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# Numerical Analysis of drilling for Aluminium Grade IS 64430 (DIN – Al Mg Si 1)

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**ABSTRACT**: This research paper is about numerical analysis of drilling of aluminium grade IS 64430. There are many numerical packages for doing numerical analysis. We chose DEFFORM 3D software for finding torque while drilling. Initially 3 D model of drill is prepared. The user interface of DEFORM 3D is used to find out torque while drilling with different speed and feed. Meshed models of workpiece are used for analysis. Drilling process is simulated for different speed and feed with external cooling and torque for these conditions is found out.

**KEYWORDS:** Drilling, Deform 3D, Torque, Aluminium.

## I. INTRODUCTION

Machining operations such as turning, milling, drilling and grinding are material removal processes that have been widely used in manufacturing, since the industrial revolution of these processes. Drilling is one of the most common machining operations in manufacturing.

Due its versatility and computational power, the FEM is commonly used in the analysis of modern engineering and scientific systems. In this study, the FEM is used to model and analyze the drilling operation through the well-known finite element package DEFORM3D. The operation consisting of the U- drill and aluminum specimens. The resulting torque computed for various level of speed, feed, drilling cycle, insert and coolant to see their effects on quality parameter of work piece.

The numerical method of analysis is nothing but the Finite Element Approach to solve the problem by using any commercial software. The problem of drilling operation in this paper can be solved by using well recognized software's, like DEFORM3D. The numerical method gives an approximate solution. But as it avoid the costly destructive testing and the time required for the same is also reduced, it is widely used now days in industry. It also provides a good visualization of the system by simulation and good documentation of results for comparison & records.

[1]. Presented a 3D thermo mechanically coupled finite element model of drilling process of steel 2080 to study the influence of cutting parameter on thrust force and torque. The thrust force increased with increasing the cutting speed and feed. Changing the feed had an approximately linear effect on the thrust forces. But in case of torque, the effect of changing feed rate increased the torque more at higher speeds compared to that at lower speeds.

[2]. Focused on using finite element method (FEM) in process of cutting tool design of solid twist drill, especially for selection of point angle. Two models of solid twist drill with different point angles were created. These models were analyzed using commercially available FEM code AdvantEdge FEM. The main observed parameters were a chip shape and a magnitude of cutting forces. In order to evaluate a performance of real solid twist drill prototype experimental measurement has been conducted. The chips produced by real twist drill prototype were collected and cutting forces were measured by 4-component piezoelectric dynamometer KISTLER type 9272. These data were compared with results from numerical analysis in order to evaluate the accuracy of numerical analysis.

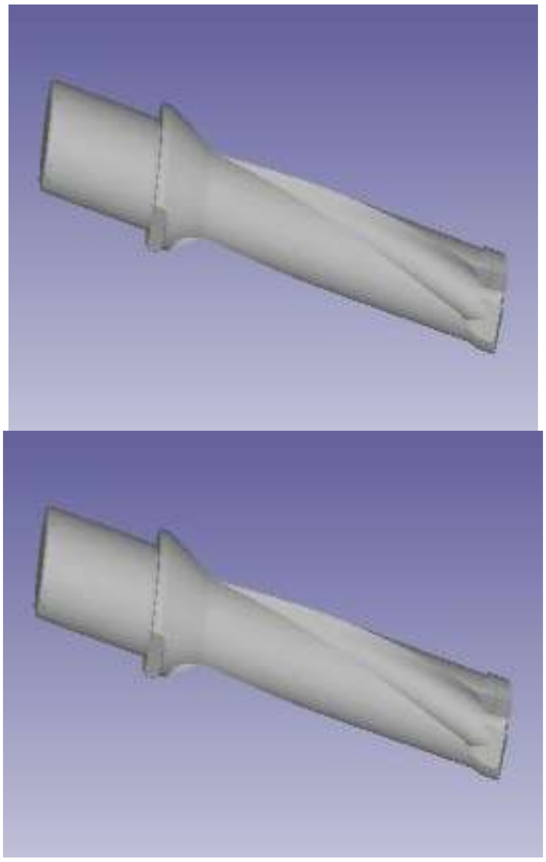
[3]. The Paper includes experimental determination of thrust force and torque occurred during drilling, and analysis of the effects of these cutting loads on cutting tool with the Deform-3D program based on finite element method (FEM). In order to improve the performance of the drill, the drilling operation was simulated and the relationships between cutting parameters and stresses were investigated using the Deform3D program. The results obtained from the study will

provide significant contributions to improving the cutting performance of the drill and to the selection of optimum cutting parameters. The stress analysis approach applied in the study can also be applied to other metal cutting operations such as turning and milling, and evaluations can be made regarding the design of cutting tools.

[4]. In this paper, a simulation procedure has been developed to study the cutting tool deflection in drilling process. Other than that, the objective of this study is to analyses the stress and deflection acting on cutting tool. Finite Element Analysis (FEA) has been used in this study which is Abacus software has been implemented in order to simulate and analyses the results. A three dimensional model of cutting tool has been develop and a force loading has been applied at the tip of cutting tool. Based on the simulation, it has been found, the deflection of cutting tool is related to the results of stress distribution and displacement along the path that has been created along cutting tool. In addition, it has been stated that the maximum stress distribute on the cutting tool can be seen from different color contour and the maximum value is 4.707e+03 which is occurred at the tip of cutting tool. While for the value of displacement, the maximum value is 1.640e-08. Lastly, by using finite element method, many parameters of cutting tool and drilling process can be studied to obtain the best cutting parameters and enhance the performance of machining process.

[5]. This paper takes BTA deep hole drilling as the research object. ANSYS software is used in the static and dynamic analysis of the force of BTA deep hole drilling process from theory and in modelling and simulation. Firstly, According to the finite element analysis, the most concentrated stress and the largest deformation of the cutting tool are the cutting edge and the cutting surface of the tool block. The main vibration of drill stem is in the form of twist and bending. Secondly, it is concluded that the main vibration of drill stem is in the form of twist and bending through the modal analysis. Finally, the natural frequency of this type of BTA drill stem is obtained by analysing the amplitude response curve, and it is suggested to avoid the rotational speed near the dangerous speed during machining to avoid resonance of the drill stem.

## II. SIMULATING DRILLING PROCESSES OF IS 64430 IN DEFORM-3D



**Drill model coated and uncoated.**

Due to the number of revolutions of a drill necessary to establish characteristic behavior, drilling simulations in DEFORM are time consuming. Therefore, every effort will be made to optimize problem size.

**Set Basic Simulation Controls**

The machining type is drilling, change units to SI, the rotate speed of spindle is 1000r/min, the feed rates is 0. 005mm/r, set working environment and properties of tool work piece interface: define the environmental temperature as 20, the shear 20℃ friction factor is 0. 6 and the heat transfer coefficient is 40 W/(m•K ).

**Defining the drill geometry.**

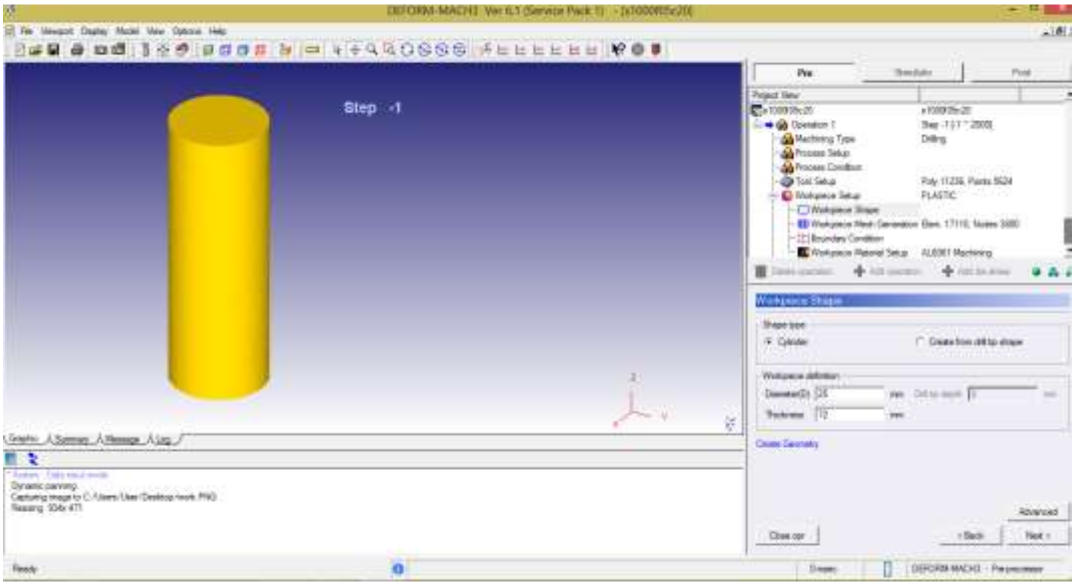
The model of indexable insert drill (U drill) can be created in unigraphics software. The material of tool is cemented carbide, and there is 3μm coating of TiN on the surface of tool.

**Defining the work piece geometry.**

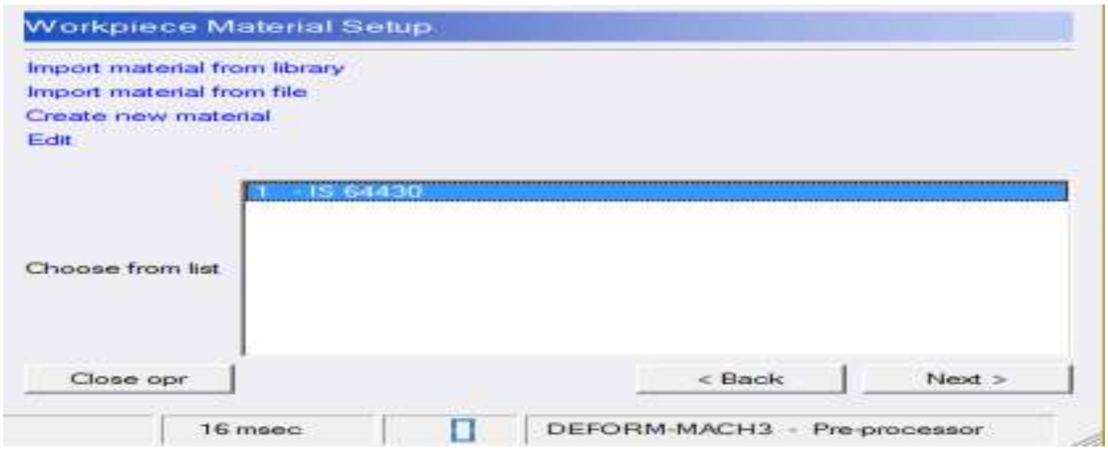
The process of drilling is so complicated that lead to the amount of calculation very great, in order to simplify calculation process and reduce the scale of the problem, the size of the work piece should be tried to reduce on the premise of meeting the simulation requirements of the condition. If the work piece shape is a simple cylinder, it can be created using the geometric primitives in DEFORM. So, we will establish a simple, solid work piece. The work piece will be round, with a radius of 25mm and a height of 72mm, the type of the work piece is plastic. So the work piece model has been established.

**Set Up a Finite Element Model of IS64430.**

As the material library deform 3D software provides do not include the model of IS 64430, a new material model need to be established. When a new material model is established, some parameters of material need to be entered: Young's modulus, Poisson’s ratio, Thermal Expansion Coefficient, Thermal Conductivity.




**Work piece geometry in DEFORM 3D**




**Work piece Material Setup.**

**Mesh the Object**

Meshing is an important step in the process of creating the FEA model, there are a lot of problems raised for consideration, this requires greater workload, the form of meshing has the direct influence on the computational precision and computational scale, and the numbers of the mesh will affect the precision and scale of the result. Generally, with the increase in the numbers of the mesh come an increase in the he precision and scale of the result, so, the numbers of the mesh can be determined by correctly weighing both aspects.

In the course of cutting simulation, DEFORM will regenerate a mesh dozens or hundreds of times as the material and mesh become distorted. The new meshes are generated based on user defined parameters to keep fine elements where they are needed for resolution, and place coarse elements in

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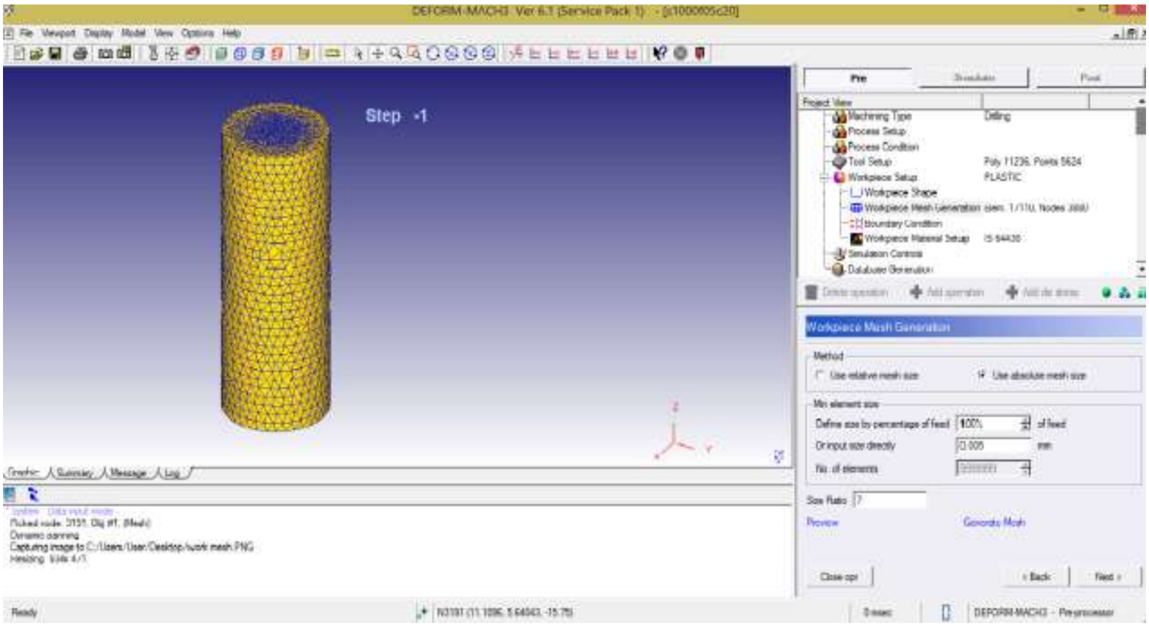
other areas. For work piece, the grid type is absolute mesh density, and the minimum element size is determined by the feed. For a U drill with 0. 05mm feed/revolution, the feed per cutting edge is 0. 1mm. To get two elements in the chip thickness, use a minimum element size of 0. 05mm. The size ratio sets the size of the largest elements, in areas where no refinement is required.

For IS 64430 cutting simulations, set size ratio to 10, larger size ratios may lead to substantial increases in the time required for mesh generation while the simulation is running. The tool mesh is not as critical as the work piece mesh. For a rigid object, the geometry is always maintained for deformation contact calculations. The mesh is only used for temperature calculations.




**Mesh of the Workpiece.**

## SIMULATION RESULTS

In DEFORM, the deformation is subdivided into hundreds or thousands of incremental time steps. The user defined time step gives the simulation a starting point for calculations. If it is too large, the simulation module will automatically reduce it to a more suitable value. For drilling, we would like to have about 1 degree of rotation per time step. We can round this off to about 300 steps per revolution.

The drill makes 1000 rev/min, which means 1 revolution takes about 16. 66 of a second. 16. 66 / 300 gives a time step of 0. 05553 seconds per step. So set the solution steps definition to with constant time increment, and assign a value of 0. 05553 sec. We can assume 40 mm of penetration is necessary for the drill to go completely through the work piece. At 5 mm/min, this means that seconds, or 20000 steps will be required to completely drill through this sample. Enter 20000 as the number of simulation steps. This is an estimate of the number of steps that will be calculated. Due to remeshing and automatic time step control, the actual number may be more. DEFORM will adjust for this automatically. However, a stopping control can be defined.

There are a large number of stopping controls which can be set in DEFORM. A simulation will run until it reaches one of the predefined stopping controls, or until it is stopped by the user. We will stop when the primary tool travel (the drill) reaches 5 mm in the direction of travel. Check up the data, there are no other errors or warnings, the database can be generated. After database generation is completed, exit database generation and the pre-processor.

### Define Boundary Conditions.

The environmental temperature is 200, set a value of 0. 6 as constant friction and set heat transfer coefficient to 40. The heat transfer convection coefficient is 20 N/sec/mm/C and the friction type is shear friction.

### Analysis of the Results.

The simulation of drilling is a highly nonlinear numerical calculation problem, which requires a rigorous element in the simulation, To ensure describe the interaction of time and torque

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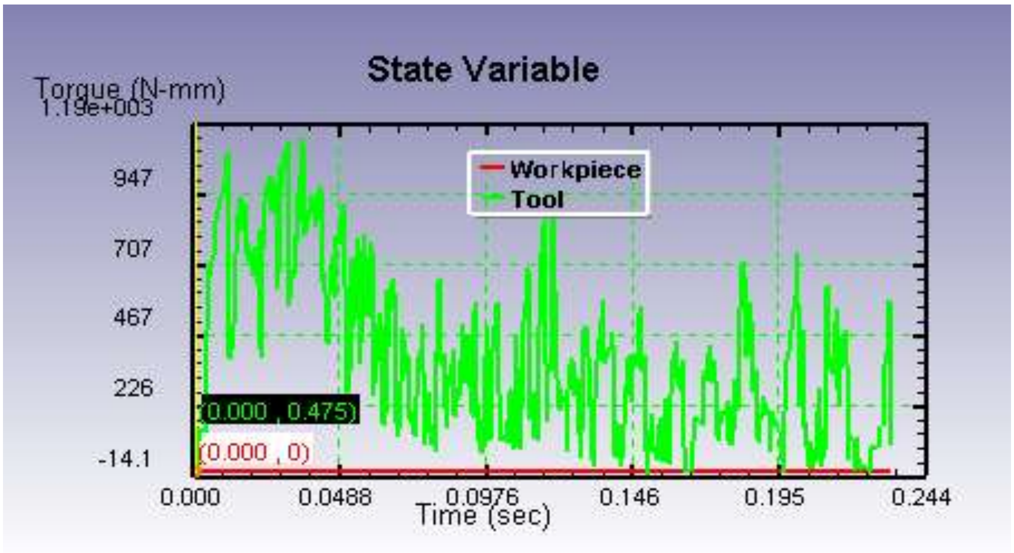
between cutting tool, work piece and chip adequately in drilling process, the elements must be small enough to meet the requirements of non-linear numerical calculations.

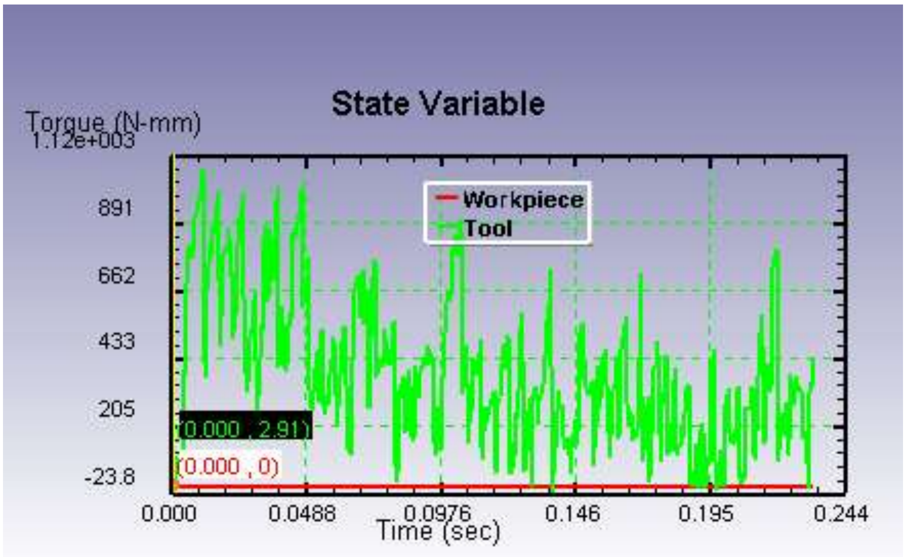
The drilling curve is divided into three periods as shown in in the initial period, the tool and work piece come into contact, since the great feed engagement, the contact between drill bit and work piece has just begun, the material hasn't been cut by cutting tool, the dramatic impact of cutting tool on the work piece lead resulting in the beginning of the drilling force is large and growing rapidly. In the second period, the drill bit began to cut the work piece, drilling force begin to decline, the curve tends to continue to rise after a short gentle. In the last period, with the drilling stabilize, curve become gentle but continued volatility.

Following figure shows that during drilling process initial torque required is more after few second it decreases. Initial maximum torque is 1190 N mm and average minimum 467 N mm.



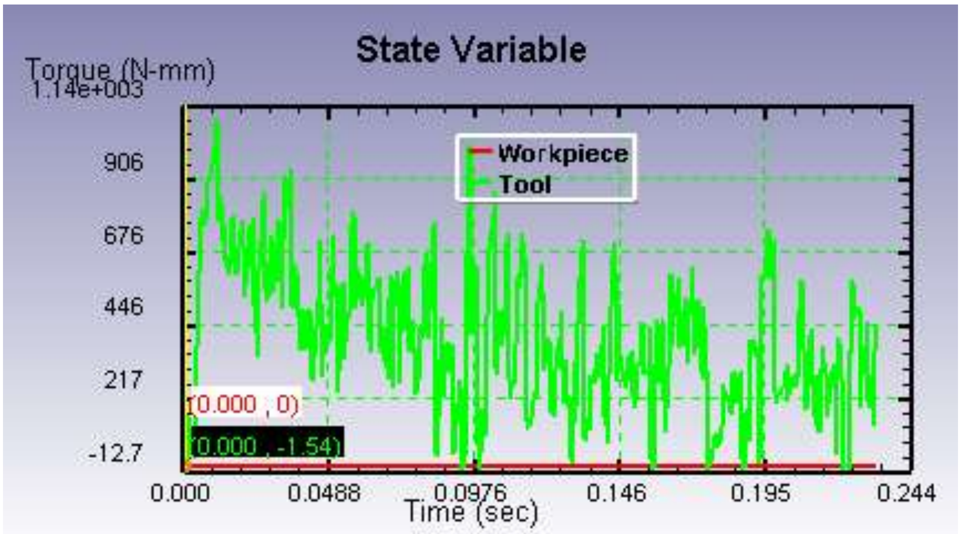

**Torque Vs time for Speed = 1000 rpm, feed = 5mm/min and external coolant.**

Figure below shows that during drilling process initial torque required is more after few second it decreases. Initial maximum torque is 1120 N mm and average minimum 433 N mm.



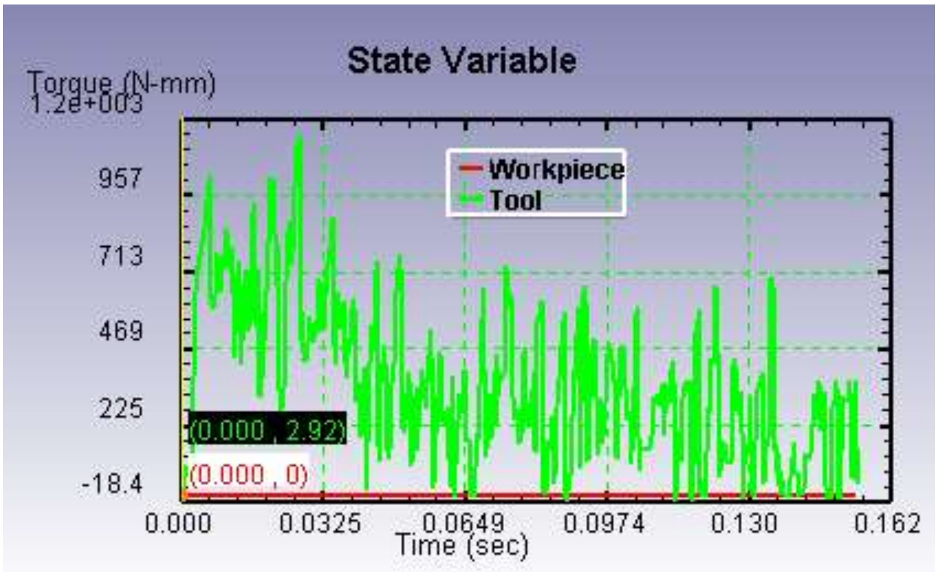

**Torque Vs time for Speed = 1000 rpm, feed = 10mm/min and external coolant.**

Below figure shows that during drilling process initial torque required is more after few second it decreases. Initial maximum torque is 1140 N mm and average minimum 446 N mm.




**Torque Vs time for Speed = 1000 rpm, feed = 15mm/min and external coolant.**

Below figure shows that during drilling process initial torque required is more after few second it decreases. Initial maximum torque is 1200 N mm and average minimum 469 N mm.




**Torque Vs time for Speed = 1500 rpm, feed = 5mm/min and external coolant.**

Below figure shows that during drilling process initial torque required is more after few second it decreases. Initial maximum torque is 1240 N mm and average minimum 490 N mm.

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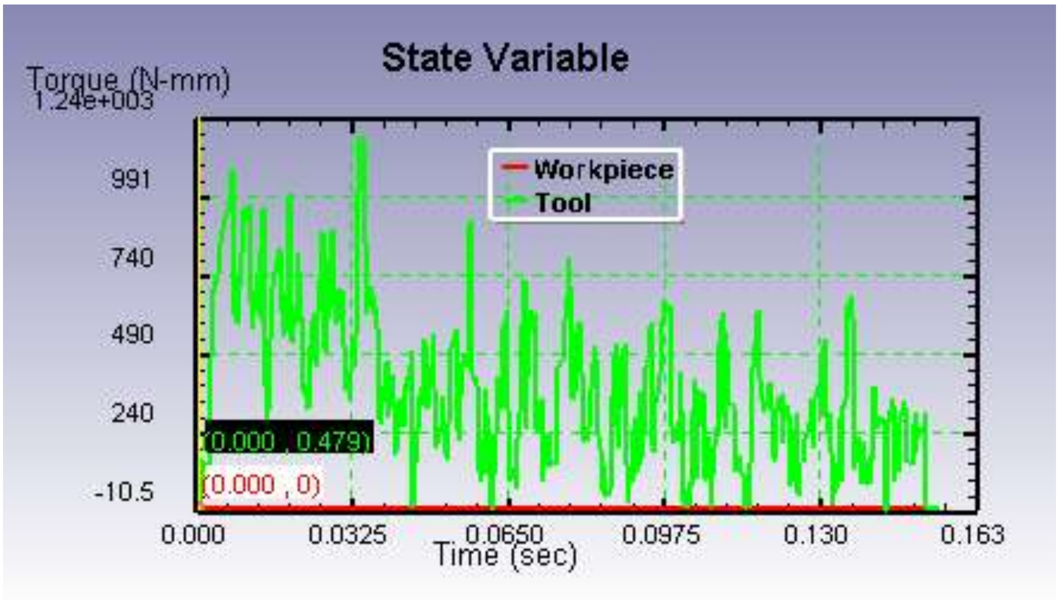
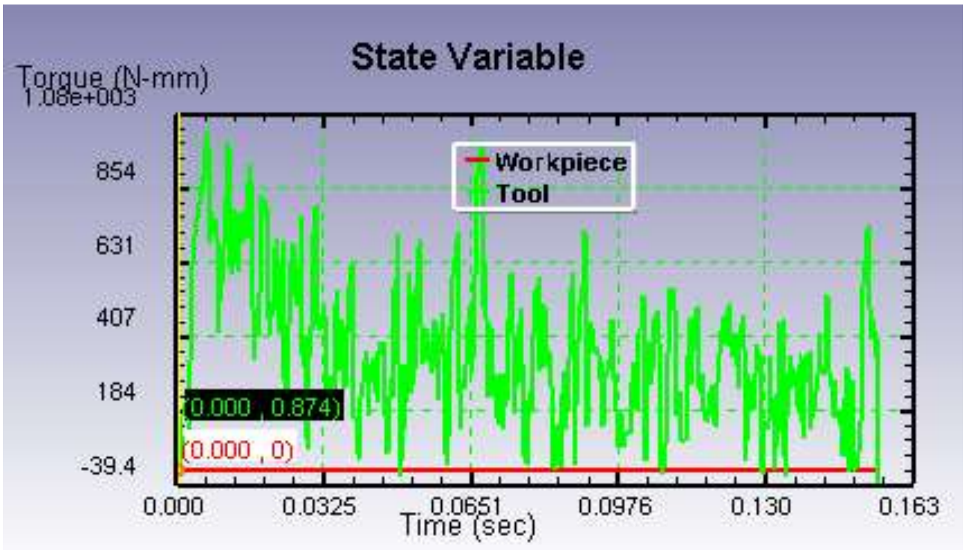



**Torque Vs time for Speed = 1500 rpm, feed = 10mm/min and external coolant.**

Below figure shows that during drilling process initial torque required is more after few second it decreases. Initial maximum torque is 1080 N mm and average minimum 407 N mm.




**Torque Vs time for Speed = 1500rpm, feed = 15mm/min and external coolant.**

## III. CONCLUSION

Numerical analysis of any machining process can be done to replace actual machining process. DEFORM 3D software can be used to simulate drilling process. Torque during drilling process can be found out using DEFORM 3D package. 3D model of the drill and Meshed work piece is used to simulate the process. Initially with different combinations of speed and feed with external coolant the drilling process was simulated for particular time period and then results for torque are observed. Following conclusions are drawn after simulation process

i. For 1000 rpm:
a) With 5mm/min feed: Maximum torque is 1190 N and average torque is 467 N
b) With 10 mm/min feed: Maximum torque is 1120 N and average torque is 433 N
c) With 15 mm/min feed: Maximum torque is 1140 N and average torque is 446 N
ii. For 1500 rpm:

a) With 5mm/min feed: Maximum torque is 1200 N and average torque is 469 N
b) With 10 mm/min feed: Maximum torque is 1240 N and average torque is 490 N
c) With 15 mm/min feed: Maximum torque is 1080N and average torque is 407 N

## REFERENCES

[1]. Naseer Ahmed "Effect of Changing Drilling Parameters on Thrust Force and Torque" Middle-East Journal of Scientific Research 21 (2) : 347-352, 2008.
[2]. P.Roud, J. Sklenicka, Using Fem In prediction of chip shae and cutting orce when drilingmaterial with different machinability, Advance in manufacturing science and technology Vol.35, No.3,2011
[3]. Abdulkadir Yıldız, Abdullah Kurt, Selçuk Yağmur,Finite element simulation of drilling operation and theoretical analysis of drill stresses with the deform-3D,Simulation Modelling Practice and Theory,Volume 104,
[4]. Muhamad Afiq Abdul Aziz, Haslina Abdullah, Numerical Study of Drilling Process Using Finite Element Method, Research Progress in Mechanical and Manufacturing Engineering Vol. 2 No. 2 (2021) 104-111, 2021.
[5]. Xin Liu and Yazhou Feng 2019 IOP Conf. Ser.: Mater. Sci. Eng. 611 012021