Review of Single Point Cutting Tool By Variable Depth of Cut Through Finite Element Method

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Abstract- *This paper highlights the effect of the temperature and cutting forces generated on the tip of the Single Point Cutting Tool (SPCT) while working. During reviewed seen the problem related to heat generation on workpiece and tool as well and the temperature measurement is done by using thermocouple at various depth of cut and it found that the temperature increases with increase in depth of cut.Specifically, three different analysis was compared to an experimental measurement of temperature in a machining process at slow speed, medium speed and at high speed. In addition, three analyses were done of a High-Speed Steel and also of a Carbide Tip Tool machining process at three different cutting speeds, in order to compare to experimental results produced as part of this study. The software analysed the model by finite element analysis at various forces and calculated the stresses developed at the tip of the tool and also the deformation of the tip of the tool. In Finite element analysis of single point cutting tool the maximum stresses are developed at the tip of tool which is the main cause of failure. Also the maximum deformation takes place at the tip of tool which blunts the tool, is the cause of failure. the experimental results reveal that the main factors of the increasing cutting temperature are cutting speed (V), feed rate (S),and depth of cut (h), respectively. It was also determined that simultaneously change in cutting speed and federate has the maximum effect on increasing cutting temperature. Much research has been undertaken into measuring the temperatures generated during cutting operations.*

Keywords- Single Point Cutting Tool (HSS), temperature, cutting forces, stresses, Finite Element Analysis, Solid Modeling, ANSYS.

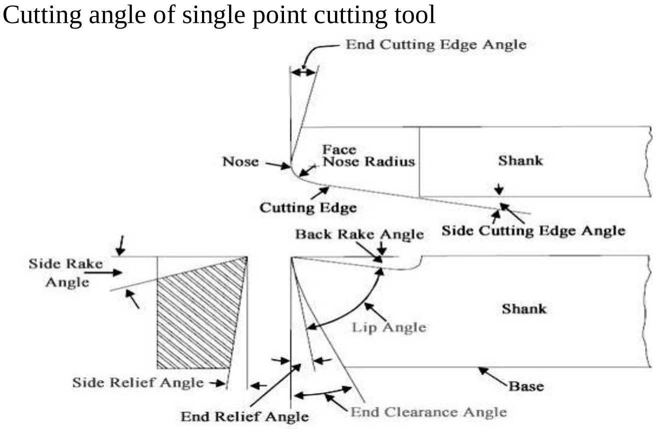
I. INTRODUCTION

The material removal may be through direct shearing as in machining or through abrasion, erosion or chemical action as observed in non-conventional machining forms. Cutting devices assume an essential part in assembling by machining. Cutting tools might be considered under two broad heads, single point cutting tool or multi point cutting devices. Multi-point cutting tools find application limited to generate high surface finish. Metal machining using a single point cutting tools stands as one of the most versatile and commonly adopted metal removal process in manufacturing industries. Recent developments in engineering materials and pressing demands to achieve higher productivity in the global manufacturing arena have resulted in concentrated research in the field of cutting device materials. Metal cutting or machining is the way toward delivering work piece by removing unwanted material from a block of metal, as chips. This procedure is most imperative since every one of the items get their last shape and size by metal evacuation, either specifically or indirectly. The significant disadvantage of this procedure is loss of material as chips.

1.1 SINGLE-POINT CUTTING TOOLS

A SPCT insinuates mechanical assembly to turn, molding, organizing, boring et cetera. that has one shank (or body) and one cutting component as a cutting edge toward one side. This cutting edge is frequently intended to be toward one side of a strong bit of steel, either framed or as an embed, held to the body of the instrument by brazing, welding or mechanical means. They are regularly utilized as a part of machines, shapers, planers and comparative machine devices. Amid machining a solitary point cutting apparatus is given translatory movement while the activity is rotated or translated.

Cutting angle of single point cutting tool



Cutting angle of single point cutting tool

1.2 TERMINOLOGY OF SINGLE POINT CUTTING TOOL

Shank It is fundamental body of tool. The shank used to grip in apparatus holder.

Flank The surface or surface underneath the neighboring of the cutting edge is called flank of the gadget.

Face It is top surface of the gadget along which the chips slides.

Base It is really a heading surface of the apparatus when it is held in device holder or clamped specifically in a device post.

Heel It is the intersection of the flank and base of the apparatus. It is curved part at the base of the apparatus.

Nose It is the place side cutting edge and base cutting edge intersects.

Cutting edge- It is the edge on face of the mechanical assembly which removes the material from work-piece. The front lines are side cutting edge (significant bleeding edge) and end forefront (minor cutting edge)

Tool angles-Tool edges have incredible significance. The apparatus with legitimate angle reduce breaking of hardware, cut metal all the more productively, create less warmth.

Noise radius It give long life and great surface complete sharp point on nose is exceptionally pushed, and leaves grooves in the way of cut. Longer nose radius produce chatter.

1.3 CONCEPT OF RAKE AND CLEARANCE ANGLES OF SINGLEPOINTCUTTINGTOOLS

Tool geometry is essentially alluded to some particular edges or incline of the remarkable faces and edges of the gadgets at their cutting point. Rake point and clearance angle are the most significant for all the cutting devices. The rake point and clearance angles are appeared with figures underneath Rake edge (γ): Angle of Slant of rake surface from reference plane Clearance edge (α): Angle of slant of clearance or flank surface from the completed surface the rake edge has the accompanying capacity:

- It enables the chip to stream convenient way
- It diminishes the cutting power required to shear the metal and thusly expands the apparatus life and lessen the power utilization. It gives perception to the cutting edge.
- It enhances surface finish & Rake point might be sure, or negative or even zero as appeared in Figure 1.3

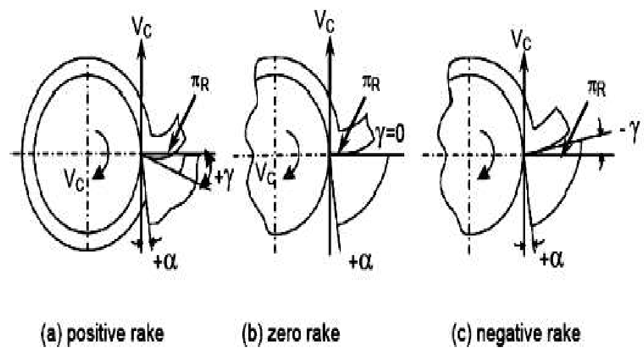


Figure 1.3: Different types of rake angle on tool

1.4 SOFTWARE USED

Analysis of all the designs is carried out with the help of ANSYS software. ANSYS is powerful simulation analysis and design software. ANSYS stands for the structural technique for look at and design which addresses every issue of structural engineering i.e. Version improvement, design, verification, and visualization. This is primarily based on the ideas of concurrent engineering. One can manufacture his model, check it graphically, perform analysis and design, survey the outcomes, sort and inquiry the data and can make a report inside similar illustrations depend climate.

II. LITERATURE REVIEW

INTRODUCTION

The literature review involves researching what other has written within the knowledge field of study of Single point cutting tool stress analysis. Insight and background knowledge obtained from the literature review was used to bring something innovative to the subject.

R.Manjunathan, et. al. (2022) Temperature at tool-chip interface of a single point cutting tool is determined, generated in different speed machining operations. Specifically, three different analyses are comparing to an experimental measurement of temperature in a machining process at slow speed, medium speed and at high speed. In addition, three analyses are done of a High Speed Steel and of a Carbide Tip Tool machining process at three different cutting speeds, in order to compare to experimental results produced as part of this study. An investigation of heat generation in cutting tool is performed by varying cutting parameters at the suitable cutting tool geometry. The experimental results reveal that the main factors responsible for increasing cutting temperature are cutting speed (v) and depth of cut (d) respectively. Various researches have been undertaken in measuring the temperatures generated during cutting operations. Investigators made attempt to measure these cutting temperatures with various techniques during machining.

Daniel Schraknepper, et. al. (2021) in this paper, a novel method for calculating stress distributions in the cutting wedge was developed, which considered residual stresses and tool wear. The condition of the surface layer of the cutting tool was accounted for by imposing measured residual stresses in the model. The tool geometry was defined considering flank wear. FEM simulations enabled good qualitative and partly quantitative analysis of the influence of residual stresses and tool wear in the surface layer of cutting tools.

NecatiUcac, et. al. (2019) The performance of an uncoated WC twist drill with a diameter of d = 5 mm was investigated experimentally and numerically during machining of Inconel 718. The tests were carried out under dry condition. During the tests, thrust force, torque, and temperature measurements were performed.

H. Katheriya,et. al. (2019) Temperature at tool-chip interface of one purpose cutter is set, enerated in numerous speed machining operations. Specifically, 3 completely different Associate in analyses are comparison to an experimental mensuration of temperature during a machining method at slow speed, medium speed and at high speed.

Praveen kumara et. al. (2018) the cutting forces at single point cutting tool-tip interface is determined, generated in high-speed machining operations. An investigation of cutting forces acting on the tool is carried out by subjecting it to the maximum possible working stress during a cutting operation. It is also determined that change in cutting speed and depth of cut has the maximum effect on increasing cutting forces. By varying the material the effect of those on cutting forces are compared with the theoretical results and FEA results. In this report, an FEM simulation technique is utilized to investigate the physical cutting and deformation of tip of single point cutting tool under the influence of cutting forces.

Hongmin Pen, et. al. (2018) A finite element method based on the cohesive zone model was used to study the micro machining process of Nano sized silicon-carbide-particle(SiCp)reinforced aluminum matrix composites. As ahierarchicalmulti scale simulation method, the parameters for the cohesive zone mode were obtained from the stress-displacement curve softhe molecular dynamics simulation. The model considers the random properties of the silicon-carbide-particle distribution and the interface of bonding between the silicon carbide particles and the matrix. The machining mechanics was analyzed according to the chip morphology, stress distribution, cutting temperature, and cutting force.

Abdiel Ramon Leon Bal A, et. al. (2017) This study presents numerical and experimental models for the analysis of the excavation of soft soils by means of a cutting tool. The computational model is constructed using an Updated Lagrangean (UL) velocity-based Finite Element approach. A hypo plastic formulation is employed to describe the constitutive behavior of soft soils. Large displacements and deformations of the ground resulting from the cutting tool-soil interaction are handled by means of the Particle Finite Element method, characterized by a global re-meshing strategy and a boundary identification procedure called a-shape technique. The capabilities and performance of the proposed model are demonstrated through comparative analyses between experiments and simulations of cutting tool-soft soil interactions.

Mr. Safal, et. al. (2016) This paper highlights the effect of the temperature and cutting forces generated on the tip of the Single Point Cutting Tool (SPCT) while working. In a experimental work, temperature measurement is done by using thermocouple at various depth of cut and it found that the temperature increases with increase in depth of cut. Cutting forces acting on cutting tool are determined analytically at different depth of cut. Modeling of single point cutting tool is done by PRO-Engineer Wildfire-4 software. The model is then imported in ANSYS software and meshing is done. Then the temperature readings and the forces calculated at different depths of cut are given as an input to the software. The software analyzed the model by finite element analysis at various forces and calculated the stresses developed at the tip of the tool and also the deformation of the tip of the tool.

I. Krajinovic, et. al. (2016) within this work, a state-of-the-art Arbitrary Lagrangian-Eulerian finite element model of a milling operation using coated hard metal cutting inserts is presented. During milling, the cutting depth constantly decreases, thus, to obtain the correct cutting depth, the model considers movement of the tool in a vertical direction. The behavior of the 42CrMo4 workpiece material is described using a standard Johnson-Cook material model. A detailed tool model able to represent both an uncoated and coated tool is created. The tool model is based on an industrial hard coated fine-grained hard metal tool with 8 wt.% Co. Three hard coatings are investigated: (i) an arc evaporated TiAlN single layer, (ii) a chemical vapor deposited TiCN/α-Al_2O_3 bilayer and (iii) a chemicalvapor deposited TiAlN/α-Al_2O_3

bilayer. An uncoated tool model is used as a reference to compare the results.

Wu Baohai, , et. al. (2016) Dramatic tool temperature variation in end milling can cause excessive tool wear and shorten its life, especially in machining of difficult-to-machine materials. In this study, a new analytical model-based method for the prediction of cutting tool temperature in end milling is presented. The cutting cycle is divided into temperature increase and decrease phases. For the temperature increase phase, a temperature prediction model considering real friction state between the chip and tool is proposed, and the heat flux and tool-chip contact length are then obtained through finit element simulation

Deepak Bhardwaj, et. al. (2014) The finite element method is used to study the effect of different rake angles on the force exerted on the tool during cutting. This method is attracting the researchers for better understanding the chip formation mechanisms, heat generation in cutting zones, tool-chip interfacial frictional characteristics and integrity on the machined surfaces. In present study, the three different rake angles are studied to find out the variation in values of Vonmisses stress for the specified applied forces. As we increase the rake angle then the value of Vonmisses stress goes on decreasing.

S. H. Rathod, et. al. (2013) In this report, we analytically predict and examine temperatures in tool-chip interface used in high speed orthogonal machining operations. Specifically, three different analysis was compared to an experimental measurement of temperature in a machining process at slow speed, medium speed and at high speed. In addition, three analyses were done of a High Speed Steel and also of a Carbide Tip Tool machining process at three different cutting speeds, in order to compare to experimental results produced as part of this study. An investigation of heat generation in cutting tool was performed by varying cutting parameters at the suitable cutting tool geometry and results were saved in computer; then the graph's of tool-chip interface temperature vs various cutting parameters were obtained. the experimental results reveal that the main factors of the increasing cutting temperature are cutting speed (V), feed rate (S),and depth of cut (h), respectively.

III. CONCLUSION

The work presented in this paper regarding the project highlights that as the depth of cut increases, the Von-Misses stresses developed in the tool increases. It is the main reason for tool failure, the deformation also on higher side with every interval of rise in depth of cut. Analysis has been carried out for two different materials such as Tungsten carbide and chrome steel. The outcomes for static auxiliary, for example, total deformation, equivalent elastic strain and equivalent stress for every material; it is additionally one reason for device failure. As per above study following conclusions are described below:

- When comparing across tool materials, by taking all the properties into account Tungsten carbide steel is best material as per given review.
- This study is useful to increase tool life and maximize the productivity.

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