ANALYSIS OF SHAPER MECHANISM

A REVIEW REPORT

BY –GROUP 3

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1. INTRODUCTION

Machine tool design advancements have increased the overall rigidity of the machine frame, reducing vibration during cutting. When more aggressive cutting parameters are applied, this provides for even chip load in the cut and a reduction in noise. Furthermore, most new spindles are direct drive, which removes gear boxes and improves spindle dynamics. Makino spindles have evolved over the years by producing great power and torque, allowing for aggressive metal removal by improving horsepower/torque curves.

Main Parts of Shaper Machine

Improvements in machine structure design, spindle technology, and computer hardware/software have increased machine tools' high-speed machining capabilities over the previous few decades, allowing for higher metal removal rates and shorter cycle durations.

2. OBJECTIVE

- To perform a Explicit Dynamics analysis of Shaper Mechanism.
- Compare the result of Total deformation, Equivalent stress.
- Getting ready with the Machining with Planar 3D models developed in Solidworks and importing it into the Ansys Workbench for Explicit Dynamics analysis.
- Conducting the parametric study for other cutting tool velocity.
- Analyzing the result and developing the interference with different velocity.

3. METHODOLOGY

A explicit dynamics analysis is to be conducted for a machining with shaper machine for two different cases of cutting tool velocity: 2.9e+005 mm/s and 90000 mm/s. The simulation is aimed at finding the Equivalent Stress, Total Deformation and also User defined result to calculate the temperature of the body for the two cases.

GEOMETRY

The 3D assembly model of the machining with Shaper mechanism developed in SOLIDWORKS is shown in figure below:

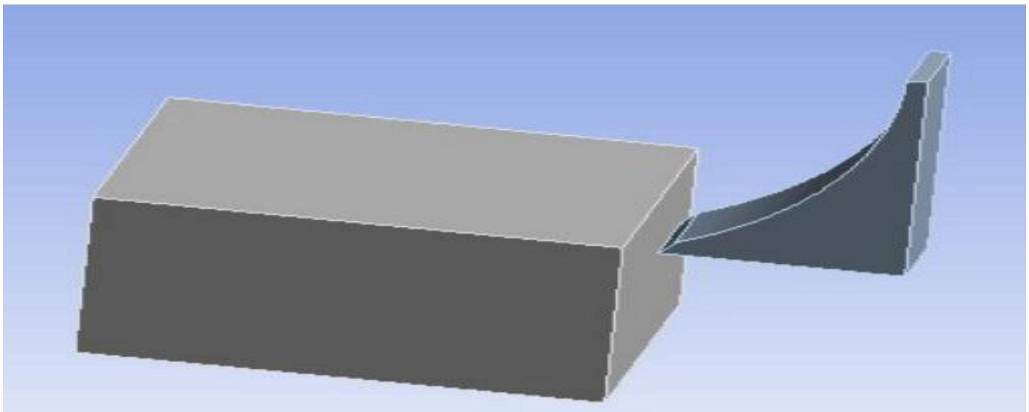

FIG 1.2: 3D Workpiece and tool

WORKPIECE:(AL 6061-T6)

TOOL:(Titanium alloy)

MESHING

An edge sizing of 10 divisions were allocated to the four corners of the workpiece thus leading to the formation of uniform element for the rectangular workpiece. For the Cutting Tool, a patch confirming technique is provided with the element method of Tetrahedrons due to its complicated shape. The total number of nodes and elements generated are 6557 and 10077 respectively.

Object Name	*Mesh*
State	Solved
Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Explicit
Element Order	Linear
Element Size	2.5 mm
Sizing	
Use Adaptive Sizing	No

Fig 1.3: Meshing details

BOUNDARY CONDITIONS

Fixed Support and Velocity for the tool.

For this analysis the number of steps is set to 1 with maximum number of cycles is 1e+07 and end time is 7e-4 and it is defined by time, hence initial, maximum and minimum time will be program controlled. The maximum energy error was set to be 2.

In order to simulate the motion, the workpiece was fixed on its bottom surface and the Cutting tool was made to move along x-axis with appropriate velocity for each case.

CONNECTION DETAILS:

The body intersection is set to be frictional.

Frictional - planer1-FreeParts To planer1-FreeParts.

Contact 3 faces and target bodies 5 faces bodies with frictional coefficient 0.3

4. RESULTS

- In order to accomodate the comparison of different cases with different cutting tool velocity, a parametric study was done which compares the maximum Total Deformation, Maximum Equivalent Stress and Maximum Temperature.
- The maximum stress at the end is 403.6MPa. According to the plots and data, we can observe that once the amount of stress hits 356.25 MPa, it is close to reaching it during the cutting time. Maximum stress can be visible along the cutting tool's edge, where chip production occurs throughout the cutting process.
- Due to the high speed cutting motion, the maximum temperature generated on the workpiece is 376.95 °C.

Velocity	Max. Total Deformation	Equivalent Stress
2.9e+005 mm/s	460.14 mm	356.25 MP
90000 mm/s	104.28 mm	403.6 MPa

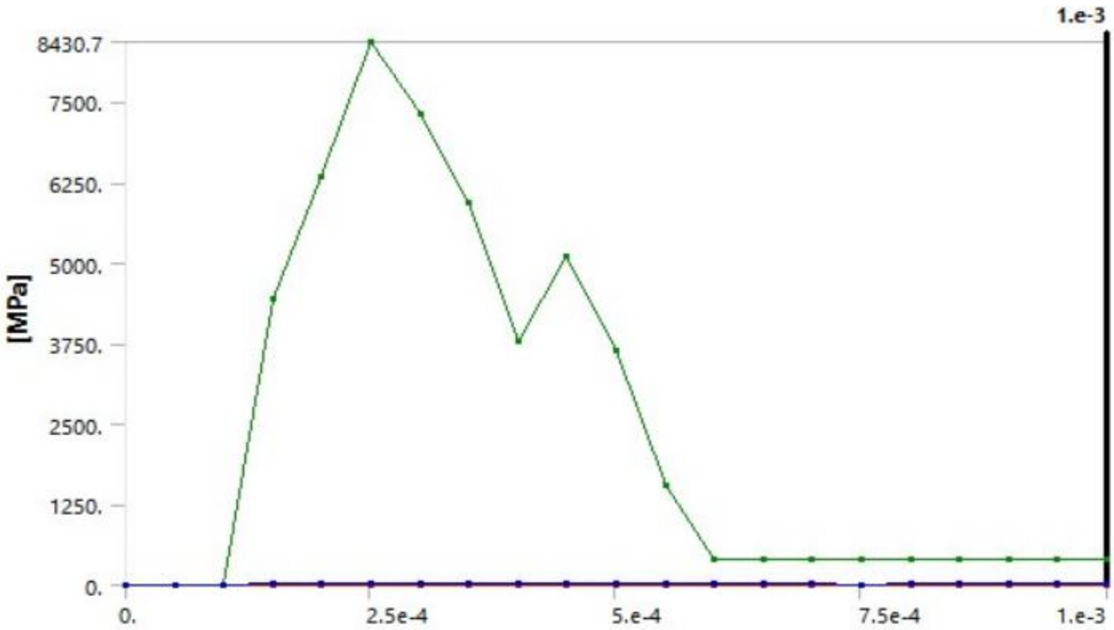

Fig 1.4: stress vs time (for velocity 90000 mm/s)

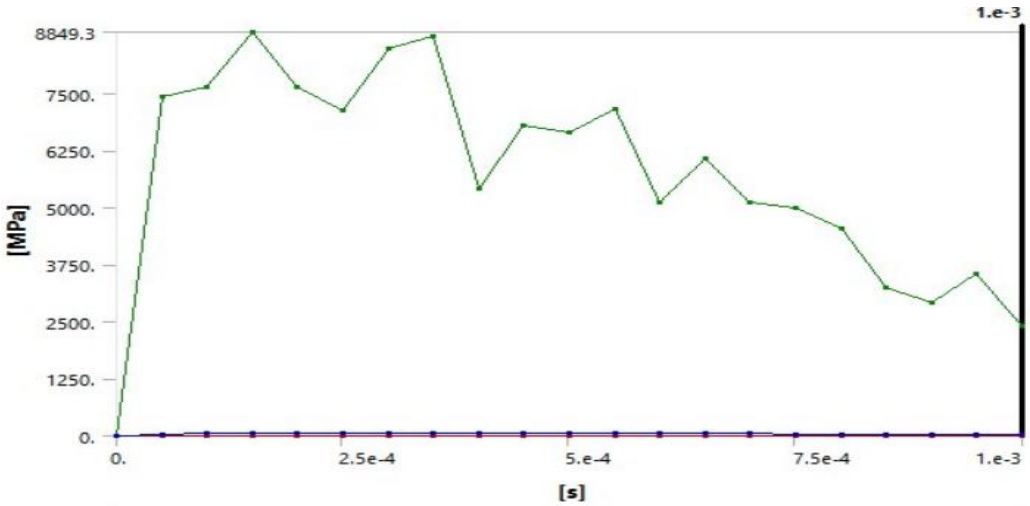

Fig 1.4: stress vs. time (2.9e+005 mm/s)

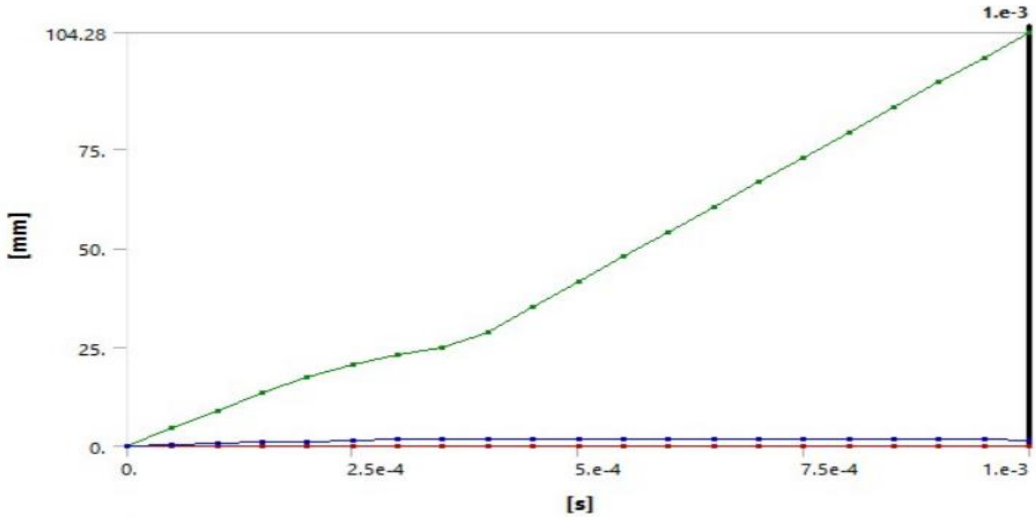

Fig 1.5: Deformation vs time(velocity 90000 mm/s)

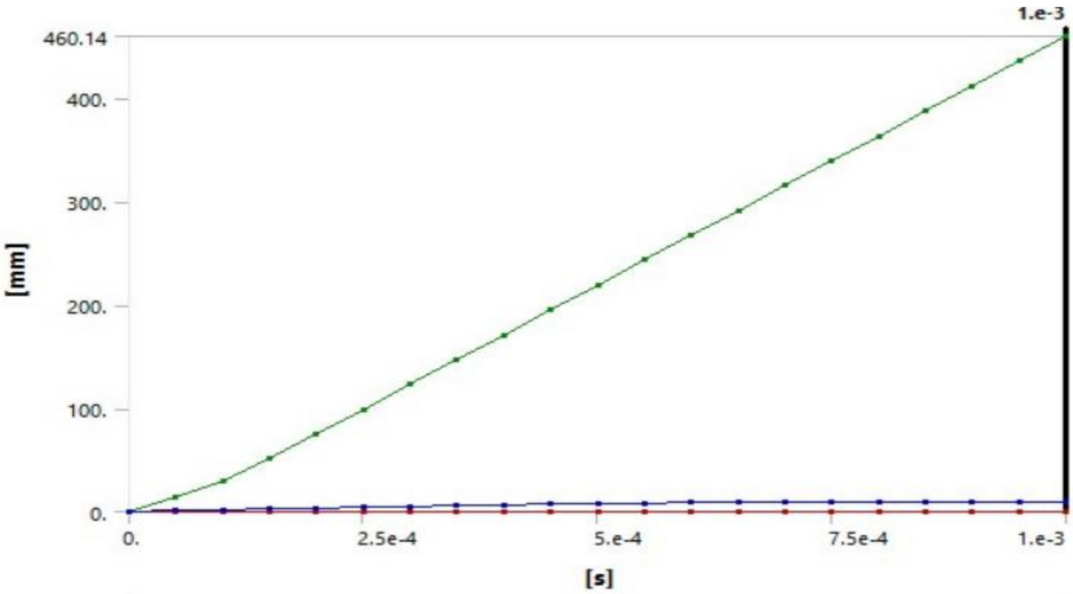

Fig 1.5:Deformation vs time (velocity 2.9e+005 mm/s)

5. CONCLUSION

- According to the results, high stresses will be generated during Shaper machining in the chip formation zone, secondary deformation zone, and on the machined surfaces. The sheer angle of the cutting tool influences the stress intensity and chip formation behaviour.
- Excessive temperature rise during the machining process occurs when the velocity of the cutting tool is low and stress is high, which can result in cutting tool failure or tool wear. The best cutting tool velocity can be determined by analysing different cutting tool velocity and reducing stress generation on the workpiece.
- With Ansys Workbench, a simulation of a mechanism of Machining with shaper was conducted for different cutting tool velocity cases. According to the analysis, for both the cutting tool velocity, the developed stress is greater than ultimate stress.
- Thus the cutting action takes place for both the cases. Higher the velocity of the cutting tool, lower will be stress developed on the tool which means lower effort required for higher cutting speed.