DESIGN AND STATIC STRUCTURAL ANALYSIS OF TOOL FLUTE WITH DIFFERENT MATERIALS

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Abstract:

Flute grinding is a critical process in end-mill manufacturing. The wheel geometry and position during the grinding process govern the flute profile and determine the 2-flute parameters Accuracy of these parameters should be ensured to obtain optimal cutting performance. For a given wheel geometry, the current technologies can only determine the wheel position for the desired rake angle and core radius without consideration of the flute width. Tool design and tool geometry are one of the few critical factors considered when machining difficult-to-cut materials. Cutting tool geometry in end-milling and drilling is a topic which needs further understanding, to evaluate the effect of geometrical parameters in machining of difficult-to-cut materials. This research explores the effect of various cutting tool geometries on tool life and surface roughness in end-milling and drilling of difficult-to-cut materials. This disadvantages seriously restricts the improvement of machining quality and the flexibility of flute grinding Machining difficult-to-cut materials such as Titanium alloys, H30 materials used to analysed the structural analysis to find out the deformation, stress and strains

Key words: Structural analysis, Titanium alloys, H30 materials

1.0 INTRODUCTION:

Mechanical micromachining is considered as a cost-effective and efficient fabrication technique to produce three dimensional features and free-form surfaces from various engineering materials. Micro cutting tools are an essential part of mechanical micromachining and they are exposed to harsh conditions which reduces tool life and adversely affect the economics of the process [1] The miniaturization trend in recent years across many industries such as aerospace, automotive, microelectromechanical systems (MEMS), optics, electronics, biotechnology, and communications requires manufacturing of small parts having micro scale features [2]. There are numerous key advantages of miniaturization from both manufacturer and customer perspectives, including portability (which reduces the risk of sample contamination and problems due to mishandling for users of analytical devices), disposability, heat transfer enhancement due to high surface to volume ratios, lower cost of raw material and reduced power consumption [3]Tolerance integrity and surface quality of machine parts are of prime importance in milling processes as well as productivity. Static and dynamic deformations of machine tool, tool holder and cutting tool play an important role in tolerance integrity and stability in a machining process affecting part quality and productivity. Excessive static deflection may cause tolerance violations whereas chatter vibrations result in poor surface finish. Cutting force, surface finish and cutting stability models can be used to predict and overcome these problems. This would require static and dynamic characteristics of the structures involved in a machining system [4]. Considering great variety of machine tool configurations, tool holder and cutting tool geometries, analysis of every case can be quite time consuming and unpractical. These properties are usually obtained experimentally using stiffness measurements and modal analysis [5]. In this study, generalized equations are presented which can be used for predicting the static and dynamic properties of milling system components. Due to its wide use in industry, milling process is considered, however, similar approaches can be applied to other machining operations as well. The structural models presented in this paper, together with the process models, can be used in the development of a virtual machining system where the physics of the process can be simulated in addition to the geometry and tool path in conventional CAD/ CAM applications

2.0 LITERATURE REVIEW

In the manufacturing industry, solid carbide end-mills are one of the commonest metals cutting tools. In an end-mill, the flute Is a critical part which determines the cutter's parameters like rake angle, core radius and flute width. The three parameters have a great influence on the cutting force, temperature, chip removal capacity, cutter life and so on [6]. Therefore, it is extremely important to ensure their accuracy in end-mill machining. Over the past decades, many research works have been focused on the methods of grinding the flutes with the specified profiles and parameters [7]. Generally, they can be categorized into two approaches. The first approach adopts the non-standard wheels of which the profiles are designed as per the desired flute profiles. Following the principles of differential geometry and kinematics, [8] determined the wheel profile based on the condition that the common normal vector at the contact point between the flute and the wheel surface should intersect the axis of the wheel. However, this is beyond the main focus of this research work, and generating the end-mill shapes is limited to the geometrical interaction with the cutters [9]. For a certain end-mill and a certain cutter a cutter's path can be generated using the approach developed previously in the first part of this work. The path should ensure an exact side cutting edge and an accurate normal rake angle for the rake face of the end-mill. However, in order to validate the path, and to ensure an end mill core with a specific radius, a machining simulation model is developed and introduced in this article. in order to generate a swept volume for the cutter along its path [10]. Subtracting the swept volume from the end-mill billet will generate the updated shape of the end-mill as a 3D model. The flute shape is defined by its cross-sectional profile in a plane perpendicular to the end-mil axis. The closest point in the profile to the end-mill axis specifies the core radius [11-12]. A comparison is performed in this work between the cross-sectional profile of the designed end-mill and the cross-sectional profile obtained from the machining simulation in order to generate an end-mill with an exact core

3.0 Research Methodology

One critical factor which can affect tool life in machining of difficult-to-cut materials is the tool geometry other factors such as the grade of tool material coolant, coating and machining techniques can also play a vital role when machining a difficult-to-cut material. Additional factors that play an important role in machining are coolant delivery method, workpiece material, machining techniques or strategies and unstable conditions in CNC machining. In most cases, it is the lack of knowledge and inadequate experience in tooling and tool material which generates problems in various areas such as machining environment, tooling, lack of information on the workpiece material being machined coatings and coolant. Therefore, the reason why the productivity of these materials is extremely low, becomes clear. Previously, the importance of cutting tools in manufacturing environments were usually ignored due to little financial support or technical expertise in the area.

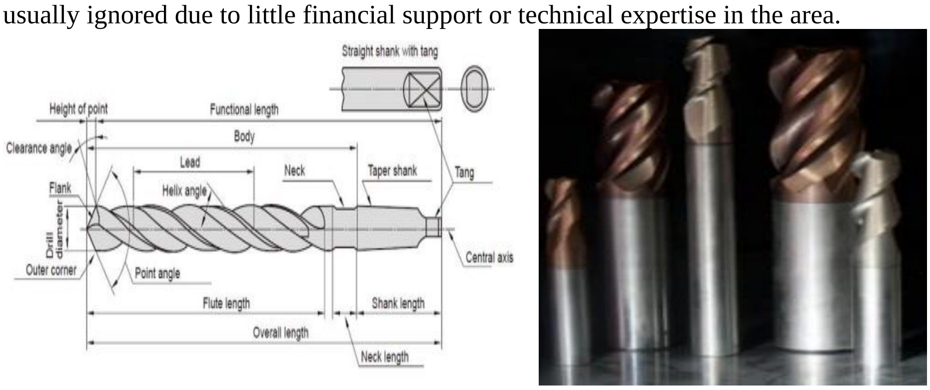

Figure 3.1: a) Geometry model b) coated carbide tools

However, tool design is now considered to be one of the most important aspects of the machining process design in tool design, it is important to thoroughly consider tool geometry, tool material, surface treatment, coating technology and their combination to improve the total machining performance. Tool geometry is of utmost importance due to the direct effect it has on.

- Tool life
- Surface finish and quality
- Chip flow

Consider a two-dimensional orthogonal cutting with a single-point cutting tool The rake angle (γ) is the angle of the rake surface where the chip is being formed as the tool cuts the material The flank angle(θ) denoted as (α) shown in Fig. is the clearance angle 10 between the cutting tool and the freshly cut surface to prevent friction between flank face and workpiece. The cutting edge can be described as a theoretical point at which the rake and flank surfaces meet. define the cutting edge at the first point of contact as the tool moves towards the workpiece. mentions that the rake angle, flank angle and the cutting edge are three major geometrical parameters with rake angle being the most critical. It should be noted that three-dimensional tools where helix angle is present, such as end-mills and drills, the rake angle becomes harder to define and model.

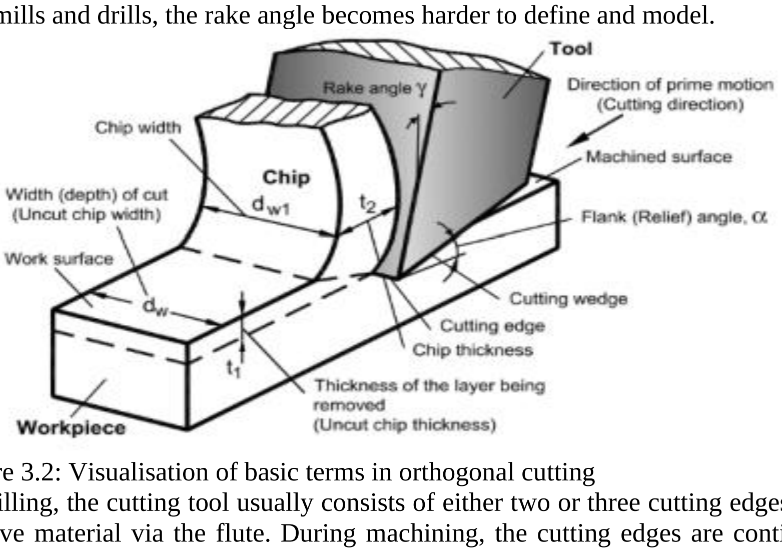

Figure 3.2: Visualisation of basic terms in orthogonal cutting

In drilling, the cutting tool usually consists of either two or three cutting edges and rotates about its axis in order to remove material via the flute. During machining, the cutting edges are continuously removing material from the

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workpiece; this is in contrast to turning in which there is one continuously engaged cutting edge. In a twist drill, material removal occurs by extrusion near the chisel edge (the cutting speed is negligible at this particular point on the drill). On the cutting edges however, material is removed by shearing the workpiece

Used materials:

Titanium alloys: Titanium alloys are alloys that contain a mixture of titanium and other chemical elements. Such alloys have very high tensile strength and toughness (even at extreme temperatures). They are light in weight, have extraordinary corrosion resistance and the ability to withstand extreme temperatures.

operty	inimum Value (S.I.)	aximum Value (S.I.)
ear Modulus	)	5
nsile Strength	52	200
oung's Modulus	10	19

H30 Material: It is main production grade, which has been approved by customers in many countries since its initial production, including our H30 round bars, flat bar, forgings, fasteners, tubes, wires, strips, sheets & Plates, as well as a variety of profiles, professional high precision auto-lathe processing manufacturer of clinching fasteners, axes, standoffs, screws, studs, nuts, bolt, OEM parts and special shaped turning parts the state of delivery includes quenched and tempered, annealed, machined semi-finished products, we also have strict management of the packaging, to avoid material damage from transportation

Mechanical Properties

Tensile strength	130 ~ 983	σb/MPa
Yield Strength	181	σ 0.2 ≥/MPa
Elongation	60	δ5≥(96)
ψ	-	ψ≥(96)
Akv	-	Akv≥/J
HBS	500 ~ 093	-

Design of tool flute analysis

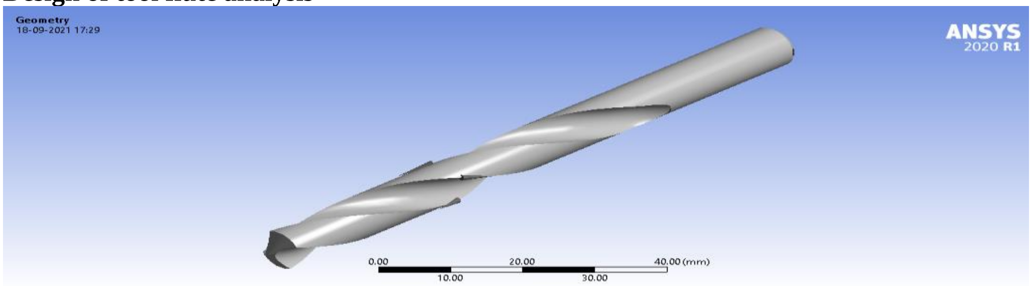

Figure 3.3: Imported geometry model

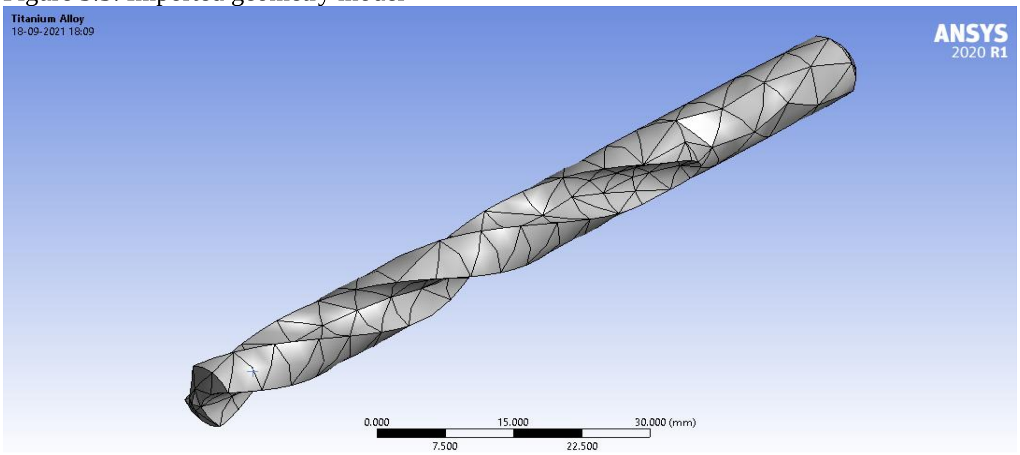

Figure 3.4: Meshed model

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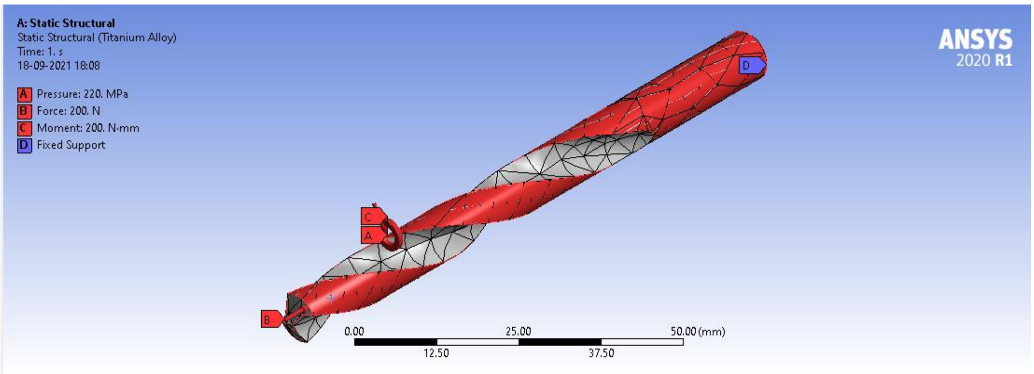


Figure 3.5: Force applied tool

4.0 Results and discussions:

Structural analysis of Tool using with Titanium alloys:

Structural analysis is the determination of the effects of loads on physical structures and their components. The results of the analysis are used to verify a structure's fitness for use, often precluding physical tests. Structural analysis is thus a key part of the engineering design of structure

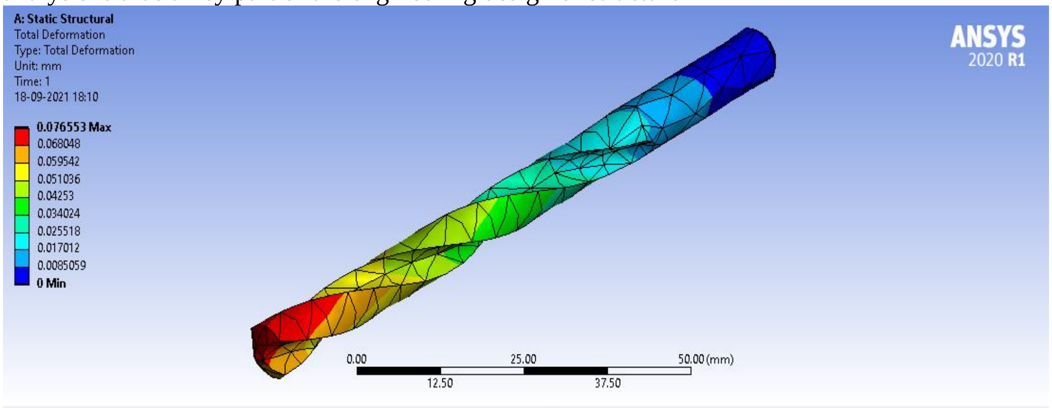


Figure 4.1: Total deformation

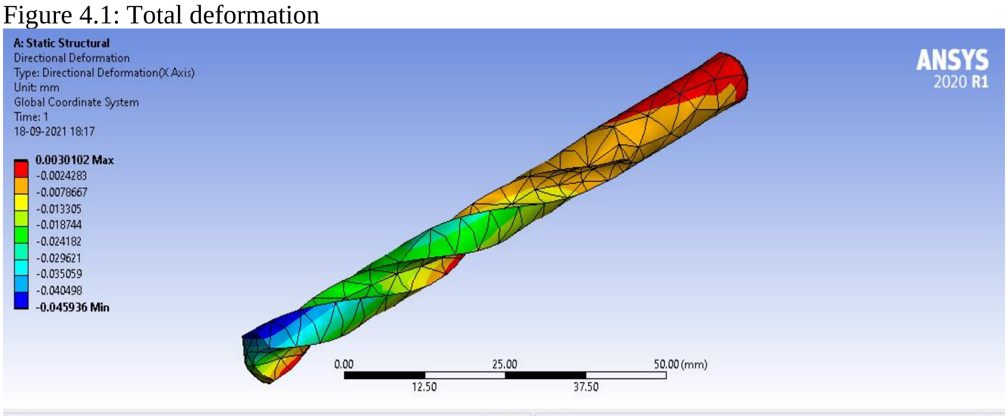


Figure 4.2: Directional deformation

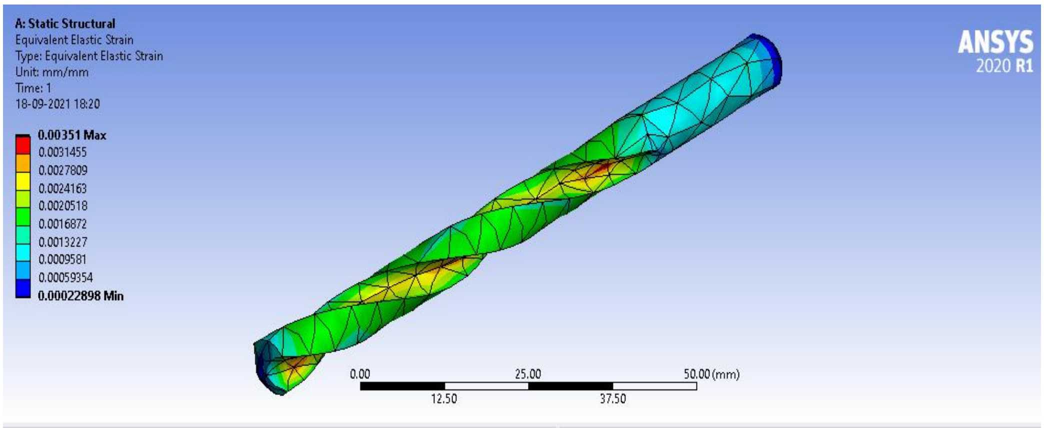


Figure 4.3: Equivalent elastic strain

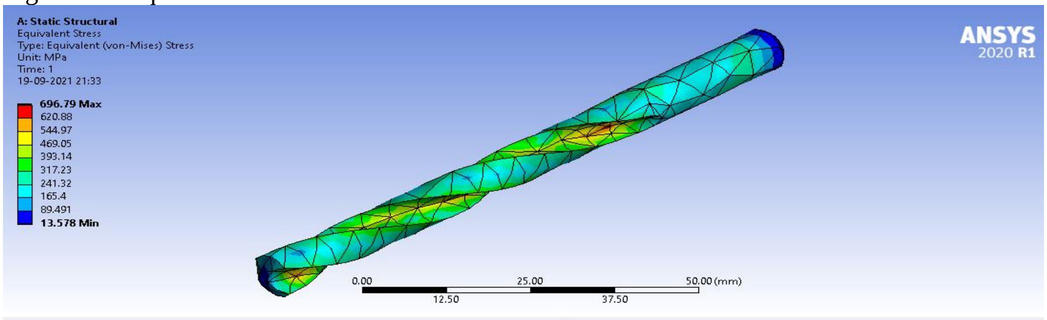
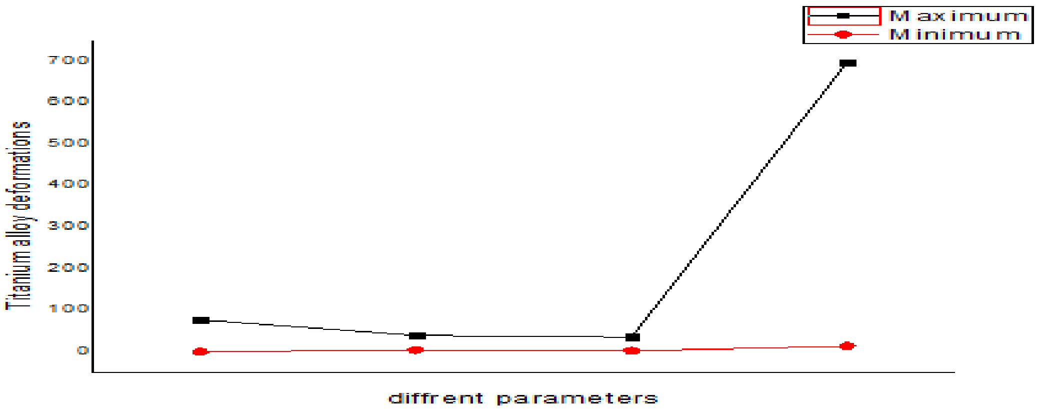


Figure 4.4: Equivalent stress

Table 4.1: Structural analysis of Tool using with titanium alloys

ırameters	**aximum**	**inimum**
›tal deformation	;.553	
irectional deformation	).102	5936
µuivalent elastic strain	;.10	2898
µuivalent stress	)6.79	;.578



Graph 4.1: Structural analysis of Tool using with titanium alloys variations

Structural analysis of Tool using with H30

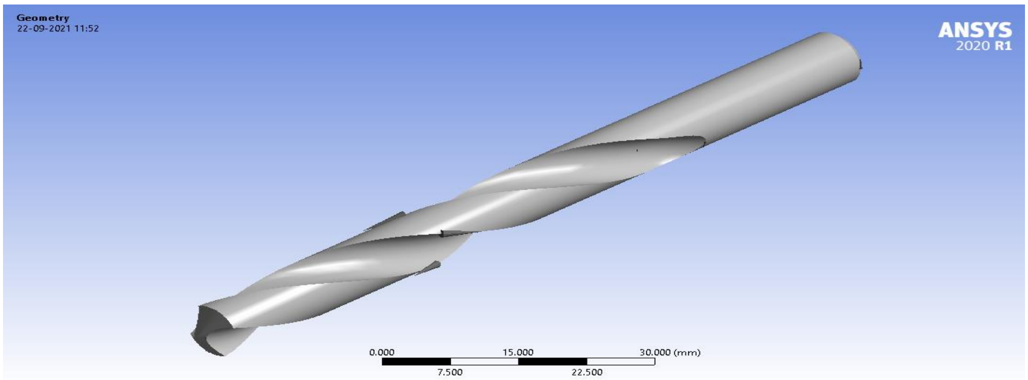


Figure 4.5: Geometrical model

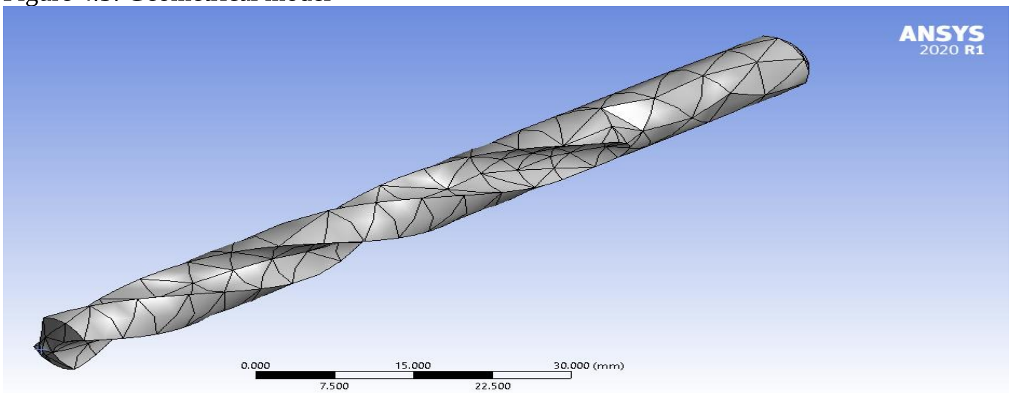


Figure 4.6: Meshed model

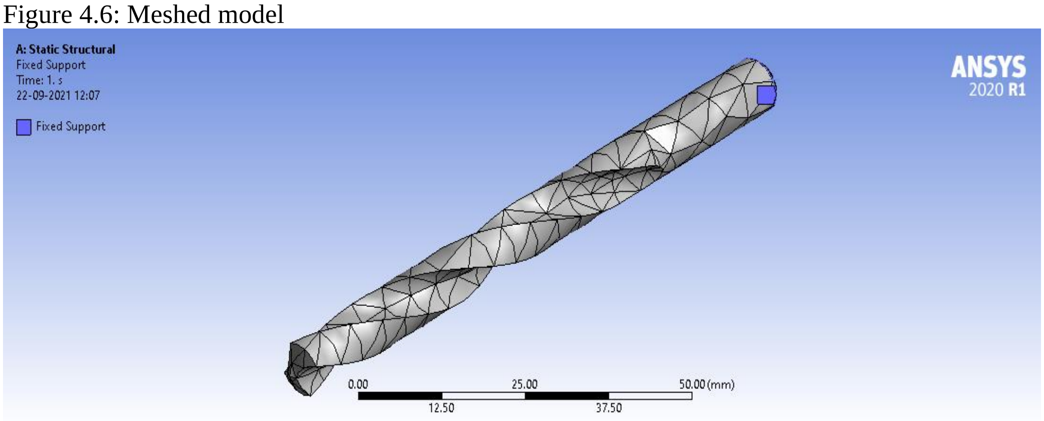


Figure 4.7: Fixed support model

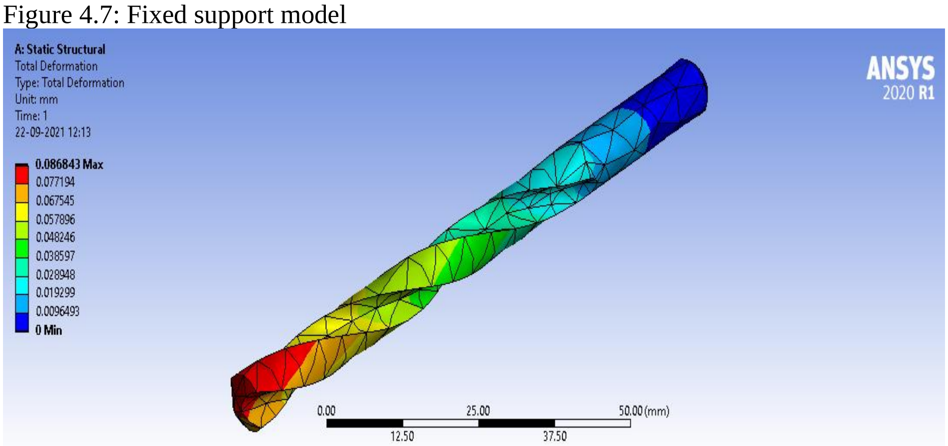


Figure 4.8: Total deformation

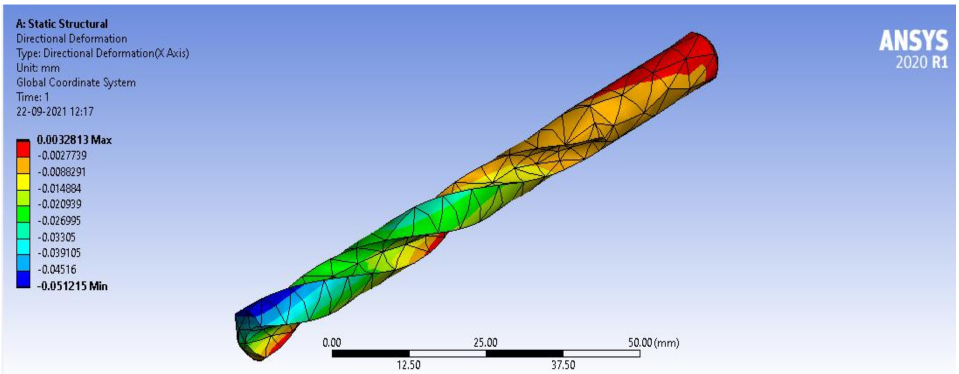


Figure 4.9: Directional Total deformation

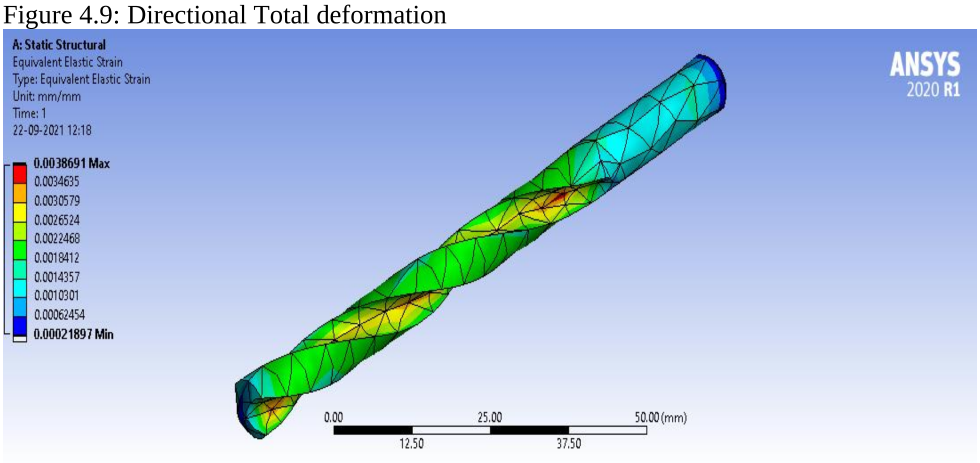


Figure 4.10: Equivalent Elastic Strain

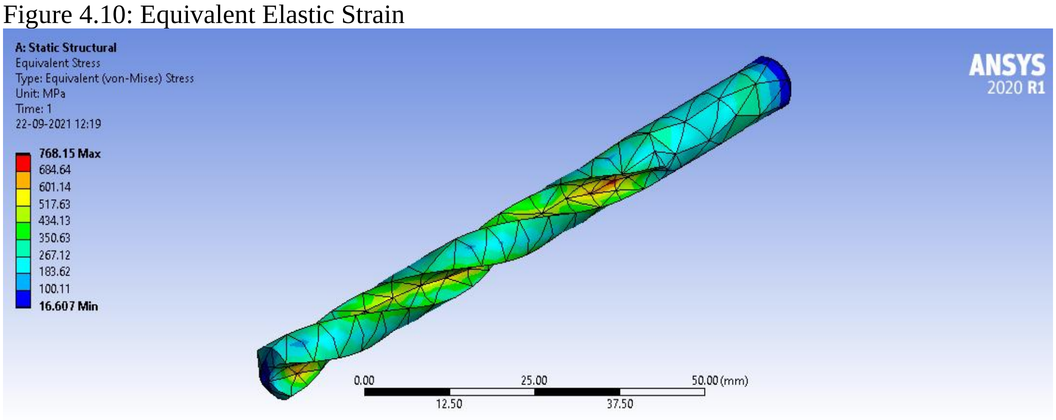
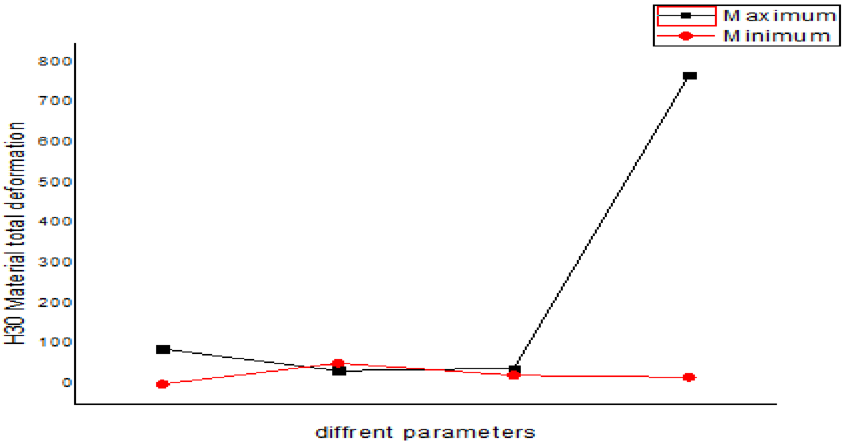


Figure 4.11: Equivalent stress

Table 4.2 : Structural analysis of Tool using with H 30 alloys

arameters	**aximum**	**inimum**
otal deformation	.843	
irectional deformation	.813	.215
quivalent elastic strain	.691	.897
quivalent stress	8.15	.607



Graph 4.2: Structural analysis of Tool using with H 30 alloys variations

A high-speed milling experiment using an ultra-fine substrate of WC-Co for machining titanium alloy was carried out the optimised cutting tool from the simulation exhibited longer tool life and produced more refined chips Carbide tools generate higher temperatures during machining than Cemented Carbide tools, as demonstrated by experiment and finite element analysis Carbide tools generate higher temperatures during machining than Cemented Carbide tools, as demonstrated by experiment and Static structural analysis

CONCLUSION:

This paper presents an accurate method of four-axis flute grinding tools in cylindrical end-mills to study that titanium alloys H30 materials with static structural analysis find out the titanium alloys is the strongest pure grade titanium, but it is also the least moldable. Still, it has a good cold formability, and it has many medical and industrial uses because of its great strength, durability and weldability The ground flutes and the measured results are synthesized It can be seen that the two ground flutes accord well with the simulation results, although the errors of the flute parameters are larger than the obtained results indicate that the predicted forces and simulated forces are closer to each other. Based on these observations it is decided to carry out further work to experimentally verify the dynamic stresses and forces of end mill while milling titanium alloys considering appropriate machining parameters.

References:

1. E. Budak, Y. Altintas, Modeling and avoidance of static deformations in peripheral milling of plates, International Journal of Machine Tools and Manufacture 34 (3) (1995) 459–476.
2. Y. Altintas, S. Engin, Generalized modeling of mechanics and dynamics of milling cutters, Annals of the CIRP 50 (2001) 25–30.
3. Y. Altintas, E. Budak, Analytical prediction of stability lobes in milling, Annals of the CIRP 44 (1995) 357–362.
4. E.J.A. Armarego, R.C. Whitfield, Computer based modeling of popular machining operations for force and power predictions, Annals of the CIRP 34 (1985) 65–69.
5.] J. Tlusty, F. Ismail, Basic nonlinearity in machining chatter, Annals of the CIRP 30 (1981) 21–25.
6. Minis, T. Yanushevsky, R. Tembo, R. Hocken, Analysis of linear and nonlinear chatter in milling, Annals of the CIRP 39 (1990) 459–462.
7. E. Budak, Y. Altintas, Analytical prediction of chatter stability in milling-part I: general formulation; part II: application to common milling systems, Transactions of the ASME, Journal of Dynamic Systems, Measurement, and Control 120 (1998) 22–36.
8. M.A. Davies, J.R. Pratt, B. Dutterer, T.J. Burns, Stability prediction for low immersion milling, Transactions of the ASME Journal of Manufacturing Science and Engineering 124 (2002) 217–225.
9. T. Insperger, B.P. Mann, G. Stepan, P.V. Bayly, Stability of up-milling and down-milling, part 1: alternative analytical methods, International Journal of Machine Tools and Manufacture 43 (2003) 25–34.
10. Yu S. R., Zhao X. H., Pu X. M. Image characteristics of dermopathic herpes virus disease under reflectance confocal microscope. China Journal of Leprosy and Skin Diseases. 2015;31(2):85–88.
11. Z.J. Yuan, M. Zhou, S. Dong, Effect of diamond tool sharpness on minimum cutting thickness and cutting surface integrity in ultraprecision machining, Journal of Materials Processing Technology 62 (1996) 327-330
12. Zhong L. S., Jin X., Quan C. Diagnostic applicability of confocal laser scanning microscopy in psoriasis vulgaris. Chinese Journal of Dermatovenereology. 2011;25(8):607–608.