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STRESS ANALYSIS SINGLE POINT CUTTING TOOL UNDER VARYING DEPTHS OF CUT: A CONCEPTUAL REVIEW

Deepesh Gehlot[1], Anil Elisala[2]
[1]Assistant Professor, [2]Research Scholar
[1, 2] BM College of Engineering and Technology, Indore (M.P.) INDIA

ABSTRACT

In modern times, manufacturing has leaded the world into new horizons to development and prosperity, and efforts to increase efficiency of machine tools and, in turn, productivity of the system is progressing day by day. In this context contribution of cutting tools cannot be overlooked. Considering these facts present research work is devoted to the survey of literature available for single point cutting tools regarding stress generation during operations, and conclude with the research gaps identified and objectives of the research work.

Keywords: Single Point Cutting Tools, Stresses analysis & Material Configuration

INTRODUCTION

Stress generation in cutting tools determine many parameters in manufacturing. Stresses generated during operations play important role and become one of the most governing factors to determine tool nomenclature. Stresses also limit the performance of tools for different depths of cut, and become determining factor for selection of particular tool for performing a particular operation. Considering all these facts present research is devoting to investigations of research gaps in the field of stresses generated in cutting tools, and objectives of the research realized from identified research gaps.

LITERATURE REVIEW

Table 2.1 shows the research contributions of different researchers in the field of cutting tools.

Table 2.1: Research Contributions in the field of Cutting Tools

S.No	Researchers (Year)	Contribution
1.	Hsieh (2010)	The angles of a cutting tool play a key role in deciding its cutting potency. However, once the tool has been mounted on a machine, setting errors inevitably cause the working angles of the tool to deviate slightly from the designed cutting angles. Consequently, this study develops mathematical models to investigate the interrelationships among the tool angles, the setting angles and therefore the operating angles. Within the projected approach, a process of homogeneous coordinate transformation is used to develop a kinematic model of the cutting tool such that the operating angles may be derived given the tool angles and setting angles. Mathematical formulae are then developed to reciprocally derive the tool angles required to get needed operating angles given prior information of the setting angles. An illustrative numerical example is given to demonstrate the validity of the proposed approach. Overall, the numerical results make sure that the methodology given in this study provides a comprehensive, simple and versatile means of modeling a range of typical single-point cutting tools.
2.	Sambhav *et al.* (2011)	The paper presents the analytical geometric details of the mathematical modeling of a single point cutting tool with a generic profile. The grinding angles and also the ground depths on the tool are allowed to vary along the tool flanks and face, fixing the cutting angles from point to point. The surface modeling begins with the creation of a tool blank model. Then unbounded surfaces are thought of and remodeled to urge the cutting tool surfaces. The intersection of these surfaces

		provides the whole model of the tool. starting from the fundamental model where the tool face and flank are planar, the generalization of the geometric design has been wiped out two steps to provide free-form shapes to the tool surfaces, termed because the two generations of the generic profile. Then a forward and inverse mapping has been conferred for the fundamental model and also the two generations of the generic tool to relate the grinding angles with the prevailing nomenclatures (ASA, ORS and NRS). The model has been validated and the variation of tool angles with the grinding parameters has been illustrated with an example.
3.	Orlowski *et al.* (2017)	The cutting force is an energetic impact of cacophonic material, and can be thought-about from a point of view of contemporary fracture mechanics. Forecasting of the shear angle in cutting broaden potentialities for modeling of the cutting process even for skinny uncut chips. Such mathematical model has been developed here for description of the orthotropic materials' cutting on the bottom of fracture theory, and includes work of separation (fracture toughness) in addition to the material plasticity and friction. the initial methodology of simultaneous determination of the fracture toughness and therefore the shear yield strength on the premise of wood cutting forces (or cutting power) is additionally conferred in this paper. The set of information necessary for computation is simply obtained whereas cutting wood with common rotating tools, such as a circular saw or a router bit. The results generated embody each fracture toughness and shear yield stresses in the shear plane, separately for two anatomical directions of wood. The simplicity and reliability of this methodology provides wide range of practical applications.
4.	Liu *et al.* (2017)	Orthogonal cutting may be a simplified two-dimensional model that neglects several geometric complexities, that describes complicated three-dimensional cutting method quite well in most cases. The orthogonal cutting ought to satisfy the plane strain assumption to stop the in depth deformation perpendicularly to the cutting direction owing to the pressure between the cutting tool and also the work piece, that is named as the side flow. To satisfy this assumption, the depth of cut (the uncut chip width) needs to be much larger than the feed (the uncut chip thickness) with a definite ratio. However, this criterion is not valid all the time. This paper presents an experimental study of the side flow with completely different cutting conditions by comparing the profiles of the cross section of the machined chip in machining of aluminum alloy. it is shown that the upper ratio between the uncut chip width and the uncut chip thickness (chip width-to-thickness ratio) and also the lower cutting speed will forestall the side flow during chip formation. a brand new criterion for plane strain assumption has been planned during this study as well.
5.	Garcia-Gonzalez *et al.* (2016)	Infrared thermography through transparent cutting tools has been accustomed measure the chip-tool interface temperature. It's of interest to increase this technique to review changes in interface temperature once tool coatings are used. an initial attempt is created here to measure the chip-tool interface temperature distribution once cutting Ti6Al4V with a TiN coated YAG tool. The TiN coating thickness is kept low at concerning 100 nm to minimize the temperature distinction between the front (chip-TiN interface) and therefore the back (TiN-YAG interface) faces of the coating. The transparency of the YAG tool permits near infrared radiation emitted by the rear face of the TiN coating to be imaged. A novel methodology is employed to measure the emissivity of the TiN/YAG

		interface. Using this technique, and the available blackbody calibration of the temperature vs. intensity response of the imaging system, the images are converted into temperature maps. The performance of the coated tool is additionally evaluated in terms of machining force and tool wear characteristics. Coatings that remain intact during the experiments can reduce ambiguity in interpretation of the results.
6.	Segalina and De Chiffre (2017)	An investigation was disbursed on the utilization of extrusion-cutting as a material test technique operating at severe conditions of strain, strain-rate and temperature, like in machining. In extrusion-cutting, a shoe constrains the chip back surface producing a geometrically outlined orthogonal cutting method which may be modeled using strategies from the idea of plasticity like, e.g., slip-line and upper-bound. the method was antecedently projected to be used as a material testing technique to work out the shear flow stress of materials under strains, strain rates and temperatures relevant for analytical modeling of metal cutting. This work represents a new step wherever the final objective is the generation of stress-strain curves which will be utilized in analytical models likewise as using Finite element method (FEM) simulations. a new experimental setup for extrusion-cutting using discs as work pieces was developed and implemented on a CNC shaping machine. an investigation was carried out extrusion-cutting copper discs using high-speed-steel cutting tools at 100 m/min cutting speed. Flow stress values for copper under machining-relevant conditions were obtained from measurement of the extrusion-cutting force on the tool and application of a simple upper-bound model for the extrusion-cutting process. an attempt to increase the validity of test information to cover a spread of cutting conditions was made, and suggestions for improvement of the simple theoretical model given.
7.	Denguir *et al.* (2017)	Tribological behavior at each tool/chip and tool/work material interfaces ought to be highly considered while simulating the machining method. In fact, it's no longer accurate to suppose one independent constant friction constant at the tool/chip interface, since essentially it depends on the applied contact conditions, together with the sliding velocity and pressure. The contact conditions at each higher than mentioned interfaces may affect the thermal and mechanical phenomena and consequently the surface integrity predictions. In this article, the influence of contact conditions (sliding velocity) on the tribological behavior of uncoated tungsten carbide tool against OFHC copper work material was investigated. Series of tribology tests combined with numerical simulations of the contact method were performed under totally different sliding speeds and contact pressures, so as to identify the friction coefficient and the heat partition between OFHC copper and tungsten carbide. The friction constant in function of the sliding velocity was then integrated into a Fe model of the orthogonal cutting off HC copper and applied to surface integrity prediction.
8.	Zanger *et al.* (2017)	The determination of cutting tool profiles for machining operations with coupled rotational kinematics like gear and screw generation may be a complex task that is executed by either numerical or analytical strategies. The cutting tool profile for whirling comes from process parameters and desired work piece geometry by each a numerical Drexel-based model and an analytical model based on the condition of tangential motion. The models are tailored to a method variant of whirling with synchronized rotation of tool and workpiece and compared concerning accuracy, computation time and geometrical flexibility.
9.	Lu *et al.* (2016)	Cutting tools are direct performers in material cutting processes of nc machining, whereas the degree of cutter attrition and breakage directly influences the standard

		of production. Mean while tool condition recognition may be a key technique in automatic and unmanned machining process. Aimed toward this downside, the popularity of tool-condition based on machining feature in real-time is expressed. Machining options are used to build relationships between geometry, processing technology and monitoring signals so as to provide the premise for cutter condition identification. Feature info is established with experimental results and a cutter condition recognition system is established primarily based on this information. Experimental results recommended that the planned technique solves the problem of tool condition monitoring, particularly for production with multi varieties and small-batches.
10.	Lopresto *et al.* (2017)	The results of orthogonal cutting tests on unidirectional carbon and glass fibre strengthened plastics are conferred. The specimens were under shape of rectangular plates, circular disks and cylinders with different fibre architectures and a milling machine, a lathe machine and a five-axis high-speed vertical machining centre, were used for the experimental tests. The cutting speed was varied. During the tests, performed at low cutting speed, avoiding thermal effects, and high speed, to analyze about the result of the cutting rate on the cut quality, the fibre orientation relevancy the cutting direction, the tool rake angle and therefore the depth of cut were varied to analyze their influence on the phenomenon. A high speed steel tool in different geometries was used. The mechanisms of chip formation and therefore the cutting quality were investigated. A tentative to correlate the mechanisms of chip formation and cutting forces signals was done. Since the property, the mechanism of chip formation consists of various failure modes occurring simultaneously and their identification, on the idea of the cutting force evolution, is incredibly complex. only in particular conditions, the options of cutting forces enable a definite identification of the chip development and detachment. The results indicated that the fibre orientation relevancy the cutting direction determines the mechanisms of chip formation and influences the cutting quality. it had been noted that for fiber orientation higher than 60°, the quality of the surface was revealed unacceptable. These conclusions were obtained independently of the actual form of specimen tested and of the speed adopted.
11.	Wegener *et al.* (2016)	Cutting technologies are the engines behind manufacturing. While not cutting, none of our modern product would ever been place into service. Developing new materials directly wants analysis for method windows in cutting. vast engineering efforts brought cutting within the position where it's these days and despite all rumors attempting to declare, that cutting is superannuated or cutting analysis is finished it's still a significant field of analysis and prone to fast innovations. Recent material developments challenge cutting technology. Recent material developments of cutting material as well as understanding of the cutting method change to deal with the challenges imposed from tough to chop materials. Analysis results and recent developments in machine tools show a way to mix the multiple necessities from ecology, economy and quality. Machine, tool and method are the ingredients of success in cutting.
12.	D'Addona *et al.*(2016)	Cognitive modeling of tool wear progress is utilized to get a dependable trend of tool wear curves for best utilization of tool life and productivity improvement, whereas conserving the surface integrity of the ground components. This paper describes a technique to characterize the dresser wear condition utilizing vibration signals by applying a cognitive paradigm, such as Artificial Neural Networks (ANNs). Dressing tests with a single-point dresser were performed in a surface

		grinding machine and tool wear measurements taken on the experiments. The results show that ANN process offers a good technique for the watching of grinding wheel wear based on vibration signal analysis.
13.	Koleva *et al.* (2015)	In the paper the chances of activity the dimensions of parts using the cutting tool that had machined the surfaces of the part are investigated. Described are the principal theme of the measuring device and its application for dimensional measurements. The method leads to additional efficient machining on CNC lathes. the applying of the tactic leads to automatic dimensional control, which otherwise would need specialized activity instrumentation or would result in increased idle time of the machine tool, automatic dynamic setup of the cutting tool, and automatic tolerance assurance using check-up data point surfaces. Reportable are the theoretical analysis of the measurement errors and also the methodology of predicting the accuracy of the measurements using the cutting tool itself. The results presented are experimental results of applying the system for direct dimensional measurements using the cutting tool on CNC lathe.
14.	Rusinek *et al.* (2015)	In this paper a brand new frictional model of cutting process developed to achieve higher insight into the mechanics of frictional chatter is presented. The model takes into consideration the forces engaged on the tool face also as on the tool flank. Nonlinear dynamic behavior is conferred using bifurcation diagrams for nominal uncut chip thickness (feed rate) because the bifurcation parameters. The influences of the depth of cut for various tool stiffness are investigated. Finally, the influence of the tool flank forces on the system dynamics is studied.
15.	Liu *et al.* (2014)	A cutting tool is a very important a part of machine tools and its responsibility influences the entire manufacturing effectiveness and stability of machine tools. The paper presents the applying of state space model within the cutting tool reliability assessment. Because the single evaluation threshold isn't simple to determine, the paper puts forward the construct of fuzzy threshold to resolve this drawback. We tend to use the performance or substitute variable to fuzzify the states of the system and also the success/failure events are treated as fuzzy sets. The acoustic emission signal is measured within the take a look at, and wavelet packet (WP) energy extracted from the acoustic emission signal is employed to estimate the tool state. The deterioration of the system is seen as a random dynamic method with continuous degrading. The deterioration tendency is foreseen by the Kalman filter algorithm and also the corresponding fuzzy reliability is calculated supported the forecasted deterioration state and a pre-set fuzzy threshold. The best time of once the tool ought to get replaced is obtained from the choice creating model.
16.	Koike *et al.* (2013)	The vibrations of a work piece during machining shorten the tool life and deteriorate the surface roughness in cases wherever the work pieces have a low stiffness (as is the case with artificial hip joints). In this paper, we tend to propose a technique to cut back the vibrations of the work at the cutting point; this methodology is predicated on an algorithm that generates a cutting path to reduce work piece displacements. The generation of the cutting path takes under consideration the work stiffness, cutting force vectors, the material removal method, feed directions, and tool orientation. The cutting path generation algorithm generates cutting path ways based mostly on the relationships among cutting force vectors, feed directions, and power orientation, all of that are measured with machining experiments.
17.	Khoroshailo *et al.* (2016).	This paper presents a mathematical model of vibratory displacement of the toll point underneath the action of variable forces with regard to the appliance of the

		developed tooling system. A three-dimensional model was additionally created, on the bottom of that the design of the tooling system was developed. As a result graphs of vibratory displacement of the toll purpose were obtained, which allow us to gauge concerning the decrease of vibration amplitude within the cutting method. The conducted experimental studies have shown the increased vibration resistance of boring tools once using the developed tooling system. Decreasing of the vibration amplitude by cutting method will improve the quality of the machined surface.
18.	Vasilko and Murčinková (2016)	The paper presents tool life extension strategies applied to cut-off tools made of high-speed steel. Despite the wide application of cutting tools made of mould carbides, that is turning into the main cutting material, as well as the coated tools, there still remain the applications of high-speed steel cutting tools for low cutting speed machining (i.e. screw taps, reamers, broaching tools, cutting off tools). Therefore the improving of their cutting ability is vital to be researched. The paper involves the application of selected modification strategies for the increasing of the tool life in in operation conditions, i.e. in manufacturing of ball bearing rings from the bar raw product. Moreover, the paper introduces and evaluates the results obtained by individual methods (tool mechanical and physical modifications) finding the reasons of longer tool-lives for instance by analyzing the metallographic micro sections of chip formation method
19.	Kahwash and Maheri (2015)	The need for prime quality machining of composite materials is rising as a result of the increased use of those materials across several applications. This paper presents experimental findings of orthogonal cutting of unidirectional glass fibre reinforced plastic (UD-GFRP) composites using HSS single-point cutting tools. Key method indicators as well as cutting forces, chip formation and surface integrity were evaluated. Full factorial style is used with fiber orientation, depth of cut, cutting speed and rake angle as method management variables. Fiber orientation and depth of cut were found to be the foremost important factors affecting the investigated responses. Lower cutting forces and higher surface quality were obtained at 0o fiber orientation and lower depth of cut. Cutting at 45o fiber orientation generated very broken surfaces with comparatively high average surface roughness values and may be avoided in sensible applications.
20.	Martínez-Romero *et al.* (2014)	The single purpose progressive forming producing method has become progressively used attributable to its flexibility in producing single items. There exists within the literature several analysis works that concentrate on learning the different phenomena ascertained throughout the only purpose progressive forming method of sheet blanks such as material fracture criterion, forming limit diagram, friction and force effects, mechanics of deformation, material spring-back, improvement processes, among others. However, the tool and therefore the experimental came upon dynamic effects that could influence the single point incremental forming method haven't been addressed. Therefore, the aim of this analysis focuses on learning the dynamics interaction among the tool, the experimental came upon and therefore the sheet blank throughout the forming method. To quantify these effects, we've dynamically characterized the method response behavior and used finite part simulations to spot the resonance wave frequencies additionally as the magnitude of the most von Misses stresses and located that if we would like to avoid undesirable wave effects that would have an effect on the ultimate shaped half, we want to own a sturdy experimental came upon.

GAPS IN THE LITERATURE

From survey of available literature, following research gaps are being identified.

1) There is very limited research available in the field of stresses generated on the basis of depths of cut;
2) There is very limited research available in the field of single point cutting tools' stresses generated in the terms of varying depths of cut & material configuration

OBJECTIVES OF THE RESEARCH

On the basis of above investigated gaps in literature, following objectives of the research are proposed:

1) To investigate different types of stresses generated in a single point cutting tools during operation and properties of material chase.
2) To investigate the effect of depths of cut on different types of stresses generated in a single point cutting tool.

CONCLUSION

Considering the importance of single point cutting tools in present manufacturing scenario, and relations between stresses and depths of cut, proposed research proposal, has investigated justified gaps in the research and may be lead to the analysis phase.

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