DESIGN AND ANALYSIS OF SINGLE POINT CUTTING TOOL BY USING ANSYS

Prathamesh Jugulkar[1], Sumit Patil[1] , Prathamesh katkade[1] , Pradnya Kesarkar[1] , Disha Kurkure[1]
Prof. Pramod kale[2]
[1]Research Scholar, Department of Mechanical Engineering VIT Pune
[2]Professor , VIT Pune

ABSTRACT - In this project, cutting forces at single point cutting tool-tip interface is applied, generated in highspeed machining operations. An investigation of deformation occurred on the tool is carried out by subjecting it to the maximum possible working stress during a cutting operation. By varying the materials, the effect of those on materials is analyzed using FEA. In this report, an FEM simulation technique is utilized to investigate the deformation of tip of single point cutting tool under the influence of cutting forces.

Keywords – SPCT , Simulation , Analysis.

I. INTRODUCTION

Cutting is the separation of a physical object or a portion of a physical object into two portions, through the application of an directed force. However, any sufficiently sharp object can cut if it has a hardness sufficiently larger than the object being cut, and if it is applied with sufficient force. Cutting is a compressive and shearing phenomenon, and occurs only when the total stress generated by the cutting implement exceeds the ultimate strength of the material of the object being cut. The stress generated by a cutting implement is directly proportional to the force with which it is applied, and inversely proportional to the area of contact. Hence, the smaller the area (i.e., the sharper the cutting implement), the less force is needed to cut something.

A cutting tool or cutter is any tool that is used to remove material from the work piece by means of shear deformation. Cutting may be accomplished by single point or multipoint tools. Single point tools are used in turning, shaping, planning and similar operations, and remove material by means of one cutting edge. Milling and drilling tools are often multipoint tools. Grinding tools are also multipoint tools. Cutting tools must be made of a material harder than the material which is to be cut, and the tool must be able to withstand the heat generated in the metal cutting process. Also, the tool must have a specific geometry, with clearance angles designed so that the cutting edge can contact the work piece without the rest of the tool dragging on the work piece surface. The angle of the cutting face is also important plus the speeds and feeds at which the tool is run.

II. GEOMETRY (SINGLE POINT CUTTING TOOL)

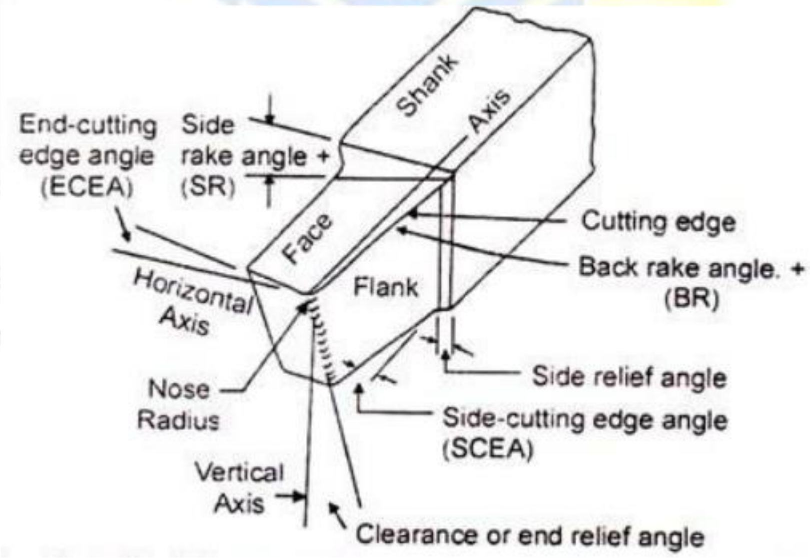


Fig. 1 Tool Geometry of Single Point Cutting Tool

Sr No.	Parameters	Values
1	Back Rake Angle	8
2	Side Rake Angle	10
3	End Relief Angle	6-8
4	Side Relief Angle	7-9
5	Standard Shank	10x16
6	Tool length depends on cross section	100 to 500 mm
7	Nose Radius	0.5 to 0.8

Table 1 Parameters of SPCT Angles

III. TOOL TERMINOLOGY

1. **Side cutting edge angle**: This angle also is known as the lead angle. This is the angle between the side cutting edge and side of the tool shank.

2. **End cutting edge angle**: This is the angle between the end cutting edge and a line normal to the tool shank.

3**. Side relief angle**: It is the angle between the portion of the side flank immediately below the side cutting edge and a line perpendicular to the base of the tool and measured at the right angle to the end flank.

4**. End relief angle**: It is the angle between the portion of the end flank immediately below the end cutting edge and a line perpendicular to the base of the tool and measured at the right angle to the end flank.

5. **Back rack angle**: It is the angle between the tool face and a line parallel to the base of the tool and measured in a plane perpendicular through the side cutting edge. The back rack angle is positive if the side cutting edge slopes downwards from the point towards the shank and the back rack angle is negative if the slope is side cutting edge is reversed.

6. **Side rack angle:** It is the angle between the tool face and a line parallel to the base of the tool and measured in a plane perpendicular to the base and the side cutting edge. This angle gives the slope of the face of the tool from the cutting edge. The main steps of the image classification process are shown in the following diagram:

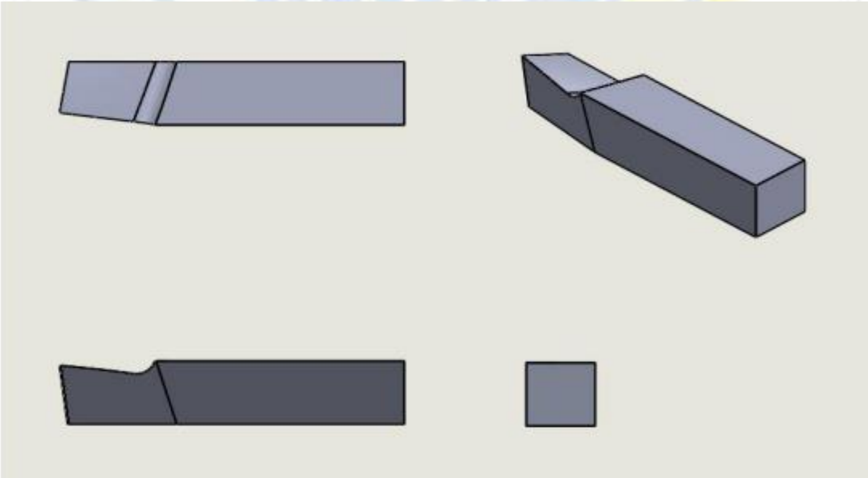


Fig. 2 Views of single point cutting tool:

IV. OBJECTIVES

• To check the deformation of material after applying the force.

• To compare the results of the different materials to check the deformation

V. METHODOLOGY

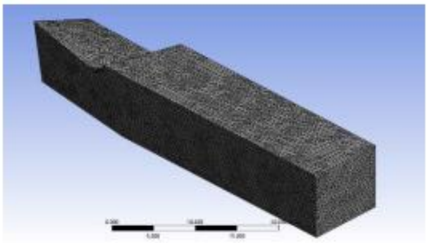
- Modelling: Modelling of Single point cutting tool is done by solid works as per the geometrical considerations.
- Meshing: Meshing is done by using ANSYS workbench. It is necessary to understand how the structure is likely to behave and how elements are able to behave.
- Boundary conditions: Fixing the end face of the Single point cutting tool and applying force on the cutting edge.
- Analysis: Analysis is done by using ANSYS

a. MATERIALS PROPERTIES

Materials	Molebdenum HSS	Tungsten Carbide	Chromium Steel
Density (g/cm3)	8.194	15.63	7.19
Young's Modulus	2x10^11	5.5x10^11	1.9x10^11
Poisson's Ratio	0.3	0.31	0.2

Table 2. Material Properties

b. MESHING



Statistics	
Nodes	421723
Elements	301913

Fig. 2 Mesh type: Tetrahedron

c. FORCE APPLICATION

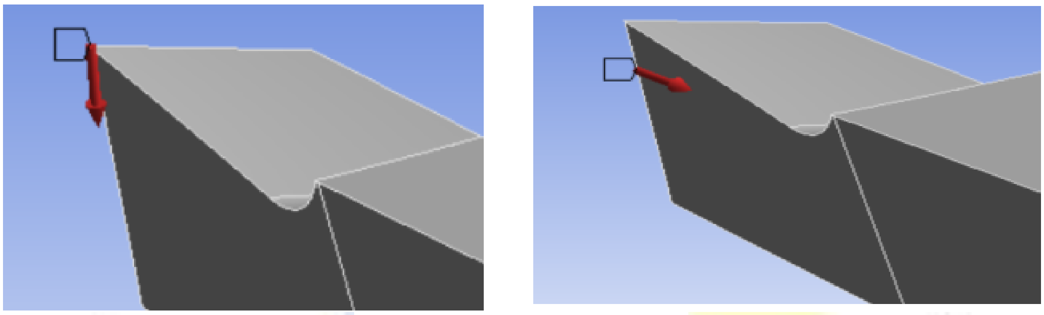


Fig .3 (a) Fc Force (b) Ft Force

VI. CALCULATION

M1 = Actual Bending Moment
M2 = Maximum Permissible Bending Moment
M1 = Fc x l
M2= Fb x z
Fc = Cutting Force
l = Overhang of tool
Fb = Permissible Bending Stress For Shank material
Fb = 655/3 = 218 N/mm2
z = Section Modulus for Shank
∴ M1 = M2
Fc x l = Fb x z
z = BH2 /6
l = 1.25 H
B = H/ 1.25
Fc x l = Fb x z
Fc x 1.25 H = Fb x (BH2 /6)
Fc x 1.25 H = Fb x((H/1.25)H2 /6)
H = √Fc x 1.25x1.25x6/Fb

$H = \sqrt{12.66 * 9.81 * 1.25 * 1.25 * 6/218}$

$H = 2.33$ mm

VII. RESULT MERCHANT FORCE CIRCLE DIAGRAM

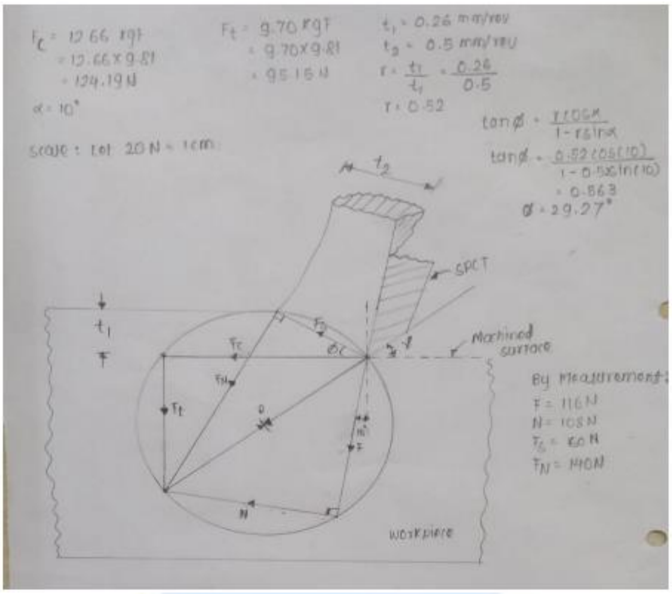


Fig .4 Merchant Force Circle

VIII. RESULT AND DISCUSSION

we take the value of cutting force (Fc) and Thrust force (Ft) as,

Fc=12.66 kgf

= 12.66*9.81= 124.1946 N

Ft=9.70 kgf

= 9.70*9.81= 95.157 N

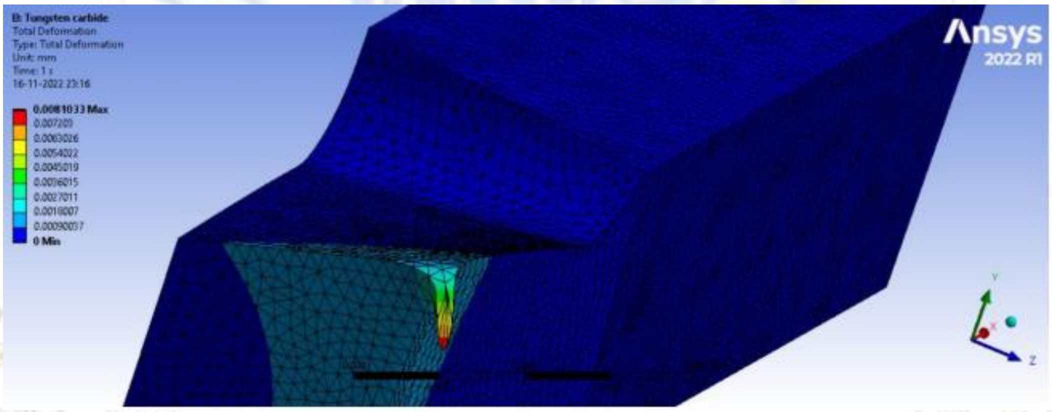


Image 1. Total Deformation of Tungsten Carbide tool

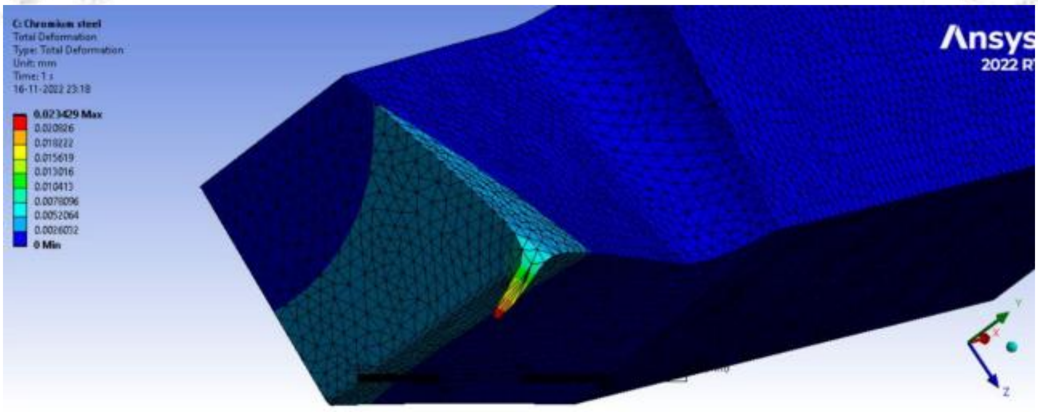


Image 2. Total Deformation of Chromium steel

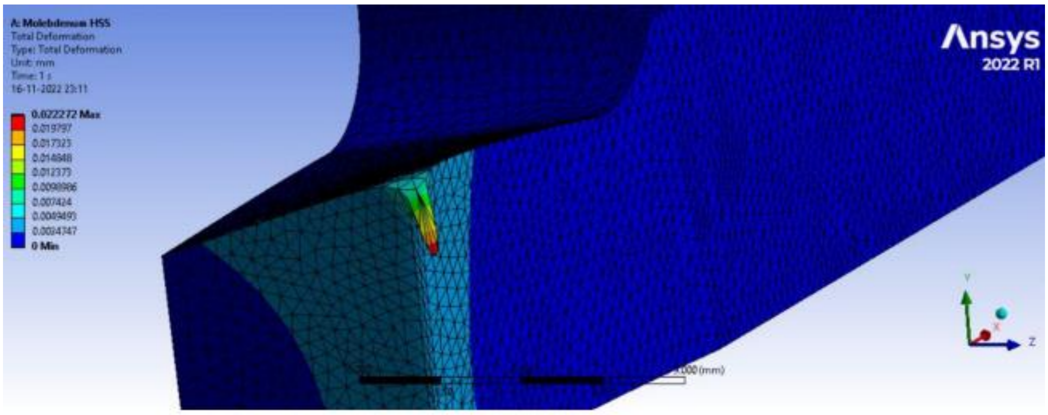


Image 3. Total Deformation of Molybdenum HSS

The Image .1 ,Image.2 and Image .3 shows the Total Deformation of the Chromium Steel , Tungsten Carbide tool and Molybdenum tool respectively. Total Deformation of Tungsten Carbide tool is 0.0081033 mm Total Deformation of chromium steel is 0.023429 mm and Total Deformation of Molybdenum HSS is 0.022272 mm at the cutting and thrust force is 124.1946 N and 95.157 N respectively.

IX. Conclusion

The result shows that the total deformation of tungsten carbide is less than the Chromium Steel and Molybdenum. As we mentioned in the objectives, it is concluded that the performance of Tungsten Carbide is better than Chromium Steel tool material.

X. Scope of Future work

The following recommendations are made for future work in this area: • For analysis the tool material can be taken as Ceramics, Cemented Carbide and Carbon Steel etc. • Design and Analysis of Single point cutting tool can also be carried by changing cutting parameters such as Rake angle, Feed etc. • The working procedure can be carried out for tool wear and vibration for further analysis.

XI. REFERENCES

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