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MULTI-POINT CUTTING TOOL

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ABSTRACT:

In this project, temperature at tool-tip interface is determined, generated in high-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), feed rate (f), and depth of cut (d), respectively. It is also determined that change in cutting speed and depth of cut has the maximum effect on increasing cutting temperature. 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. In this project, "Fluke 62 max IR thermometer" (Range -40 0C to 650 0C) is used for measuring temperature at tool-tip interface. Single point cutting tool has been solid modelled by using CAD and FEA carried out by using ANSYS Workbench. By varying various parameters the effect of those on temperature are compared with the experimental results and FEA results.

Keywords: *Multi Point Cutting Tool (carbide) tool and Carbide tip tool (P - 30), Computer Aided Design (CAD), milling, Fluke 62 max IR thermometer (Range -40 0C to 650 0C), Finite Element Analysis, Solid Modelling.*

INTRODUCTION:

The fabrication of a wide variety of parts and products in various fields, like aeronautics, automotives, biomedical, medical and electronics requires proper finishing for proper mating and functioning of products. A variety of operations like milling, drilling, turning, grinding, EDM and water jet cutting are utilised to fabricate and finish parts. One of the most common and important form of machining is the milling operation, in which material is cut away from the work piece in the form of small chips by feeding it into a rotating cutter to create the desired shape. Milling is typically used to produce parts that are not axially symmetric and have multiple features, such as holes, slots, pockets, and even three dimensional surface contours. Contoured surfaces, which include rack and circular gears, spheres, helical, ratchets, sprockets, cams, and other shapes, can be readily cut by using milling operation. Recently, micro milling process has gained immense popularity due to market requirements and technological advancements which has lead to fabrication and use of micro structures. It possesses several advantages like ease of use, capability to produce complex three dimensional geometries, process flexibility, low set-up cost, wide range of machinable materials and high material removal rates. This chapter develops the background for the present work and discusses the need to take up this work. It presents a review of available relevant literature. Objectives of the present work along with methodology adopted to accomplish them are also discussed here.

Problem Definition

This work is an attempt to optimize micro milling tool parameters for minimization of micro burrs formed during micro machining. The objectives of this work are stated as follows:

• To develop three-dimensional solid models of multi point milling cutters.

• To perform the static finite element analysis of the tools during milling.

• To perform the finite element detailed analysis of the tool and work piece combination during milling.

• To perform burr formation simulation in milling

Scope of the present work

The outcome of the research will be a static finite element analysis of multi point cutting tool formed during milling which can help in determining tool life and detailed dynamic analysis of tool formed during milling operation in Al6061T6 which can benefit the aerospace industry, which utilises this alloy for fabrication of a large number of components. The results obtained during the analysis may be used for further research for burr minimization through tool optimization and process control.

Flow of Work

The approach adopted to accomplish the present work is by:

(i) Generating CAD models of multi point cutting tool for milling operations as well as of the work piece.

(ii) Performing detailed FEA on the tool by varying tool parameters in each case.

(iii) Performing simulation during the process.

(iv) Results in the form of Von Mises Stress and deformation of selected cutters.

Compare the results with experimental procedure

Development of Three Dimensional CAD model :

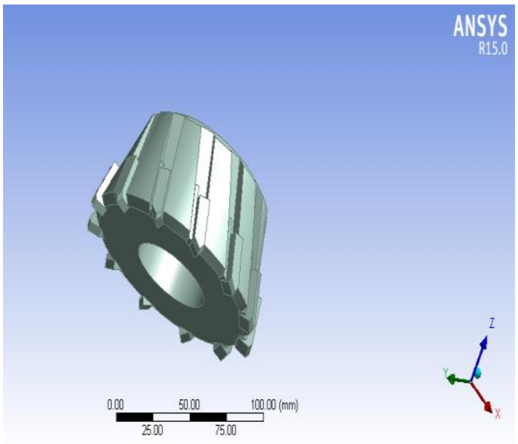
Method involved in the design of a cutter includes:

• Creation of cross-sectional profile of the tool and helix generation • Flute creation using slot operation • Creation of back surface of the tool • Cutting edge generation

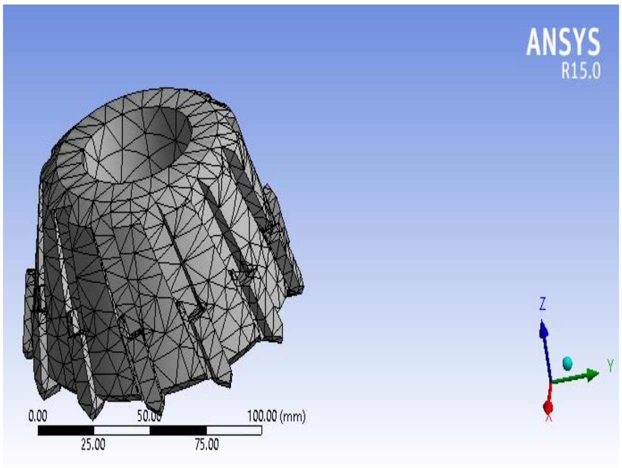
Parameters involved in generating the cross sectional profiles are: • Rake angle of the tool • Relief angle of the tool • Tool diameter • Number of flutes

Parameters involved in modelling the helix are: • Height of the tool • Diameter of the tool • Pitch of the helix • Helix angle of the tool

The three dimensional CAD models of both the flat end mills was produced by performing ansys work bench.



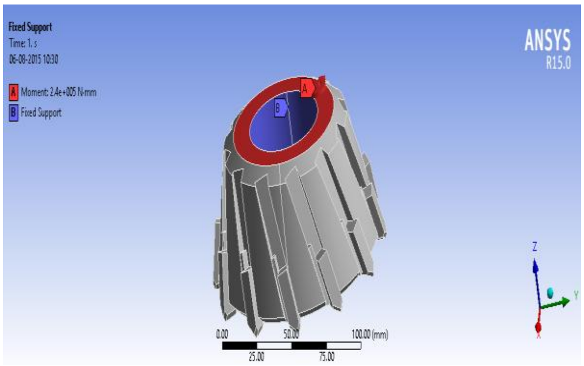
Cad model of the tool



Meshed Model

BOUNDARY CONDITIONS :

The displacements of X, Y and Z directions are zero at the upper surface and the center hole, Mz at the upper surface of 100nm is applied. Static and dynamic analysis is carried out for two materials, stresses deformations and mode shapes have been extracted.



MATERIAL PROPERTIES :

The table shows the material properties of two materials used, High speed steel and cemented carbide.

Materials	HSS	Cemented Carbide
Density (kg/m3)	7980	12100
Young's modulus, E (GPa)	210	558
Poisson's ratio, n	.30	.22

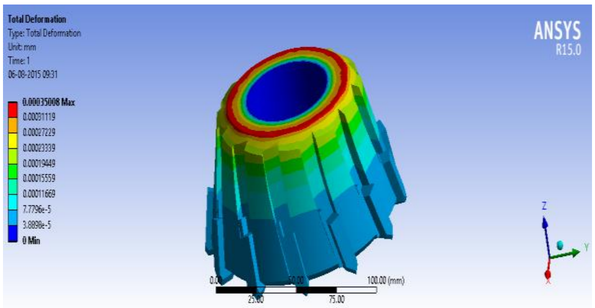
Chemical composition of HSS in percentages

Molybdenum high-speed tool steels (M7) UNS Designation- T11307

Chemical	C	Si	Cr	V	W	Mo
Composition	1.01	0.38	3.75	2.00	1.75	8.70

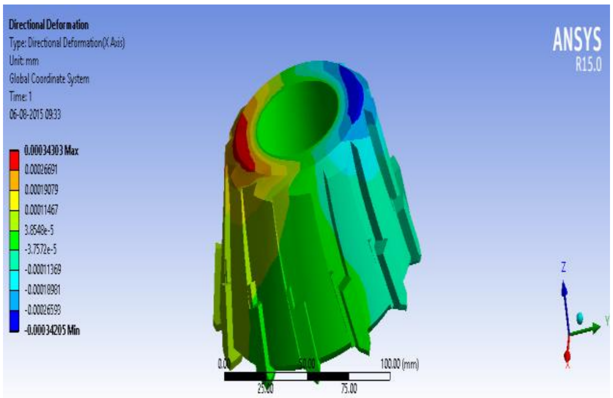
RESULTS AND DISCUSSIONS:

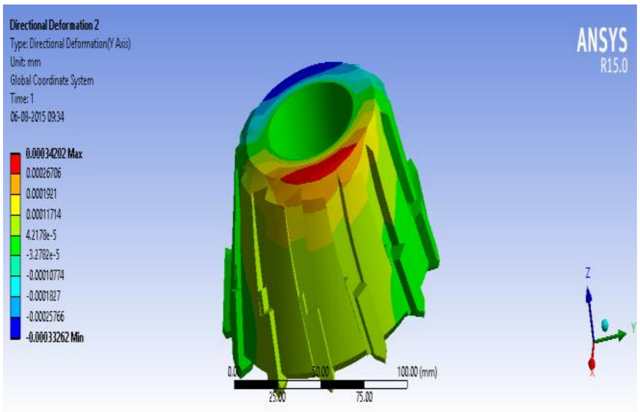
Static analysis with HSS material:



The figure shows the total deformation of the tool under the moment applied for High Speed Steel material, Maximum deformation was observed at the top face of the tool with magnitude of 0.00035.

Total Deformation of the tool for HSS material The figure below shows the variation of Directional Deformation along X axis in mm, The maximum deformation of magnitude 0.000343mm was observed.

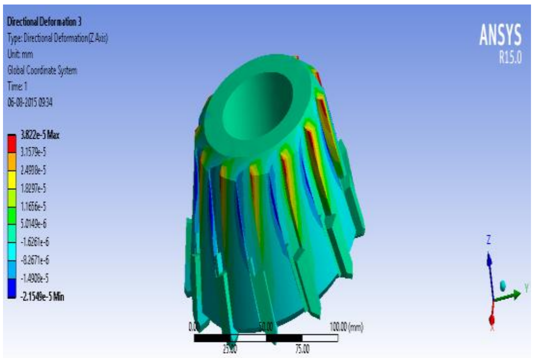


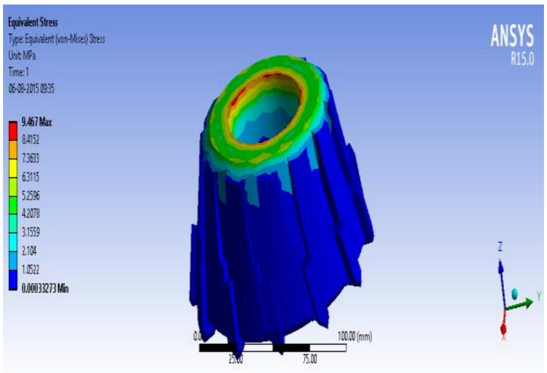


Deformation along X Axis for HSS material tool

The figure above shows the variation of Directional Deformation along Y axis in mm, The maximum deformation of magnitude 0.000342mm was observed.

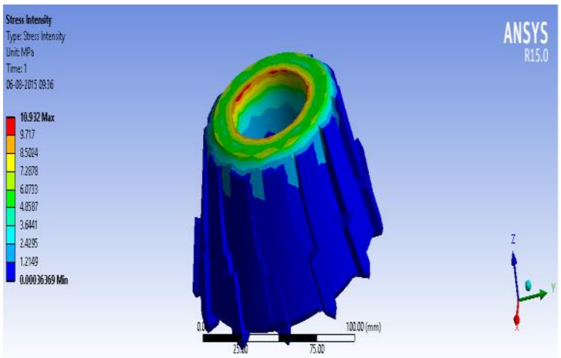
Deformation along Y Axis for HSS material tool: The figure below shows the variation of Directional Deformation along Y axis in mm, The maximum deformation of magnitude 3.82 e-05 mm was observed.

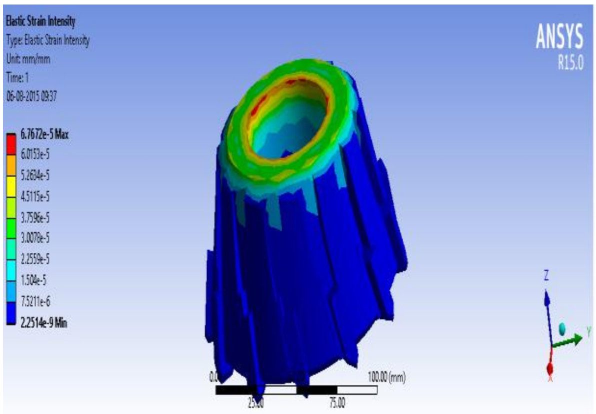




Deformation along Z Axis for HSS material tool : The figure shows the variation of equivalent or Von misses Stress under the moment applied, maximum of 9.46Mpa was found. The von-misses stress was under the material yield strength and hence can withstand the load.

Equivalent Stress for HSS material: The below figure shows the stress intensity observed on the tool during rotation. Maximum of 10.932Mpa was found on the top face of the tool.



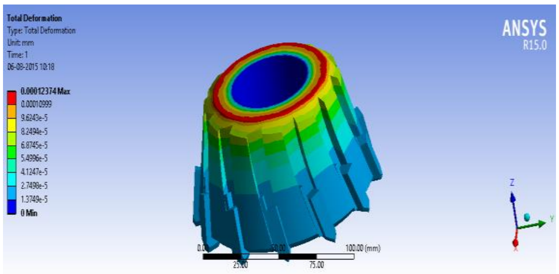


Stress Intensity for HSS Tool : Figure shows the variation of strain intensity for the tool

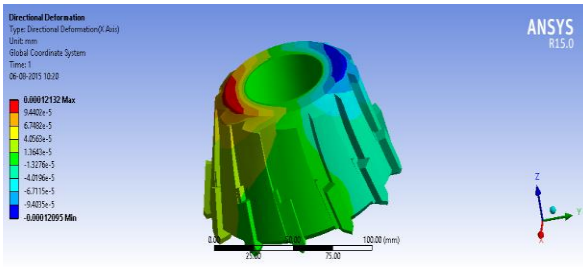
,maximum of 6.76e-5mm/mm was observed at the top face, this is very less magnitude and thus the tool will be able to withstand more deformation.

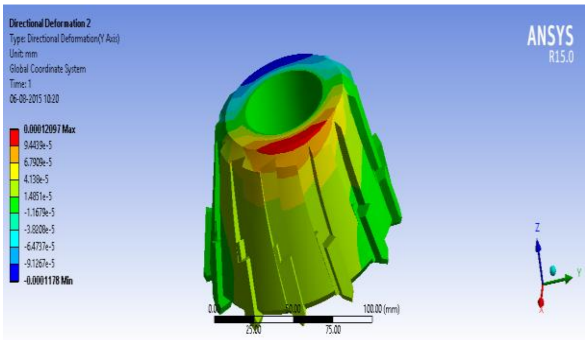
STATIC ANALYSIS OF TOOL WITH CEMENTED CARBIDE MATERIAL:

The figure shows the total deformation of the tool under the moment applied for cemented carbide material, Maximum deformation was observed at the top face of the tool with magnitude of 0.00012.



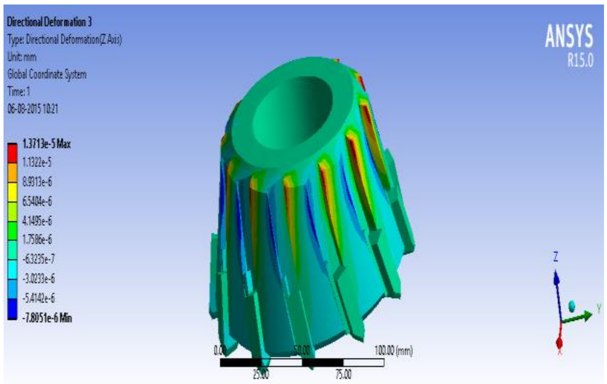
The figure below shows the variation of Directional Deformation along X axis in mm, The maximum deformation of magnitude 0.000121mm was observed.

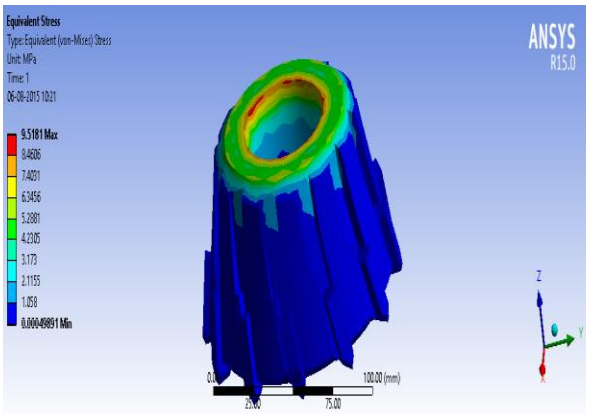




Deformation along X Axis for cemented carbide material tool: The figure shows the variation of Directional Deformation along Y axis in mm, The maximum deformation of magnitude 0.00012mm was observed.

Deformation along Y Axis for cemented carbide material tool : The figure below shows the variation of Directional Deformation along Y axis in mm, The maximum deformation of magnitude 1.37 e-05 mm was observed.





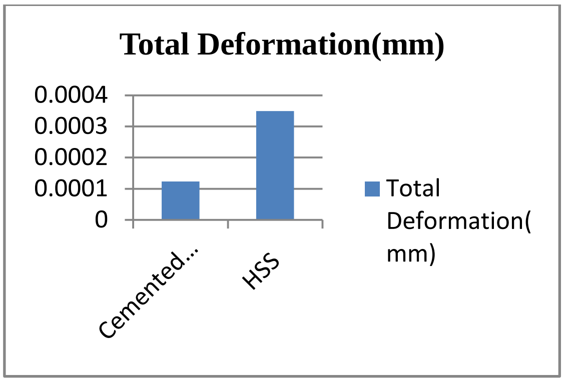
Deformation along Z Axis for cemented carbide material tool:

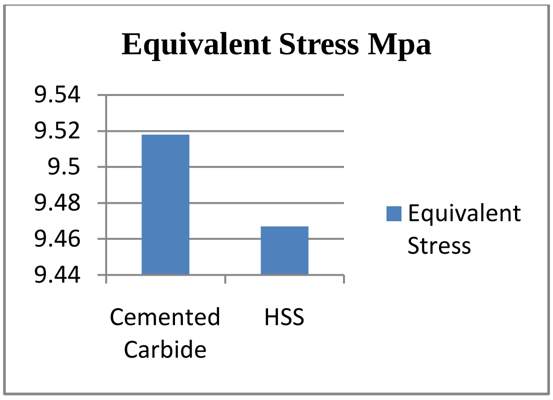
The figure shows the variation of equivalent or Von misses Stress under the moment applied, maximum of 9.5Mpa was found. The von-misses stress was under the material yield strength and hence can withstand the load.

Equivalent Stress for cemented carbide material:

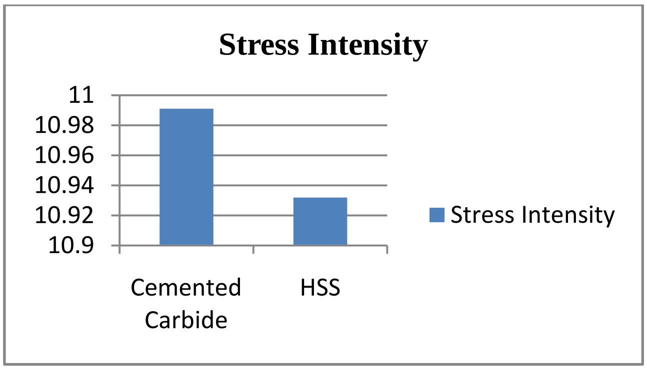
Figure shows the variation of stress intensity for the tool, maximum of 10.99Mpa was observed at the top face, this is very less magnitude and thus the tool will be able to withstand more deformation

RESULTS COMPARISONS:





Comparison of Total Deformation and Equivalent Stress for cemented carbide and HSS



Comparison of Stress intensity for cemented carbide and HSS

CONCLUSIONS : From the results obtained in ANSYS it can be observed that the deformation for HSS material tool is more than the Cemented Carbide tool by approximately 85%.This is due to the high density of cemented carbide.

- Equivalent stress observed for cemented carbide tool is more than HSS material tool
- Stress intensity for the cemented carbide material multi point tool is more than the high speed steel tool
- From the results the fail safe condition for the tool has been established by comparing with the practical data
- Cemented carbide material can be used for the tool when the force required for the milling process is more.

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