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ANALYSIS OF RESIDUAL STRESS AND STRAIN ON THE FORMATION OF WORKPIECE BASED ANSYS 12.1

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ABSTRACT

Machining process to produce plastic deformation on the workpiece. Plastic deformation during the machining process are formed by friction against the cutting tools to workpieces generate furious. During the deformation process appearance residual stress on the surface which can affect the fatigue resistance, fracture strength, and corrosion. Failure in the component structure is not only due to external forces, residual stress is an important parameter in this case. The purpose of this study to analyze the residual stresses that occur on the workpiece from turning process. In the analysis performed using the Finite Element Method (FEM) with the software to obtain the desired results by entering input data including modeling of cutting tools and the workpiece. The result is a visual overview of the residual stress in the workpiece and areas of plastically deformed as a result of feeding from the cutting tools motion. 2D visual modeling using the software Ansys 12.1 with three comparison rake angle 5º, 10º.15º to determine the result of the residual stress on the surface of the workpiece

Keywords: residual stress, deformation plastic, machining processes

1. INTRODUCTION

Machining processes using machine tools one of which is the process of turning. Lathe works by rotating the workpiece and then cutting tool cut workpieces wrenching moving parallel to the spin axis on a lathe. Their motion with a cutting tool cut workpieces generate chip and lead to plastic deformation in the workpiece. Uneven deformation can generate residual stress on the surface. The residual stress is the stress that works on the material after all the forces acting on the outside of the material removed. The presence of residual stress can be beneficial or detrimental depending on the state of the material, the magnitude and direction of residual stress. The residual stress is not obvious but very important role in the reliability of a product. To measure the amount of residual stress generated by lathing process can be calculated using the approach of the Finite Element Method (FEM) and computational methods to simulate into the computer with the help of software. where each element is connected to the nodal. To get the closeness results in the analysis of the actual situation depending on the number of elements to be shared. With the Finite Element Method is the right method to understand in detail the formation and development of residual stresses in the machining process. An analysis on the workpiece or cutting tool currently is very important for the machining

process, because it can determine the outcome of the machining process itself. The quality of the workpiece obtained from lathing process is affected by the presence of residual stresses. With the formation of residual stresses affect the fatigue life, corrosion resistance, and fracture strength of the product.

Machining Process is the most cutting excess material with machine tools intended to form the desired product. Machining process is a continuation of the casting, and forging. Machining processes are often made in the manufacturing industry is the process of turning, shaping, drilling, milling, and the grinding. In the process of turning the workpiece gripped by using a chuck and rotates on an axis, chisel cut axial and radial moving direction of the workpiece, causing cuts and produce a surface that is concentric with the rotary axis of the workpiece. Schematic of turning process where (n) is the main shaft rotation, (f) is a funeral, and (α) is the depth of cut [8].

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Residual stress can be generated in the structure of the components during the manufacturing process such as machining, heat treatment, shot peening and others, affecting fatigue resistance, fracture strength, and corrosion. The residual stress is the stress that works on the material after all the forces acting on the outside of the material removed. The presence of residual stress can be beneficial or detrimental depending on the state of the material, the magnitude and direction of residual stress. The failure of the structure or component is not only due to the force of external components. The residual stress is an important parameter in this case. By increasing the amount of residual stress can affect the mechanical properties and structure of the material. For example, in the manufacturing process, the incidence of residual stress will have a positive effect as increasing the fatigue limit in the case of compressive stress on the surface. Or it can have a negative properties such as reducing the corrosion resistance in the case of tensile residual stresses. Residual stresses can reduce the elasticity and can menyebabkam corrosion in materials. Other effects on residual stress can be seen in Figure 2.3. [14]

Residual stress plays an important role in the performance of the machining process. Therefore, understanding the residual stress generated in the machining process is an important aspect in understanding and quality of the output.

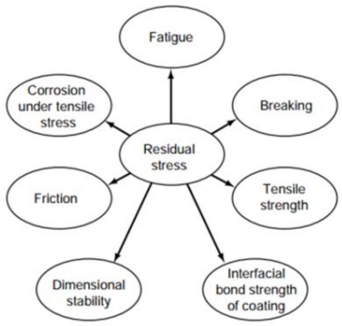

Figure 1 Effects of residual stresses in the material performance (Handbook Residual Stress)

2. METHODOLOGY/ EXPERIMENTAL

The method used in this research is the simulation of the machining process with a turning powered relevant literature. In this research, several phases of activities that aims to make the research can be running starts from the study phase to study the literature of the intent and purpose of this study by utilizing studies ever undertaken before. The next stage of collecting data relating to the workpiece residual stress of steel using FEM Simulation, with three differences rake angle 5º,10º,15º 2D. The data required includes determining the type of cutting tool used, the type of workpiece material and machining conditions used. After all the data is collected data are evaluated prior to the simulation process. The sequence of work on this study can be seen in the study flowchart in Figure 3.1 below

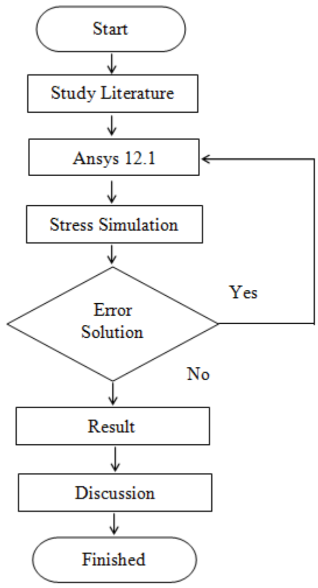

Figure 3.1 Flowchart of Research

Table 2.1 Material Properties [11]

Material	Density (Kg/m^3)	Young Modulus (Gpa)	Poison Ratio
Tungsteen carbide	13	600	0.15
Steel	8.49	180	0.3

3. RESULTS AND DISCUSSION

In this simulation process machining parameters to be used is based upon research that has been done before by Liu and Guo C.R Y.B. distinguishing parameters of this research is in the workpiece is used. Parameter C.R Liu and Guo Y.B using 304 stainless steel workpiece annealed with twice the cutting surface. While in this study using a steel workpiece and only one cutting using three corner rake angle. The machining parameters can be seen in Table 4.1. below this.

Table 4.1 Machining Parameters

Rake angle	5^0, 10^0, 15^0
Clearance angle	5^0
depth feed	0.3 mm
Cutting length	8 mm
Feed rate	0.2 mm/rev
Cutting time	1 s
Type	Orthogonal

After setup simulation then we can see the results of the simulation process residual stress that occurs between the contact cutting tool and workpiece. Results obtained in the form of von-mises stress, von-mises strain, residual stress in each respective rake angle. Simulation is displayed in 2D with every angle of rake angle ratio of 50, 10°, 150. The results shown by the region concentrated on cutting line of workpiece.

Rake Angle 5°
Von Mises Stress

The simulation results of von mises stress rake angle 5° indicates a maximum value of 5666.4 MPa. Maximum stress shown by the concentrated red area on the workpiece. The increase in stress due to the plastic deformation that occurs in the contact area cutting tool and workpieces during the machining process. The simulation results shown in Figure 3.1.

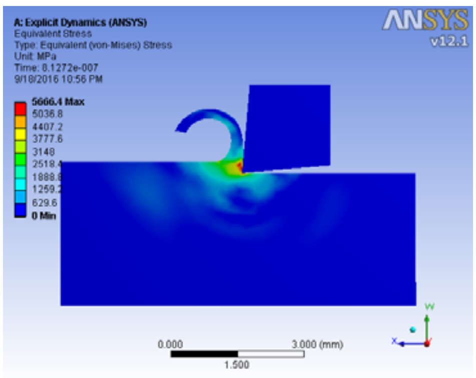

Figure 3.1 Von-mises Stress 5°

Von Mises Elastic Strain

The simulation results of Equivalent Elastic Strain showed a maximum value of 0.03148 mm / mm. the emergence of elastic strain due to external forces that will shape the workpiece deformation of the workpiece. The simulation results shown in Figure 3.2.

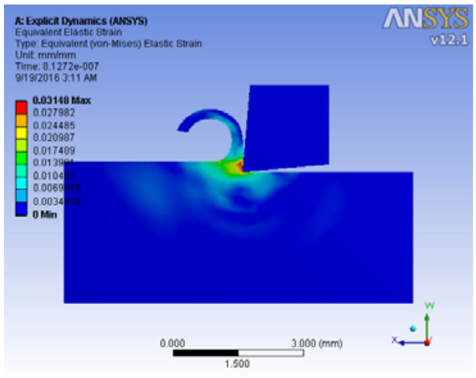

Figure 3.2 Von-mises Elastic Strain 5°

Residual Stress

The simulation results of Residual Stress shows maximum values of 780.6 MPa. This formation indicates the formation of deformation that the source of cracks in the workpiece. The simulation results shown in Figure 3.3.

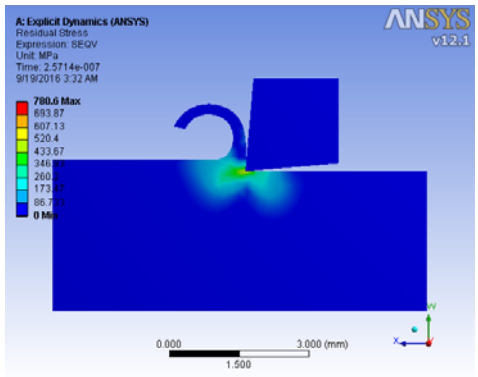

Figure 3.3 Residual Stress 5°

Rake Angle 10°
Von Mises Stress

The simulation results of von mises stress rake angle 10° indicates a maximum value of 5510.1 MPa. Maximum stress shown by the concentrated red area on the workpiece. The increase in stress due to the plastic deformation that occurs in the contact area cutting tool and workpieces during the

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machining process. The simulation results shown in Figure 3.4.

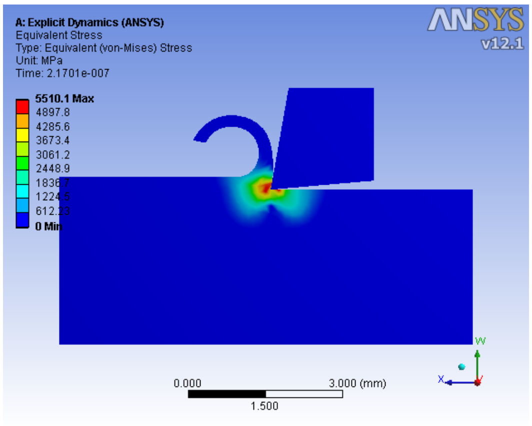

Figure 3.4 Von mises Stress 10º

Von Mises Elastic Strain

The simulation results of Equivalent Elastic Strain showed a maximum value of 0.02755 mm / mm. the emergence of elastic strain due to stretching as a result of having supplied stress of 5510.1 MPa. elastic strain is concentrated at the tip of the tool tip radius and angle of rake angle of the cutting tool. The simulation results shown in Figure 3.5.

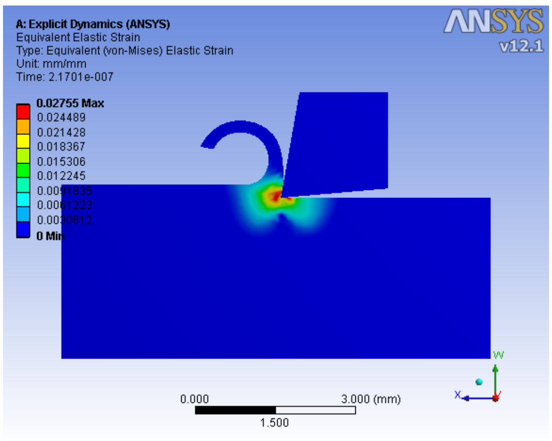

Figure 3.5 Von mises Elastic Strain 10º

Residual Stress

The simulation results of Residual Stress shows maximum values of 759.69 MPa. This formation indicates the formation of deformation that the source of cracks in the workpiece. The simulation results shown in Figure 3.6.

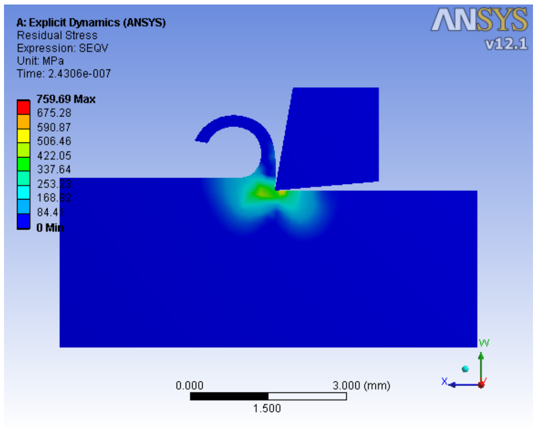

Figure 3.6 Residual Stress 10º

Rake Angle 15º
Von Mises Stress

The simulation results of von mises stress rake angle 15º indicates a maximum value of 5381.5 MPa. The increase in voltage due to the plastic deformation that occurs in the contact area cutting tool and workpieces during the machining process. The simulation results shown in Figure 3.7.

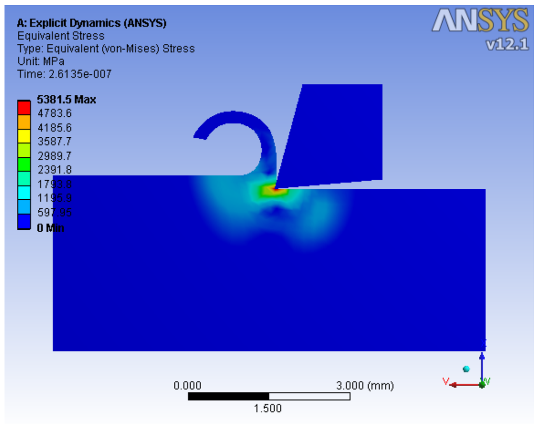

Figure 3.7 Von mises stress 15º

Von Elastic Strain

The simulation results of Equivalent Elastic Strain showed a maximum value of 0.00896 mm / mm. the emergence of elastic strain due to stretching as a result of having supplied stress of 5381.5 MPa. elastic strain is concentrated at the tip of the tool tip radius and angle of rake angle of the cutting tool. The simulation results shown in Figure 3.8.

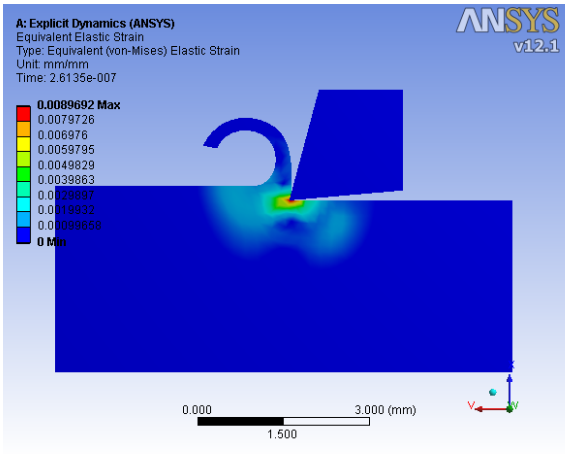

Figure 3.8 Von mises Elastic Strain 15º

Residual Stress

The simulation results of Residual Stress shows maximum values of 736.23 MPa. This formation indicates the formation of deformation that the source of cracks in the workpiece. The simulation results shown in Figure 3.9.

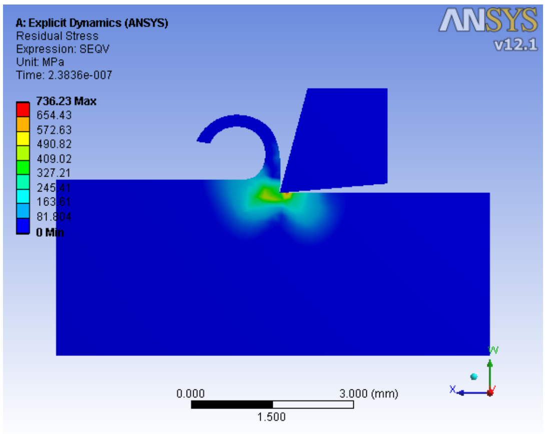

Figure 3.9 Residual Stress 15º

Based on the results of the simulation using Ansys 12.1 stress during machining process caused by contact between motion feed of cutting tool to workpiece. Given these contacts resulted in the emergence of plastic deformation to form the residual stress in the workpiece. As shown in the figure, the parts that have the stress concentration part is red.

The results of the simulation lathe with Rake Angle 5º, 10º, 15º, obtained the value of von mises stress, von mises elastic strain, residual stress. From each rake angle 5º, 10º, 15º. As shown in Table 4.3.

Table 4.3 Simulation result

Rake Angle	Von-Mises Stress	Von-Mises Elastic Strain	Residual Stress
5^0	5666.4	0.03148	780.6
10^0	5510.1	0.02755	759.6
15^0	5381.5	0.00896	736.2

In Table 4.3 looks impairment von mises stress, von mises elastic strain and residual stress of a rake angle of 5º, 10º, and 15º. Values decreased due to the amount of corners cut workpieces which means to increase the angle cut will lower the voltage that occurs between two objects will work but if too large will adversely affect the cutting tool itself.

Rated residual stress decreased due to the release of design the cutting tool. Machining parameters influence in the formation of residual stresses. Design of cutting tool a major effect on the residual stress generated. Workpieces experiencing residual stress will have an impact on fatigue life and corrosion in the material.

4. CONCLUSION

Based on the results of the simulation has been done it was concluded as follows.

1. Based on the results of the simulation parts that have large stress concentration contained in the motion feed cutting tool the workpiece.
2. Plastic deformation that occurs in the workpiece can form residual stress affects the strength and resilience of the workpiece.
3. In the simulation cutting tool tungsten carbide and steel can result in a decrease in the value of the von mises stress, von mises strain, residual stress decreased with chisel cutting rake angle design 5º,10º,200.
4. Rake Angle 5º obtained result Von Mises Stress-5666.4 Mpa, Von-Mises Elastic Strain 0.03148 mm / mm, Residual stress 780.6 MPa.
5. Rake Angle 10º obtained results of Von Mises Stress 5510.1 Mpa, Von-

Mises Elastic Strain 0.02755 mm / mm, Residual stress 759.69 Mpa.

6. Rake Angle 15º obtained results of Von Mises Stress 5381.5 Mpa, Von-Mises Elastic Strain 0.0427566 mm / mm, Residual stress 736.23 Mpa.
7. Design effect on cutting tool workpieces produced.

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