Review on Explicit Dynamic Analysis of Single Point Cutting Tool using ANSYS

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Abstract— This paper studies the researches conducted on the study of various operating parameters on output parameters. The study includes analysis on different materials and application of Taguchi design of experiments for determining the effect of operating parameters. The application of Finite Element Method in determining stresses and deformation generated on cutting tool is also discussed. This study will help us in understanding, which parameters is significant parameter for Surface Roughness, Material Removal Rate, Feed Force, Tangential Force, Tool Life, etc.

Keywords: Cutting Parameters, Taguchi Method, Finite Element Analysis

I. INTRODUCTION

The recent development in science and technology has put tremendous pressure on manufacturing industries. The manufacturing industries are trying to decrease the cutting costs, increase the quality of the machined parts and machine more difficult materials. Machining efficiency is improved by reducing the machining time with high speed machining. When cutting ferrous and hard to machine materials such as steels, cast iron and super alloys, softening temperature and the chemical stability of the tool material limits the cutting speed. The productivity enhancement of manufacturing processes accelerates the development in design and evolution of improved cutting tools.

II. LITERATURE REVIEW

The geometry and nomenclature of cutting tools, even single-point cutting tools, are surprisingly complicated subjects. It is difficult, for example, to determine the appropriate planes in which the various angles of a single-point cutting tool should be measured; it is especially difficult to determine the slope of the tool face. The simplest cutting operation is one in which a straight-edged tool moves with a constant velocity in the direction perpendicular to the cutting edge of the tool. This is known as the two-dimensional or orthogonal cutting process illustrated in Fig 1. The cutting operation can best be understood in terms of orthogonal cutting parameters.

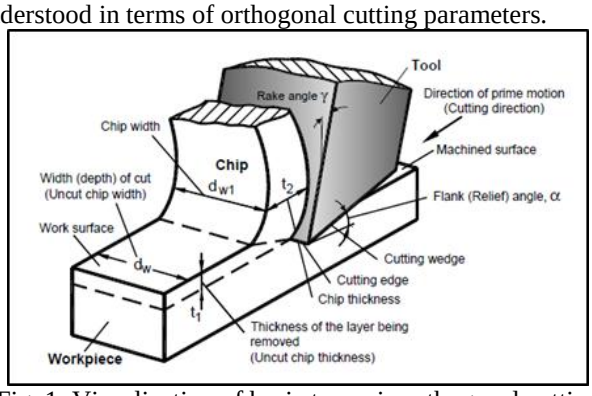

Fig. 1: Visualization of basic terms in orthogonal cutting

The different angles in single point cutting tools are back rake angle, side rake angle, end relief angle, side relief angle which are described below.

A. Back Rake Angle:

It is the angle between the face of the tool and a line parallel to the base of the tool and measured in a plane (perpendicular) through the side cutting edge. This angle is positive, if the side cutting slops downward from a point towards the shank and is negative if the slope of side cutting edge is reverse. So this angle gives the slops of the face of the tool from the nose towards the shank

B. Side Rake Angle:

It is the angle between the side cutting edge and a line parallel to the top surface of the tool when viewed from side.

C. End Relief Angle:

It is the angle between the flank and the line perpendicular to the shank when viewed from the front.

D. Side Relief Angle:

It is the angle between the line perpendicular to the shank and the surface formed by side cutting edge and end cutting edge if viewed from side.

DeoreDhirajet.al [01] have studied the optimization and evaluation of cutting forces in turning operation of EN19 steel. In this optimization technique used is Taguchi method and analysis of variance is done to find which parameters have significant effect. It is found out that feed is the most significant factor followed by speed which influences the feed force. For tangential force Depth of cut followed by feed is the significant factor.

Sayak Mukherjee et.al [02] conducted experiments on SAE 1020 steel using Taguchi method to optimize cutting parameters with respect to material removal rate. L25 orthogonal array was used in conducting experiments. The result shows that Depth of cut had significant effect on Material Removal Rate followed by feed and speed.

Manjunatha.Ret.al [03] investigated the optimum value of tangential force, feed force, and surface roughness for EN19 steel using confirmation test. They have used L27 orthogonal array. For Surface Roughness Annova result shows that, Feed is the most dominant factor. For Cutting forces (Feed and Tangential force) Depth of cut and Feed is the significant factor.

R. Suresh, et.al [04] developed a mathematical model correlating cutting parameters with Tool Wear and Surface Roughness. Turning operation was done hardened AISI H13 steel with PVT coated ceramic tool in dry condition. Experiments were conducted using the concept of Response Surface Methodology. For Surface roughness, Feed was the dominating factor followed by Depth of cut and

speed. For Tool wear, Speed and feed were the dominating factor.

Vikas B. Magdum, et.al [05] used Taguchi method for optimization of cutting forces andprocess parameters on EN8 steel. For conducting experiments L9 orthogonal array was selected. For Cutting forces (Feed and Tangential force), Feed and Depth of cut were the dominating factor followed by speed and Tool material. Optimum value of process parameters is also determined.

S.R Das, et.al [06] determine the optimal cutting parameters for low Tool wear and low Surface temperature. They performed turning operation on AISI D2 steel. The experiments were conducted using Taguchi's L9 Orthogonal technique and analysis of variance was used to identify the effect of cutting parameters. For Tool wear, Depth of cut and speed has significant effect compare to feed. For Surface Temperature, Depth of cut is the dominant factor followed by speed and feed. Multiple regression equation are also developed to estimate the performance level for any parameters.

Krishnakantet.al [07] conducted experiments on EN24 steel to optimize the Material Removal Rate (MRR). Taguchi technique with L9 orthogonal array is used with 3 factors and 3 levels. Response variation is studied using S/N ratio for larger-the-better characteristic. Material Removal Rate increases with increase in feed, speed and depth of cut.

U.D. Gulhane, et.al [08] investigated the surface roughness in turning operation of 316L stainless steel using Taguchi technique. L9 orthogonal array was selected for conducting experiments and the results were verified with ANNOVA. The most significant factor was feed followed by depth of cut and speed. Also the optimum values for cutting parameters were found out.

L B Abhang, et.al [09] conducted turning operation on EN31 steel using tungsten carbide tool. Experiments were conducted using Taguchi method and verified by analysis of variance. The result shows that lubricant has significant effect on surface roughness compared to feed and depth of cut. The conclusion drawn was higher surface finish can be obtained by applying cooled lubricant.

M. Kaladhar, et.al [10] investigated optimization of process parameters of AISI202 stainless steel in turning operation. They studied the effect of process parameter i.e. speed, depth of cut, feed, and nose radius on surface roughness. Experiments were conducted using Full Factorial design technique and to analyze the process parameter significance, ANNOVA was used. Feed and Nose radius were the dominant factor followed by speed and depth of cut.

W.H Yang, et.al [11] used Taguchi method to find the optimum cutting parameters. They investigated the cutting parameters of S45C steel using tungsten carbide tools by. For Tool Life, speed and feed were the significant factor followed by depth of cut. For Surface roughness, Feed and depth of cut were the significant factors followed by speed. Also, the optimum values of cutting parameters were found out to increase tool life and surface roughness.

III. CONCLUSION

Researchers have highlighted the operating parameters speed, feed and depth of cut, while some has taken nose radius, lubricant etc. to find out its impact on the performance parameters like MRR, surface roughness, cutting forces, tool wear and tool life. The optimization technique like Taguchi design of experiments also enables to determine sensitivity of various operating parameters on performance parameters.

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