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DESIGN ANALYSIS OF SINGLE POINT CUTTING TOOL WITH VARIOUS DEPTH PARAMETERS USING TAGUCHI METHODS

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Abstract:
Single point cutting tool is most widely used tool in several machining and metal cutting operations. The work piece material is removed or machined step by step by force which increases temperatures of both work piece and tool Itself. Where it causes in thermal damage and high tool wear rate. The tool tip may deform plastically due to high temperature which results in poor accuracy in machining. There are several experiments and research going on to minimize these temperatures The modelling is carried out in NX 10.0 and analysis is done using ANSYS Explicit solver. The stress vs. deformation curves were drawn for each depth from 0.1 mm, 0.2 mm, 0.3 mm, respectively and results are obtained for the optimum depth for a single stroke to be used for the cutting operation The input of the model consists of feed rate, cutting speed and depth of the cut while the output from the model. This research is to test the collecting data by Taguchi method. The model is validated through a comparison of the experimental values with their predicted counterparts. The optimization of the tool life is studied to compare the relationship of the parameters involved. The result of the experimental optimization shows that depth of cut was the only parameter found to be significant. The experimental optimization also shows that the predicted values and calculated values are very close, that clearly indicates that the developed model can be used to reduce the cost of machining

Key words: Single point cutting tool, ANSYS R21, Taguchi methods, Inconel 718, SS 304, H30 materials

I. INTRODUCTION

Machining, the most widespread process for shaping metal, has become a very significant aspect of modern society and industry. The importance of the machining process is evident by the observation that nearly every device used by humanity in day-to-day life has at least one machined part or surface. From a materials viewpoint, high speed machining is a relative term, since different materials should be machined with different cutting speeds to insure acceptable tool life. Because of this difference and the fact that cutting speed determines whether a material will form continuous or segmented chips, one way to define high-speed machining is to relate it to the chip formation mechanism. Machining is a common fabrication technique where material removed from a part using a tool with a small, hard tip. Usually, the material being cut is a metal, such as aluminum or steel. In order to fabricate a part quickly, a high cutting speed desired. These higher speeds, however, lead to a faster degradation of the tool tip, which requires that the tool tip replaced more frequently. Over the history of machining, guidelines and conventions have arisen based on empirical information of trade-offs between cutting speed and tool replacement time. Machining is a term covering a large collection of manufacturing processes designed to remove material from a work piece

II. LITERATURE REVIEW

The primary problem that metal-cutting companies face is the requirement to improve manufacturing quality while also lowering production costs. Other factors like as lubricants and coatings affect both the quality and the price of the finished product depending on how the cutting parameters are set up as well as the wear and tear on the tooling.

Abdullah, K.; Ulvi, S. (2005)developed a turning process surface roughness prediction knowledge-based system. This project necessitated the usage of fuzzy set theory and neural networks. Set theory that is a bit fuzzy Surface roughness can be predicted using process variables. the authors constructed a rule that also predicts process variables for known surface roughness.

Abukhshim N.A., Mativenga(2005) in their research, they focus on micromachining, namely metals micro-milling and the study of micro-cutting in this context. Tools having a diameter of less than 1 mm and a resolution of 0. 05 mm are used in micro-milling. Due to manufacturing issues, these tools do not have the same complicated and sharp geometries as traditional tools. Cutting parameters for small tools differ greatly from those used in normal machining, and manufacturers typically recommend "adapted" cutting settings like a feed per tooth lower than 10 μm. However, using a top-down (scale reduction) technique in micro milling results in the appearance of critical size effects.

III. RESEARCH METHODOLOGY

Increasing tool longevity and ensuring a more constant production flow lowered tool wear, according to research. The cutting tool's force components were used to estimate how much metal was removed by the tool. The cutting tool's lifespan will be shortened if the feed rate or cut depth are increased because doing so raises the temperature of the machine. The temperature of the chip tool's contact rose as the feed rate and main cutting force were increased; it fell as a result.

Theory of machining

A well-documented flexible machining procedure, using cemented carbide (WC/Co) cutting tools, is widely utilised for metals or other hard materials, such as granite. It's not uncommon for a cutting tool to be made up of two parts: a steel shaft with a removable cemented carbide cutting tool insert. Cobalt (Co) matrix and tungsten carbide (WC) particles are the two major constituents of cement carbide. Inserts are formed by crushing together WC or Co powder, together with any additional carbide additives (such TiC, CroAr, or SiC) that may be used. The characteristics of the insert will be affected by the WC particle size and the amount of Co or other carbides applied. For the most part, the desired qualities of the insert dictate the amount of Co to employ (3-20 wt percent). More Coating increases the toughness of cutting tool inserts while lowering their hardness and strength.

EXPERIMENTAL SETUP AND CONDITIONS

A three-jaw centre lathe was used for the experiment, which was done in dry conditions. Using a tool that can feed deep work while traversing the work, a lathe eliminates unwanted material such as chips from a revolving work piece. This work piece has a hole drilled in the face so that it can be supported by the tailstock while it is being machined.

Design and Manufacturing Considerations:

Computer aided technologies are broad terms describing the use of computer technologies to aid in design, analysis and manufacturing of products. Computer aided engineering (CAE) is computer aided technology for supporting the engineers in the tasks such as design, analysis, simulation, manufacturing, plarming, diagnosis and repair. Software tools that have been developed for providing support to these activities are considered as CAE tools. CAE tools' are being used to analyze the robustness and performance of components and assemblies. It encompasses simulation, validation and optimization of products and manufacturing tools. In the future CAE system will be major provider of information to help support design teams in decision making. CAE embraces the application computers from preliminary design (CAD) through production (CAM).

IV. RESULTS AND DISCUSSIONS

Static structural analysis:

It was decided to use a meshed model, total and directional displacements, and equivalent stress and strain as factors in the investigation. The flywheel under consideration was part of a device used to measure how much speed can be slowed down. Working with different materials such as Inconel718, SS3304, and H30 Materials, Annoys Workbench 2020R1 is well-designed software.

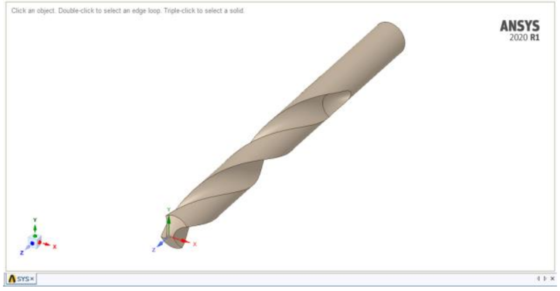
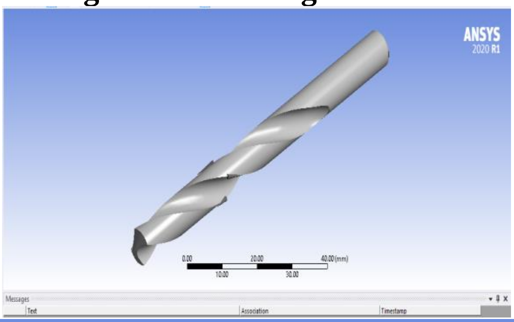


Figure : Tool Designed model



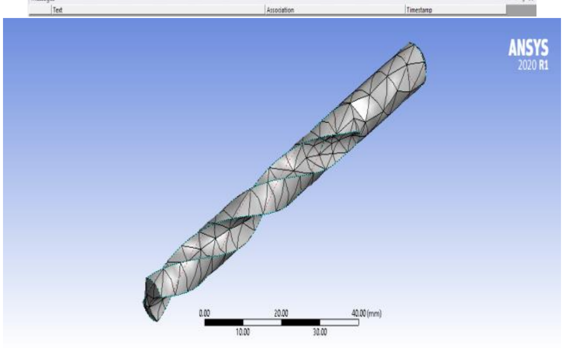


Figure: Imported model

Figure: Meshed model

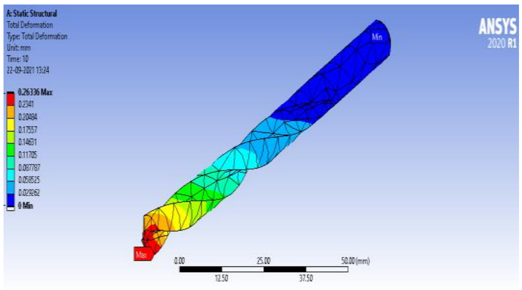


Figure: Total deformation

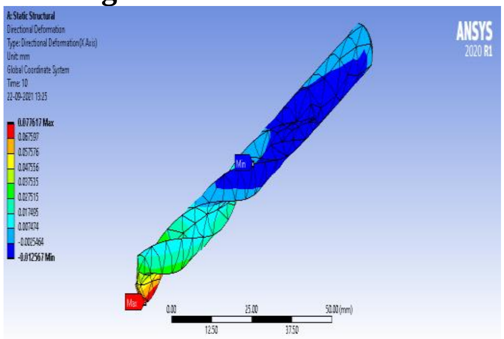


Figure: Directional deformation

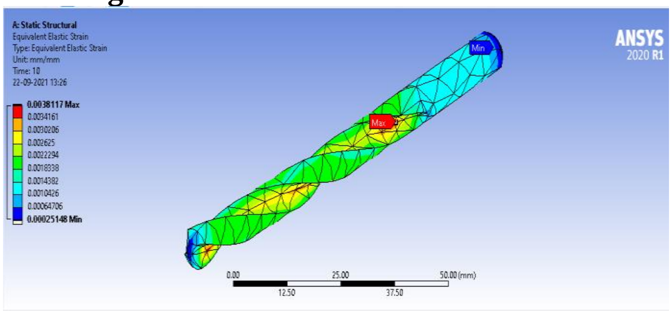


Figure: Equivalent elastic strain

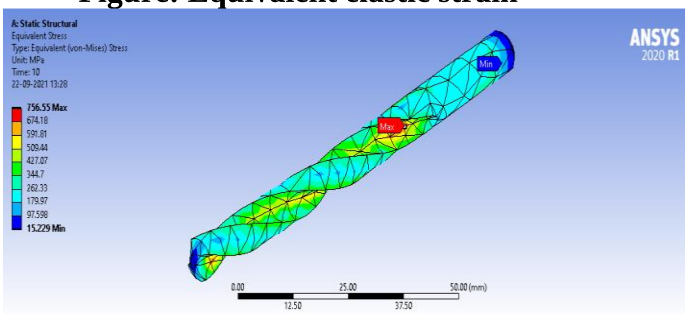


Figure: Equivalent stress

V. CONCLUSIONS

Finally, the concluded that structural analysis using different materials and observing the simulation results Inconel 718 has a higher tensile strength than grade 304 stainless steel H30 and does a better job of maintaining that strength at higher operating temperatures. This is because Inconel is stronger than stainless steel at high temperatures, while being more resistant to oxidation and scaling as well.

To investigated a single characteristic response optimization model based on Taguchi Technique was developed to optimize process parameters, such as speed, feed, depth of cut, and nose radius of single point cutting tool. Taguchi's L9 orthogonal array is selected for experimental planning. The experimental result analysis showed that the combination of higher levels of cutting speed, depth of cut and lower level of feed is essential to achieve simultaneous maximization of material removal rate and minimization of surface roughness

A L9 orthogonal array, S/N ratios and ANOVA are used to study the performance characteristics of cutting speed, feed rate and depth of cut as turning parameters with tool flank wear width as response variable. The result of the analysis show that the selected machining parameters affect significantly the tool flank wear width of Tungsten Carbide cutting tool while machining Inconel 718 and also indicate that the cutting speed is the most influencing

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