International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 4 April 2023, pp: 1331-1333 www.ijaem.net ISSN: 2395-5252

Design of a Single-Point Cutting Tool

Dipak Devrao Padole, Prasad Dilip kumar Ransing

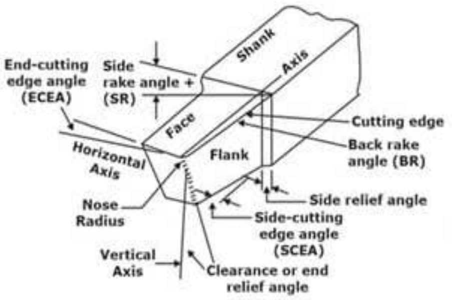
Date of Submission: 15-04-2023 Date of Acceptance: 25-04-2023

ABSTRACT –A single-point cutting tool is the type of cutting tool or cutter that removes material by means of one cutting edge during a single stroke of movement. This paper deals with the design of a single-point cutting tool for machining medium carbon steel with a cutting velocity of 400 m/min, feed of 0.5mmperrevolutionanddepthofcutof0.5mm. Single point cutting tool is used for important operation in the lathef working facing and turning hence study of geometry of a single point cutting tool is very important part of study required for manufacturing. The single point cutting tool design involves collecting data from the data book. It is an iterative process that involves varying the angle within a certain limit provided by the data to get an optimum result.

KeyWords: Single point cutting tool, design, medium carbon steel, carbide tool, power consumed, lathe, American standard association, orthogonal rake system, vector method of conversion.

I. INTRODUCTION

Single point cutting tool is a tool which touches the work piece at only one point. An operation like turning, facing, shaping, planing, boring etc use single-point cutting tool. shank. As an important part of tool increasing the durability and life of the tool material is an important factor while making a tool. A small change of even 1 in the tool parameters can alter the force encountered by the tool by more than ten times. Hence the proper design of the tool is very important .



Single point cutting tool

In this paper, we designed a single point cutting tool based on a proper condition that can be extended to any variation of data. In this paper we have taken the following prerequisite-

- Work piece material – cast iron or mild steel
- Cutting velocity [Vc] - 36.576meter/minute
- Feed[S_0]-:0.5mm/rev
- Depth of cut[t]-:0.5mm

The important properties of the work material are are like as

- Ultimate Tensile Strength– 827 MPa
- Tensile Strength Yield - 124Mpa
- Modulus of Elasticity - 200GPa
- Density -7.8*10^3kg/m^3
- Brinell Hardness Number [BHN] -110
- Shear Modulus - 77.5GPa

Before designing cutting tool we know of the requirements. The requirements of the cutting tool are as

1)The cutting tool and the work material must be held rigidly so the tool can penetrate the work piece when forces are applied.
2)The shank of the tool must be properly analyzed for strength and rigidity.
3)The deflection of the tool must be within a certain limit.

II. MATERIAL SELECTION

The required properties of tool material are listed below

- The tool material is harder than the work piece.
- The tool material must be chemically inert.
- The material must be able to resist wear and tear.
- The material should be thermally stable.
- The material should have good thermal conductivity and less coefficient of thermal expansion.

Some common Tool materials most widely used are-:

- Carbide
- Ceramic
- Cubic Boron Nitride
- Diamond
- High speeded steel
- Tool with coating of Titanium Carbide(TiC) and Titanium Nitride (TiN).

In our design wes electe Carbide tool with a coating of TiC as BHN of Carbide is much higher than that of medium carbon steel.

III. DETERMINATION OF ANGLES

From the data book , the recommended angles for carbide tool in ASA system.

- Back rake angle(Yy) -0
- Side rake angle(Yx) -6
- End clearance angle(αy) -5
- Side clearance angle(αx) -5
- Side cutting edge angle(ϕs)-15
- Approach angle(ϕ)-: -75
- Nose Radius(r) -1 mm

3.1 Conversion from ASA system ORS

We have used the vector method of conversion from ASA system to ORS

1]Tan(Y_0)=Tan(Yx)Sin(ϕ)+Tan(Yy)Cos(ϕ)
=Tan(Y_0)= Tan(6)Sin(75) +Tan(0)Cos(75)
=Tan(Y_0)=0.1015
=Y_0=Tan^{-1}(0.1015)
Y_0=5.795

2]Tan(**λ**)= Tan(Yy)Sin(ϕ)-Tan(Yx)Cos(ϕ)
=Tan(**λ**)= Tan (0)Sin(75)-Tan(6)Cos(75)
=Tan(**λ**)=-0.0272
=λ=Tan^{-1}(-0.0272)
=λ=-1.568

3]Cot(α_0)=Cot(αx) Sin(ϕ)+Cot(αy)Cos(ϕ)
=Cot(α_0)=Cot(5)Sin(75)+Cot(5)Cos(75)
=Cot(α_0)=13.998
=Tan(α_0)=0.0714
=α_0=Tan^{-1}(0.0714)
=α_0=4.083

Hence the angles in ORS (Orthogonal Rake System)are as
λ -In clination Angle--1.558
Y_0-OrthogonalRakeAngle-5.795
α_0-Orthogonal Clearance Angle-4.083
α_0'-Auxiliary ClearanceAngle-2
ϕe–Auxiliary Cutting EdgeAngle-15
ϕ-EndCuttingEdgeAngle-75
r-Nose Radius-1mm

CALCULATION OF DYNAMICSHEAR STRESS

Dynamic shear stress is the product of Brinell hardness number and 0.186.

We know,τ=0.186*BHN
=0.186*110
=20.46kg/mm²
=204.6N/mm²

DETERMINATION OF CHIP REDUCTION COEFFICIENT(ζ)

Chip Reduction Coefficient is defined as the ratio of chip thickness before cut to the chip thickness after cut .It indicates the degree of deformation.

Assuming it to be rough turning cycle the chip reduction coefficient is assumed to be 2.5 and Factor of safety [FOS] is assumed as10.

CALCULATION OF TANGENTIAL FORCE

Tangential force is defined as the component of force which acts on the edge of the cutting tool along at angent to cutting tool body.
PZ = t s_0 τs(ζ - Tan(Y_0) +1)Here,
t is the thickness of the work piece
s_0 is the feed,
PZ=0.5*0.5*303.18(2.5-0.1015+1)
=173.83N

CALCULATION OF LONGITUDINAL FEED FORCE

Px= t s_0 τs(ζ - Tan(Y_0) -1) Sin(ϕ)Here,
t is the thickness of the work pieces$_0$ is the feed
=0.5*0.5*204.6(2.5-0.1015-1)Sin(75)
=69.07N

CALCULATION OF RADIALFORCE

Py=t s_0τs (ζ - Tan(Y_0)-1)Cos(ϕ)
=0.5*0.5*204.6(2.5-0.1015-1)Cos(75)
=18.50N

CALCULATION OF CROSS-SECTION ALDIMENSION

We assume that
H/B must be between1.25-1.6, Here
His the height the tool
Bis the breadth of the tool
The effective length Le of the tool must be between 25-30mm for proper holding of the tool.
So, we assume H/B = 1.5 and Le =30 mm We Know,
Total stress is given by the sum of principal stresses i.e.,σ=σ_1+σ_2

$$\sigma = \frac{6PzLe}{BH^2} + \frac{6PxLe}{HB^2} \ldots\ldots\ldots\ldots\ldots(i) \text{----}(1)$$

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 4 April 2023, pp: 1331-1333 www.ijaem.net ISSN: 2395-5252

Now,

$$\sigma = \frac{\sigma\, ut}{FOS} = \frac{565MPa}{10} = 56.5\ MPa) \_\_\_\_\_ (2)$$

Now, from(1)and(2),
Sigma =82.7Mpa

$$82.7 = \frac{6*257.596*30}{2.25*B^3} + \frac{6*102.39*30}{1.5*B^3}$$

B=15.46 mm
Assuming a nearest standard value of the integer we get B=15mm
From the recommended set of cross section 15*10 is available.
So the Cross-Section of the cutting Tool is 15*10mm.

POWER CONSUMED
The power consumed in the cutting operation the work piece is given by the equation

P= Pz*Vc Here,
Pz is the Tangential Force Vc is the cutting velocity
={(173.83*36.57)/60}Watt
=105.94Watt
=0.105 KW

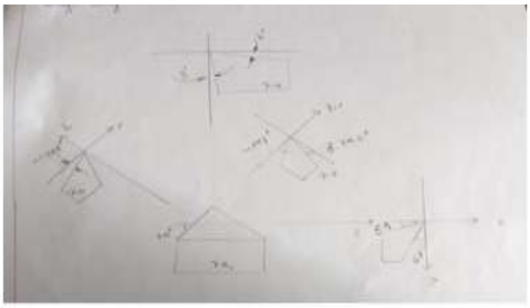
DEFLECTION

$$\delta = \frac{4PzLe^3}{EBH^3}$$

= 0.00625788 mm
=6.25788microns

TOOL SIGNATURE
The expected tool signature in ORS System is
-1.558-5.795-4.083-2-15-75-1

ROUGHDIAGRAM



IV. CONCLUSION

This work deals with the design of single point cutting tool and after the determination of forces the effect of these forces were studied. With all these forces it can be summarized that the design of the single point cutting tool is strong enough to be ar cutting for ces during all kind of lathe operation.

REFERENCES

[1]. Dr. P.C.Sharma, A Textbook of Production Engineering Technology .
[2]. Pradeep Kumar Patil, A.I. Khandwawala Design of single point cutting tool , International Journal of Engineering Science Invention Research & Development; Vol. I Issue I
[3]. Hemanth ,Muralidharan ,Predictive analysis of mill cutters for improved surfacefinish quality and effects of coolant on carbide tools,Advanced Research Journals Of Science And Technology,Volume: I, Issue : II
[4]. U.Pradeep Kumar, C Fakrunnisha, Experimental Investigation of Optimizing En8 and En19 Steels Using Cryogenic Technique With Ansys Results, Journal of Mechanical and Civil Engineering ,Volume 15 ,Issue 4
[5]. Shiv Prakash Singh, TanweerAlam, Somnath Chattopadhyaya, A Review on the Excavator Tool Bits Wear, Proceedings of the 1st International and 16 th National Conference on Machines and Mechanisms (iNaCoMM2013), IIT Roorkee, India, Dec 18-20 2013