# Dynamic Analysis of Drilling Burr Formation Process

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***Abstract*--In the present scenario of manufacturing industries minimization of cost of the product plays a vital role. In most of the drilling operations, the burrs are formed. The burr formation, adversely affect the quality of the drilled hole. We require an additional de-burring and surface finishing process, which requires 30% of the total cost of the product. So, the minimization of burr formation having a bigger role to play in the quality of the drilled hole. The objective of the work is to develop a 3D -finite element model for the simulation of drilling burr formation process. Based on the series of stress contours and the progressive deformation of the work piece edge obtained from simulation, a drilling burr formation mechanism was developed. The FEM simulation demonstrates the effect of the feed rate in the drilling burr formation process.**

***Keywords*: de-burring, FEM, burr formation, drilling**

## I. INTRODUCTION

Burr is a plastically deformed material, generated during cutting or ploughing. Burrs formed in drilling can be classified into entrance burrs and exit burrs. The entrance burr is formed around the hole when the drill enters into the material. The exit burr is formed on the other side, when the drill pierces the material and pushes out the uncut material. Exit burrs strongly affect the product quality and assembly process, sometimes necessitating an additional procedure results in deburring process. This additional procedure results in the high cost of the edge finishing of precision parts. Burr size depends on several cutting conditions such as cutting velocity and feed rate. Drill shape, point angle, helix angle and length of the chisel edge etc., viii influence on cutting force, whole accuracy and burr formation as well. In this paper the simulation of drilling burr formation is considered on the effect of feed rate. Drilling is a machining process by which a hole is produced or enlarged by the use of a specific type of end cutting tool called the 'drill'. It is usually the most effective and economical method of producing holes in solid materials. Drilling of holes can be regarded, as one of man's earliest machining achievements and it is one of the most widely used manufacturing processes. However, in spite of its economic significance, not many changes were made in the geometrical shape of a drill point. It is only in recent years that considerable development has taken place to evolve more efficient drill

Designs, newer tool materials, productive methods of manufacturing drills and better methods of sharpening the drill point Twist drills are continuing to gain greater acceptance for critical hole making operations in the metal working industry. It's easy to see why. Every shop and plant needs to maximize productivity and improve product quality. Today's advanced machine tools have the capability to exploit high performance cutting tools.

## II. LITERATURE

In most of the drilling operations burrs are formed as the drill exits the work piece. The presence of these exit burrs requires additional manufacturing steps for disassembly and deburring. These additional steps are typically difficult to automate and are usually performed manually.

Gillespie et al points out that deburring and edge finishing can amount to as much as 30 percent of the cost of the part. These additional deburring steps represent an enormous cost to the manufacture of aircraft where the drilled holes can easily number in the hundreds of thousands per plane. Inspite of the costs associated with burrs and the prevalence of drilling operations. The formation of burrs in drilling has received little research attention. Ti et al has been classified as difficult-to-machine material. Seven reasons were listed by Yang and Liu. Among these reasons, the first is its poor thermal conductivity. Since the work piece will not help getting out the heat generated in machining, the heat tends to concentrate at the cutting edge, causing the edge temperature to easily reach 1000ºC. This will result in short tool life. The second reason is its strong affinity to many tool materials (especially at high temperatures) Dornfeld et al., Kumar, This will also cause rapid tool wear. Furthermore, because Ti can retain its hardness and strength at high temperatures, the force and stress on the cutting edge will be higher. This can potentially cause some tools to fail. Therefore, Ti machining usually encounters the problems of high tool wear rate, high machining cost, and low productivity. There is a crucial need for cost-effective machining processes applicable to Ti.Li et al Reported that WC-Co drills performed better than HSS tools because of lower thrust force and torque. The WC-Co spiral drills (a kind of twist drill with advanced geometric design with S-shaped chisel edge and lower negative rake angle than that of the conventional twist drill) produced lower cutting force and torque than WC-Co twist drill. Kim et al reported that, when drilling Ti/graphite stacks, the torque with HSS-Co tools was at least 40% higher than that with carbide tools.

## III. TYPES OF BURRS

Depending on the specific machining operation being performed and all of the variable parameters discussed previously, different types of burrs can form. The following four different burr formation types have been identified in the literature as: a Poisson burr caused by material bulging under compression, rollover and tear burrs formed by a chip being pushed or torn away respectively instead of sheared, and a cut-off burr caused by raw material separating before a separation cut is finished.

Three different kinds of drilling burrs, all of which are rollover burrs, have been identified. They include the following a uniform burr, which is small and even around the hole; a crown burr, which is tall and jagged, and a rolled-back burr, which is long burr material that has rolled under itself.

In "Type A" is a small uniform drilling burr, "Type B" is a large uniform burr, and "Type C" is a crown burr. Typical drilling burr in aluminium, similar to the ones observed in the current study as can be seen, the burr most closely resembles a uniform burr, despite the fact that the burr thickness is somewhat variable around the diameter of the hole. This variability reflects the fact that burr formation is very random, and will generally form in a slightly different way for every hole.

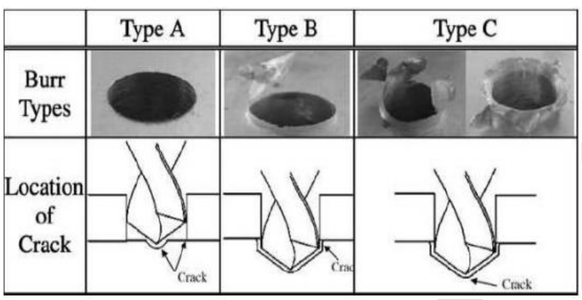


Figure-1. Types of burrs

## IV. BURR PROBLEMS

Some of the main problems associated with burrs are that they cause misalignment between adjacent parts and can reduce the fatigue properties of assembled systems. Other problems include the introduction of stress risers in critical areas, operator danger of getting cut by sharp burrs, and poor part aesthetics.

Additional problems are caused when burrs break off and move between assembled parts. For example, because burrs are typically harder than their parent material due to strain hardening effects, the relative motion of the burr trapped between mating surfaces can cause cracks to form. Broken-off burrs can also cause interference with other product operations, such as shorting out electronic equipment. For industrial situations, however, the main negative effect felt by burrs is the cost of deburring operations. Although deburring costs vary depending on the specific application and deburring method used so theSimulation of drilling burr formation is considered on the effect of feed rate.

## V. FEM

Many finite element models have been developed to predict drilling burr formation. One model employed a 2D analysis based on temperature and stress distributions and verified the model using experimental data other models have employed a 3D analysis of burr formation. An example of a finite element model of drilling burr formation Vijayarghavan discussed how interlayer burr formation could be modelled and gave details regarding the necessary use of thermal and mechanical contact elements, failure, and crack propagation. Although no complete finite element model has been created for interlayer sheet metal burr formation like this thesis focuses on, finite element models have been used to study the effect of having a thick backup material against the machining exit surface. It has been found that the use of a backup material, or more specifically a backup material level with the predefined machined surface, is the best way to minimize burr formation, due to the fact that it does not allow any room for a burr to form and provides a force that opposes the plastic deformation of burr material.

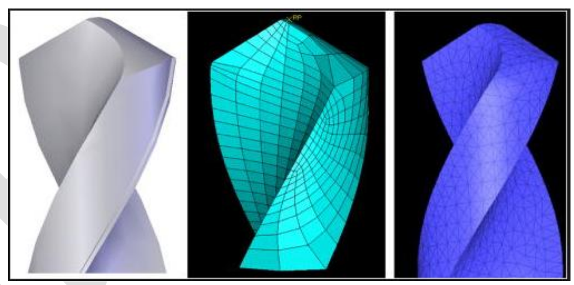

Figure-2. FE Modelling of drill

## VI. ANALYSIS

Finite element analysis is a process, which can predict deflection, and stress on a structure. Finite element modeling divides the structure into a grid of elements, which form a model of the real structure. Each of the elements is a simple shape (such as a square or a triangle) for which the finite element program has information to write the governing equations in the form of a stiffness matrix. The unknowns for each element are the displacements at the node points, which are the points at which the elements are connected.

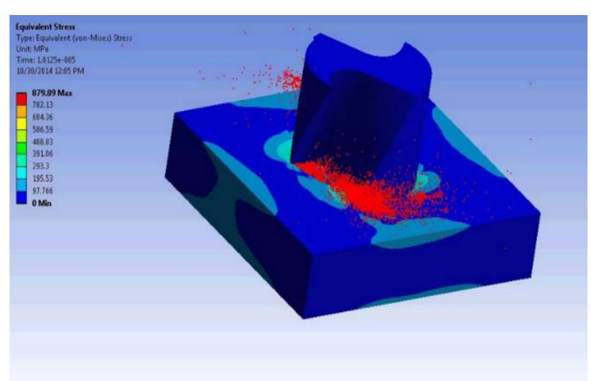


Figure-3. Trial run model

## VII. CONCLUSION

A 3D finite element model was developed for simulating drilling burr formation. FE analysis using ANSYS software can be used to calculate the stress distribution of the work piece. The model is used for analysis by varying the feed rate, for which the series of stress contours and deformation are plotted as for a trial run.

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