a pitti in this way the cutting force value which obtained is not accurate, it is because the factors that influence the cutting process are not taken into account entirely, such as process temperature, value the frictional force, the vibrations that occur during the process does not quite match as actual happens. The second way to get the cutting force value is by direct measurement. The mean used to measure the Cutting force known as the Dynamometer.By Dynamometer the cutting force could measuring of 3 different styles of direction: tangential, axial, and radial.

On the use of the Dynamometer, the Dynamometer is attached to the cutting chisel, so that when the cutting process takes place, the chisel that cuts the work piece will cause a strain on the dynamometer sensor. The strain received by this sensor is usually very small and cannot be read by the computer. In purpose of that sinyal on the sensor can be read by, so Strain Amplifiers is adapted to strong sthe sinyal then then forwarded to the data acquisition.

The Data acquisition generally involves the process of taking signals and then processing them for information. A Sensor, one of the data acquisition componen system then convert a measurement parameter into an electrical signal. The data obtained is usually displayed, analyzed and stored in a Personal Computer base.

## 2. RESEARCH METHODS

Use at most three levels of headings that correspond to chapters, sections and subsections. The first level headings for chapter titles should be in 10pt, bold, justified, and upper case font. Leave one-blank line before and after the first level headings, respectively.

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## 2.1 STRAIN GAUGE DYNAMOMETER

### 2.1.1 The Discription

The main component of the Dynamometer with strain gauge sensor consists of a cutting toots holder that serves for the cutter holder as well as placing the strain gauge sensor. Strain gauges Sensors are attached to its tool holder ring (since the form of ring is lieg ring). The Strain Gauge, as a signal reader,read the strain value of cutting tool when it cutting materials. The Data Acquisition serves to store and process the cutting measurements data that have been strengthened by the strain amplifier before .

*2.1.2 The Components Preparation*

The first thing to be prepared is the tool holder which consits of base strain gauge, strain gauge rings and cutting knife holder. Next, preparation of strain amplifier system before all of Dynamometer components being assembly. It is need to thorouh check the function of system before it is asssembly on lathe machine.

## 3. STRAIN GAUGE DYNAMOMETER

The Geometry and dimension of dynamometre components as discribe below

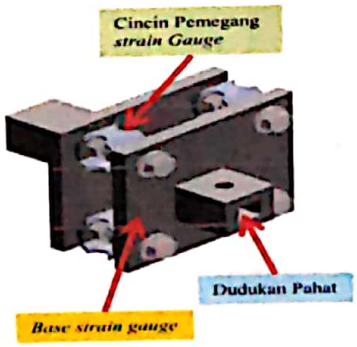


Fig 1. The cutting holder assembly

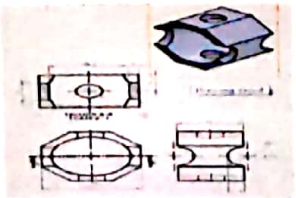

Fig 2. The Strain Gauge Ring

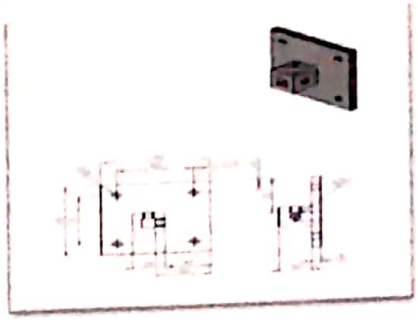

Fig 3. Cutting Tool holder

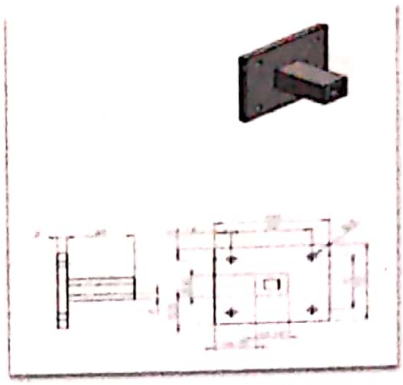

Fig 4. Strain Gauge base

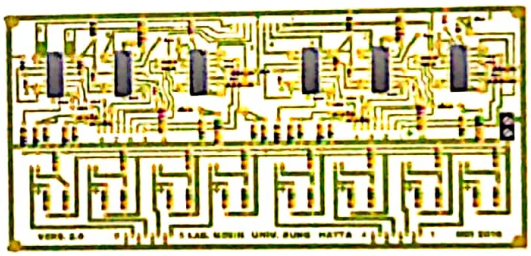

Fig 5. Strain Amplifier

### 3.1 Working Principle

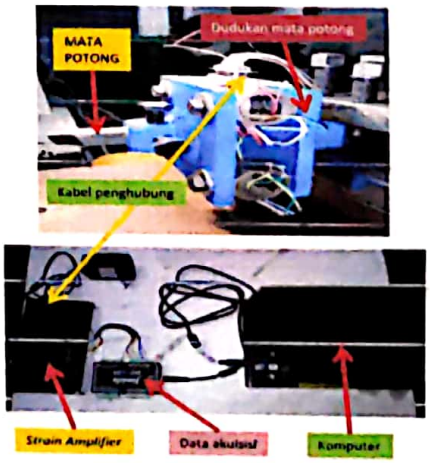


**Fig 6. strain Gauge circuit**

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As seen on Fig 6, strain gauge circuit, When the cutting tool cuts the work piece material, the cutting tool will receive strain in the axial, tangential, and radial directions. The Yield value/strain value that happend will be read by the strain gauge sensor, since the strain value is too low to be read then the strain signal will be amplified first by a strain amplifier so that it can be read and displayed on the monitor. Acuisition data is used to enable measurement results data gathering and storing.

The unit measurement that appears on monitor is value of electrical voltage and current. Then that value must convert to cutting force value using formula

$$F = \frac{Vakt * 2 * y * A}{E} \quad (1)$$

F : Cutting Force
$V_{act}$ : Actual Measurement voltage
E : Input Voltage
Y : Young Modulus
A : Area of *strain gauge*

## 4. TEST RESULT

The result of the cutting process will be displayed on the monitor screen as shown below

Fig 7. Display data on monitor

The graph on monitor as clearly seen shown below,

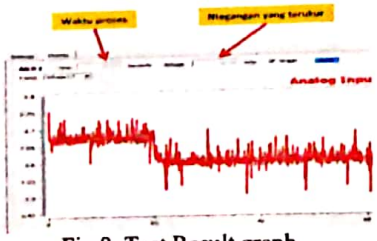

Fig 8. Test Result graph

From the graph in Fig 8, On the horizontal axis shows the time of the cutting process, The value on the Vertical axis shows a measured Voltage value with magnification value 1.000 (thousand) times.

For the evaluation of the tool, the process of lathing is done by adjusting the parameters of certain test lathe process, one example of the process parameters of the lathe process that is carried out are with value of Round (n) of 275 rpm, Feeding (F) of 1.5 mm.

The Voltage Value generated for the Axial Style measurement as shown in the Figure 4 and Figure 9 views of Gafik .

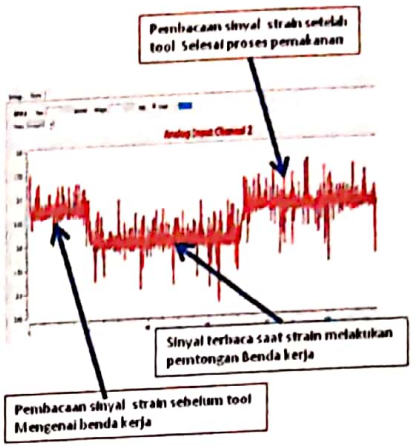


Fig 9. Data of chanel 2

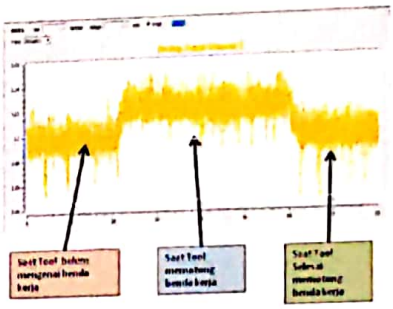

Fig 10. Data of Chanel 5

### 4.1 Discussion

At the time of Tool or eye chisel cuts workpiece, as on Fig 9, the value of stress decrease compared betwen before and after cutting tool cut the material. While in Fi 10 it shows the different values from Fig 9.

Based on the principle of the strain Gauge resistance, If a wire is drawn, the wire will lengthen and the cross section become narrows, so that the electrical resistance will increases. The addition of electrical resistance will causes the voltage value to increase as they are directly proportional, and vice versa

Based on that principle above, the value shown in Fig 9 The data was gained from input channel 2 indicates that the strain gauge wire experience compressed force, so the electrical resistance will decrease and causing its voltage to decrease as well

While in Figure 10, the data obtained from chanel no 5, strain gauge wire has experience extension

force (indicating the lathe part of the lathe that has withdrawal during cutting), so that the electrical resistance increases as well as the voltage increases.

From the data above, it can be seen that when cutting process happen there are side of chisel eyes experience an extention and at back side is shortend.

Based on the data of the lathe result shown on channel 2, the voltage value is 0.014348 Volt after enlarged 1,000 times on the strain amplifier. It is mean that the actual voltage value that occurs is the value of the displayed resistance divided by 1,000.

To obtain the value of the Cutting force, then the value of the voltage is converted into a force value using eq 1.

By using the conversion factor as in Eq 1 above, for the measurement voltage in chanel 2 of 0.014348 volts, obtained a cutting force as 12,052 N

## 5. CONCLUSION

The Strain Gauge Dynamometer has been produced with Technical specifications as follows:

- Strain Amplifier with 1000 gain
- Acquisition Data Jmida MF 126
- Material Base strain gauge aluminum, with overall dimension diameter 32 mm and length 20 mm
- Material Base holder ST-37, with dimensions 100 mm iong and 100 mm wide
- Material Case chisels ST-37, with dimension length 30 mm, thickness 8 mm and height 28 mm.
- Strain gauge used with type of a resistance of 350 ohms.

## 6. ACKNOWLEDGEMENTS

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