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REVIEW PAPER ON ANALYSIS AND DEVELOPMENT OF RELATIONSHIP FOR TOOL FORCE AND TOOL STRESS IN END MILLING CUTTER

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ABSTRACT :- Tool life is an important indicator of the milling operation in manufacturing process. Studies and analyses of milling process are usually based on three main parameters composed of cutting speed, feed rate and depth of cut. The aim of this study is to discover the role of these parameters in tool life prediction in milling operations by using numerical analysis and developed a real time simulation of end milling cutter. Machining experiments were performed under various cutting conditions by using sample specimens. A very good agreement between predicted model and experimental results will be obtain. We have to develop correlation between the estimated and experimental data.

I. INTRODUCTION

Metal cutting is one of the most significant manufacturing processes in the area of material removal. Black defined metal cutting as the removal of metal chips from a work piece in order to obtain a finished product with desired attributes of size, shape, and surface roughness. The imperative objective of the science of metal cutting is the solution of practical problems associated with the efficient and precise removal of metal from work piece. It has been recognized that the reliable quantitative predictions of the various technological performance measures, preferably in the form of equations, are essential to develop optimization strategies for selecting cutting conditions in process planning.

The progress in the development of predictive models, based on cutting theory, has not yet met the objective; the most essential cutting performance measures, such as, tool life, cutting force, roughness of the machined surface, energy consumption, … etc., should be defined using experimental studies. Therefore, further improvement and optimization for the technological and economic performance of machining operations depend on a well based experimental methodology. Unfortunately, there is a lack of information dealing with test methodology and data evaluation in metal cutting experiments. [5 End milling is widely used in machining molds and dies, as well as various aircraft components. To ensure cutting quality, tool life prolongation and the productivity, accurate milling process analysis is critically necessary for beforehand process planning and adaptive controlling. During the entire milling process, cutting force is one of the most important issues and an efficient and precise cutting force model is thus crucial for the selection of machining parameters, such as feed rate, and spindle speed. Traditional researches on cutting force model usually focus on linear milling process. Chip thickness calculation as well as cutting force coefficients identification is also analyzed specially for linear milling force simulation.

These approaches do not always meet other cutting conditions, especially circular milling process. Cutting condition independent force coefficients concept was introduced into milling force modeling, however; precise instantaneous cut chip thickness and run out offset and angle factors are needed in this method to get desirable instantaneous cutting force coefficients. Size effect and other characteristics during the process may influence the simulation results eventually. Therefore a particular model for circular milling is necessary to satisfy practical request. Regarding force simulation of circular milling, relative researches have been done recently. Proposed an approach to predict the cutting forces in the end milling of rectangular circular corner profiles by discrediting the corner into a series of steady-state cutting processes, each with different radial depth of cut investigated the relationship between working parameters and the corner coordinates by way of combination of tool tracing and cutting geometry dynamics. Developed a method for cutting force modeling related to peripheral milling of curved surfaces including the effect of cutter run out. For curved surface milling process, a series of accomplishment concluding process geometry, curvature effect, cutting force, surface error and so on.

Although the above-mentioned literature has extended to a bunch of stuff for circular milling, it does not mention the variation of feed rate along cutting tool envelope during circular milling process. For the existence of work piece curvature, the feed rate along the cutting tool envelope will not remain the same as that of the tool center, and this is an important difference from the linear milling process. When establishing a cutting force model, one of the key issues is the calculation of instantaneous chip thickness, which has dependent relationship with feed rate. Abundant researches have been done on this aspect. The effects of run out, tooth trajectory as well as tool deflection on chip thickness are discussed, respectively or simultaneously. It is noticed that studying the cutting force in milling with a circular tool path, the variation of uncut chip thickness is too important to be neglected. Actually the key elements involved in force model, for instance, feed rate and chip thickness, will deviate from their normal values during circular milling process. [9]

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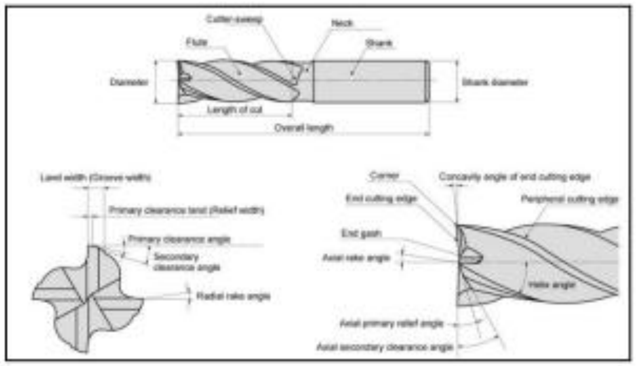

Fig.1. End milling cutter

II. LITERATURE REVIEW

Zheng, Yun Shun Shiou and Steven y. liang developed in this paper. This involved the convolution integration of local cutting forces with respect to the cutter orientation to yield the solution of cutting forces in the feed, cross-feed, and axial directions. The effect of the intermittent engagement is 3odelin with a rectangular window function in the cutter angle domain, and the effect of axial depth of cut is described by the upper limit of the convolution integration. The resulting force solutions in the angle domain are trains of pulses as functions of material cutting pressure constants, tool geometry, machining configuration, and cutting parameters. Through Laplace transformation, the frequency components of cutting forces are established in closed form expressions at the harmonics of the tooth passing frequency. The frequency model provides both the magnitude and the phase angle information in all three directions. It can he used to reconstruct the angle domain waveform of forces via inverse transformation, thereby offering a near-explicit solution for time/angle domain analysis by virtue of the algebraic nature of the frequency model. The model of this nature will allow the prediction, interpretation, optimization, and control of cutting force systems to be performed without the need of numerical iterations.[1]

Wen-Hsiang Lai In the simulation model, the most significant influence on the forces is the chip thickness (Tc). However, the dynamic radius caused by cutter run out and tilt is another key point to affect chip thickness. The effect of feed per flute on milling forces is apparent When feed rate is increased, the instantaneous chip thickness is increased, and forces are increased. Radial and axial depths of cut affect the width and length of the contact area, respectively. That is, when the radial and axial depth of cut are increased, the contact area is increased, and the forces become larger.[2]

Zhang, T. Huang, The main conclusions that can be drawn from this work are as follows. Under stable cutting conditions, the static deflection of the cutter is the most significant deflection. Therefore, if only the static deflection is taken into account, the error of the predicted result will not be too great. Under unstable cutting conditions, the errors of the predicted surface profiles relative to the measured values at the bottom, middle and top elevations were all less than 20 percent. In an up-milling process, an excess cut will occur, and the excess cut at the free end of the cutter was greater than at the fixed end.[3]

Wasawat Nakkiewa, Chi-Wei Linb, Jay F. Tuc, * The proposed technique has been applied to determine the effect of the spindle speed, level of unbalanced mass, and spindle stiffness on the cutter/spindle radial error. The results confirm that centrifugal forces generated by the unbalanced mass are mainly responsible for the increase in cutter/spindle radial error at increased spindle speeds. This result is consistent with the prediction from a previously developed comprehensive spindle thermomechanical dynamic model. One way to compensate for the effect of unbalanced mass is to increase the spindle stiffness. Experimental results confirm that a higher front-bearing preload can render the spindle stiffer, thus reducing the cutter/spindle radial error. This new and practical technique for the measurement of cutter/spindle radial error is an effective tool in verifying the actual running accuracy of spindles at their actual operating speeds and can be accomplished without the need for a reference sphere. [4]

WAN Min*, ZHANG Wei-hong, TAN Gang, QIN Guo-hua. A new approach is developed to calibrate the cutting force coefficients and the cutter radial run out parameters in flat end milling. It is shown that the total cutting forces have a closed form consisting of a nominal component independent of run out and a perturbation component depending upon run out. This decomposition makes it possible to identify the instantaneous cutting force coefficients with the nominal component. The cutter run out parameters are then determined based on the cutting force coefficients calibrated and the perturbation component. The advantage is that the influence of the cutter run out that is unknown in advance is eliminated in the calibration procedure of cutting force coefficients. Finally, the proposed approach is tested and validated by experimental results covering. [5]

A B Abdullah, D Y Chia and Z Samad The purpose of this study is to developed analytical based surface prediction technique which can be more accurate, flexible, reliable, and no-destructive and then evaluate its prediction ability. The sensitivity analysis problem proposed in this study is useful computational tool to help analysis of the relationship between the cutting parameter and the surface roughness of machined surface.[6]

Amir Mahyar Khorasan, Mohammad Reza Soleymani Yazdi and Mir Saeed Safizadeh In this study, (ANN) for 4odeling and predicting tool life in milling parts made of Aluminium (7075) material was developed. Given the accuracy that was achieved it is safe to conclude that all the significant factors were included in the (DOE) process. The research in the present paper can be extended towards three different steps. The first step is using Taguchi (DOE) and different combinations of cutting parameters for building database. The second step is 4odeling tool life by using (ANN). Third step is validation by carrying out the experimental tests. In generating the (ANN) model statistical (RMS) was utilized. The accuracy error was found to be insignificant (3.034%). It was found that (ANN) prediction correlates very well with the experimental results. Finally, the correlation for training and test was obtained 0.96966 and 0.94966 respectively and mean square error was calculated 3.1908% for test data.[7]

Min Wan, Wei-Hong Zhang∗, Yun Yang This paper provides a cutting force analysis methodology to clarify the milling mechanistic effects of titanium alloy. Emphasis is put on how to effectively reveal the force generation mechanism of flank edge and bottom edge in the presence of cutter runout. Novel procedures and algorithms are derived to identify process parameters, i.e., cutting force coefficients and runout parameters. [8]

Wu Baohai, Yan Xue, Luo Ming, GaoGe A cutting force prediction model considering the tool path curvature for circular end milling process is studied in this paper. Validation of the proposed method has been demonstrated through a serious of milling experiments. The main contributions of this paper are listed as follows☹1) By taking tool path curvature into account the chip thickness model has been improved for circular end milling process. (2) With the improved chip thickness model, cutting force model for circular end milling process has been deduced and the simulation results meet the measured results well. (3) The deduced cutting force model can be used not only for linear and circular end milling processes, but also for freeform splines if improved.[9]

Zahia Hessainia, Ahmed Belbah, Mohamed Athmane Yallese, Tarek Mabrouki, Jean-François Rigal at the end of this research work some valid conclusions can be announced for the hard turning of 42CrMo4 steel (56 HRC) with Al2O3/Tic mixed ceramic. (1) Response surface methodology (RSM) combined with the factorial design of experiment is useful for predicting machined surface roughness. Only a small number of experiments are required to generate helpful information exploited for predicting roughness equations. (2) Analysis of variance (ANOVA) demonstrates that the feed rate and the cutting speed have the highest influence on the evolution of machined surface roughness. For the arithmetic average roughness (Ra) the influences are 67.32%, 22.02% for (f) and (Vc), respectively. For the maximum peakto-valley height (Rt), the feed rate (f) effect is 73.72%. Nevertheless, the depth of cut has no influence on the surface roughness. [10]

III. OBJECTIVES

a. To develop a numerical analysis method to calculate a forces in end mill cutter.
b. To develop a numerical method for force analysis and surface finishing of end mill cutter.
c. To determine prediction of tool failure and condition of work piece. d. To validate real-time simulation of end mill cutter

3.1 METHODOLOGY

- To Calculation of cutting forces induced on cutting tool.
- To Simulation of Cutting tool forces for determination of stress and deformation
- Experimental analysis of forces for turning and milling operation
- Proposing a co-relationship for forces on tool and stress induced in tool

. • Defining allowable stresses for cutting tools in different condition

• Developed a numerical calculation and prediction of cutting tools condition in simulation. Conclusion Most research on tool life predication works on overall life of tool. Two research on artificial neural network (ANN) based predictive model of average surface roughness in turning steel has been presented. Surface roughness research works on how to improve a surface finishing by reducing a vibration in tool. One of research explains image processing to evaluate existing tool wear and wear prediction considering the previous behaviour of similar tools. Analysis and validation of forces and stresses induced on the cutting tool by selecting work piece material in Master CAM simulator.

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