REVIEW OF INFLUENCE OF DIFFERENT CUTTING ANGLES OF SINGLE POINT CUTTING TOOL ON TURNING OPERATION

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Abstract-*In order to improve surface finishing, reduce the production time and energy loss which is being wasted to re sharp the tools when they got blunt during machining, hence in accordance to this problem, in this research work the effect of different cutting angles on surface finishing have studied. The various angles using in our project while the other parameters like depth of cut, feed rate, cutting speed keeping constant. All the experiments will apply on mild steel with High Speed Steel HSS M7 (S400) grade material as cutting tool.*

Keywords- surface finishing, HSS M7 (S-400), cutting angles, turning operation ,tool signature.

I. INTRODUCTION:

In industries even a single second is precious in production sector. Useful production time, money and energy is being wasted during the re sharpening of cutting tools. Other than casting, forming, shaping etc. machining is one of the major operations to be carried out in almost every mechanical industry. During this operation cutting tool cuts the metal sometimes need to regrind the tool become necessary to get good surface finish. In accordance to this, it may require extra time to regrind the tool achieve the desired requirements. On the other hand if we already choose such geometry of the cutting tool so that the chances of getting it blunt may be minimized. Hence in this account, it becomes necessary to find out the influence of cutting angles on surface finishing. The angles which may influence the surface finishing are:

SINGLE POINT CUTTING TOOL GEOMETRY:

Back rack/ Front rake / Top rake angle:

It is the angle between face of tool & plane parallel to base.

Side rake angle :

It is angle between face of tool & the shank of the tool.

Front clearance angle / End relief angles –

The angle between front surface of the tool & line normal to base of the tool is known as a front clearance angle It avoid rubbing of workpiece against tool.

Side clearance /relief angle:

This formed by the side surface of the tool with a plane normal to the base of the tool.
It avoid rubbing between flank & workpiece when tool is fed longitudinally.

Lip angle / cutting angle :

It is the angle between face & flank. Longer lip angle stronger will be cutting edge. This angle is maximum when clearance & rake angle are minimum. Lager lip angle allows high depth of cut, high cutting speed, work on hard material. It increase tool life & transfer heat fastly.

Side cutting edge angle :

It is the angle between side cutting edge & side of too flank. The complementary angle of the side cutting edge is called "Approach angle".
With lager side cutting edge angle the chips produced will be thinner & wider which will distribute the cutting forces & heat produced more over cutting edge. On other hand greater the component for force tending to separate the work & tool. This causes chatter.

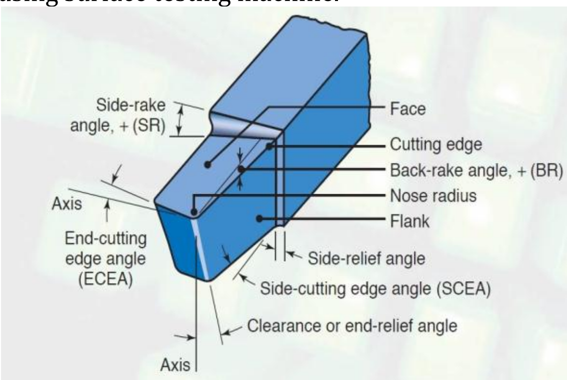
End cutting edge angle –

This is the angle between end cutting edge & line normal to tool shank.
It satisfactory value is 80 to 150.
Function – Provide clearance or relief to trailing end of cutting edge.
It prevent rubbing or drag between machined surface & the trailing port of cutting edge.

Noise radius –

It provide long life & good surface finish sharp point on nose is highly stressed, & leaves grooves in the path of cut. Longer nose radius produce chatter.

In this project we are doing research on the different cutting angles and nose radius of the single point cutting tool of lathe machines. For this project we are select the material of cutting tool is HSS M7 (S400) material. In which we are changing the different angles of single point cutting tool and also change nose radius and finding the optimum surface finishing of the work piece and also find the tool life on the single point cutting tool. We will measuring the surface finishing of work piece by using surface testing machine.



Shank
It is the main body of the tool.

Flank:
The surface or surfaces below the adjacent to the cutting edge is called flank of the tool.

Face
The surface on which the chip slides is called the face of the tool.

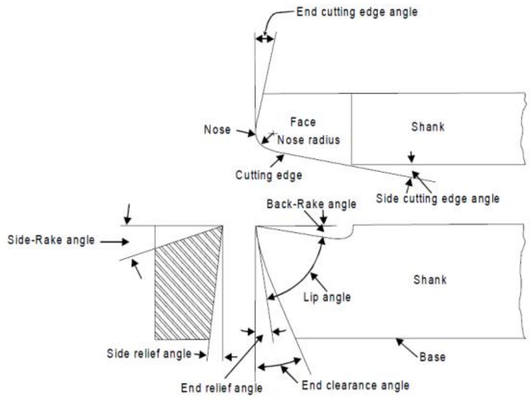
Heel
It is the intersection of the flank and the base of the tool.

Nose
It is the point where the side cutting edge and end cutting edge intersect.

Cutting Edge
It is the edge on the face of the tool which removes the material from the work piece. The cutting edge consists of the side cutting edge(major cutting edge) and cutting edge(minor cutting edge) and the nose.

II. TOOL SIGNATURE OF SINGLE POINT CUTTING TOOL:

Convenient way to specify tool angles by use of a standardized abbreviated system is known as tool signature. It indicates the angles that a tool utilizes during the cut. It specifies the active angles of the tool normal to the cutting edge. This will always be true as long as the tool shank is mounted at right angles to the workpiece axis.



Elements of tool signature

The seven elements that comprise the signature of a single point cutting tool are always stated in the following order:

1. Back rake angle (0°)
2. Side rake angle (7°)
3. End relief angle (6°)
4. Side relief angle (8°)
5. End cutting edge angle (15°)
6. Side cutting edge angle (16°) and
7. Nose radius (0.8 mm)

It is usual to omit the symbols for degrees and mm, simply listing the numerical value of each component in single point cutting tool:
A typical tool signature is 0-7-6-8-15-16-0.8

III. AIM

Aim is to finding the optimum surface finishing of work piece by changing of different cutting angles of single point cutting tool.

IV. OBJECTIVES

- The main Objective of this project is finding different cutting angles of single point cutting tool and check the surface finishing accordingly.
- Selection of material of cutting tool and workpiece.
- Finalise the different tool signature for turning operation.
- Turning of workpiece by different single point cutting tool using varying tool signature.
- Checking the surface finish of workpiece to see impact of tool signature on surface finishing
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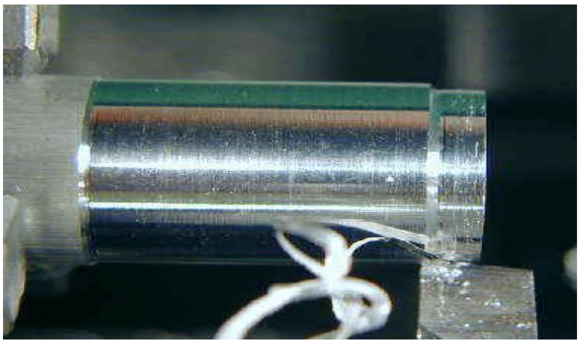
V. TURNING OPERATION

In this process of straight tuning the work piece is fixed in between the chucks, with the help of tool feed that is provided along the longitudinal direction with required depth of cut. Straight turning operation is used to produce a cylindrical surface by removing the excess materials by providing the required depth.

Cutting speed for turning
The cutting speed for machining is represented as surface velocity of the work piece material in the motion.



V= π×D×N/1000 m/min

Where,
V= Cutting speed
D= diameter of the work piece (mm)
N= speed required to rotate the shaft

Cutting feed –
The distance that the cutting tool or workpiece advances during one revolution of the spindle, measured in inches per revolution (IPR). In some operations the tool feeds into the workpiece and in others the workpiece feeds into the tool. For a multi-point tool, the cutting feed is also equal to the feed per tooth, measured in inches per tooth (IPT), multiplied by the number of teeth on the cutting tool.

Cutting speed –
The speed of the workpiece surface relative to the edge of the cutting tool during a cut, measured in surface feet per minute (SFM).

Spindle speed –
The rotational speed of the spindle and the work piece in revolutions per minute (RPM). The spindle speed is equal to the cutting speed divided by the circumference of the work piece where the cut is being made. In order to maintain a constant cutting speed, the spindle speed must vary based on the diameter of the cut. If the spindle speed is held constant, then the cutting speed will vary.

Feed rate –
The speed of the cutting tool's movement relative to the work piece as the tool makes a cut. The feed rate is measured in inches per minute (IPM) and is the product of the cutting feed (IPR) and the spindle speed (RPM).

VI. LITERATURE REVIEW

Lungu, N. at al. have studied the finite element analysis of the influence of cutting tool geometrical parameters: nose radius, rake angle and clearance angle – on the some evaluation indicators of the machining process, namely: cutting forces, temperatures and thermal deformations of the tool. The optimum cutting tool geometrical parameters were found after carrying out the experiments specified by Taguchi's L9 orthogonal array table and analysis of variance. The study involves both, finite element analysis and optimization of cutting tool geometric parameters by Taguchi method. Thus, in agreement with the results obtained it can be concluding that: force values increase with nose radius increase; the lowest forces value were recorded for a nose radius of 0.4mm; the lowest temperature value was also obtained for a nose radius of 0.4mm.

Y. Kevin Chou et al. have studied the Tool nose radius effects on finish turning of hardened AISI 52100 steels have been investigated. Surface finish, tool wear, cutting forces, and, particularly, white layer (phase transformation structures) were evaluated at different machining conditions.

Kaisan Muhammad Usman have studied the effect of tool rake angles on tool life. the rake angles of 0°, 5°, 10°, 15°, and 20° and a constant clearance (Relief angle) of 80 were used to turn bright mild steel on the lathe machine, with a high speed steel of 18mm side as cutting tool and soluble oil was used as coolant. This is all in order to explore the energy savings opportunities during regrinding of tools, useful production time and energy is being wasted due to regrinding or re-sharpening of tools when cutting tools got worn or blunt, selection of the best rake angle which elongates tool life goes a long way in saving these time and energy.

Ship-Peng Lo. Have done an analysis of cutting under different rake angles using the finite element method. The elastic plastic finite element method is developed in this study to investigate the effect of the tool rake angle on the chip and the machined workpiece during the precision cutting process. Cutting simulations were conducted under a variety of tool rake angles to explore the effect of tool rake angle on cutting force, the geometric shapes of the chip, the equivalent stress distribution, the residual stress and the surface of the machined work piece.

Z. Karim et al. have studied tool wear and surface finishing by applying the positive and negative rake angle during machining. The experiment was conducted by using conventional lathe machine and aluminium alloy Al6061 as the workpiece. The machining parameters were kept constant while the rake angles were varied from positive to negative values. At every 200mm tool travel distance, the flank wear and surface roughness values were measured using Microscope Motic Images Plus and Handysurf surface roughness tester respectively. author concluded that In this work, the effect of different rake angle toward flank wear and surface roughness was successfully performed and recorded. From the tool wear result, the flank wear increase with respect to the increase of positive rake angle or negative rake angle. The flank wear is at maximum value when the rake angle equal to 15˚. The plot of flank wear versus cutting length shows a linear relationship with similar slope which indicate similar rate of wear in the cutting tool. Base on the data that were recorded through the experiment as summarized in Table 1 and Table2, negative and positive rake angle give very close values of flank wear. Thus, It can be concluded that the negative and positive rake angle give the same effect to flank wear during machining process. Surface roughness value shows an inverse relation with the rake angle. When the rake angle is increased, the value of surface roughness will decrease. The result in this work can be used in optimizing machining parameter setting to get the best value of surface roughness with minimum flank wear.

Dr. Saad Kariem Shather. Have studied the effect of tool nose radius on workpiece run out and surface finish. They focused on effect of tool nose radius on surface roughness and run out which causes tool chatter, the experiments proved that high values of nose radius causes rough surface with high value of run out also in this paper use seven different values of nose radius of cutting tool were (0.3, 0.4, 0.5. 1, 1.5, 2, 2.5mm) under different of cutting conditions (such as feed rate, cutting speed, depth of cut). They conducted 14 experiment. Work piece materials was carbon steel and tool material was High speed steel (HSS). Author concluded that Author concluded that, Increasing nose radius refers to increase surface roughness but not less than 0.4 mm. Maximum roughness value was (Ra=4.1 µm) when nose radius = 2.5mm and good surface finish at nose radius = 0.4 mm when Ra=0.5 µm. Experimental work proved that small difference between arithmetic roughness values and experimental values except nose values (1,5 ,2,2.5mm). Anew relationship was found between nose radius and run out according to tool chatter occurs during turned workpiece surface. Maximum run out occurs at high research recommended use suitable value of nose radius=2.5 mm and surface roughness= 4.1µm. In order to reduce tool chatter nose radius such as (0.4, 0.5mm) . Also a suitable nose radius for run out was (0.4, 0.5 mm) to get good surface finish (0.5, 1.2 µm).

Kapil Sharma et al [2] The parameters like rake angle, depth of cut, feed rate, temperature and cutting speed are taken in to account so as to predict their effects on tool life. The cutting force decreases as the tool rake angle increases. With increase in feed rate, this tends increase in cutting force. The increase in absolute value of negative tool rake angle and cutting speed these results in the decrement of tool chip friction. The tool tip temperature increases with an increase in cutting speed. With the increased in positive rake angle, the cutting forces are decreased which means that less force/power is required.

VII. RECOMMENDED TOOL ANGLES FOR HSS TOOL

MATERIAL	FRONT RAKE ANGLE	FRONT CLEARANCE ANGLE	SIDE RAKE ANGLE	SIDE CLEARANCE ANGLE
MILD STEEL	10-12	6-8	10-12	6-8

TOOL SIGNATURE:

For this project using following tool signature.

Sr. No.	Back rake Angle	Side Rake Angle	End Relief Angle	Side relief Angle	End Cutting edge Angle	Side cutting edge angle	Nose radius
1	10	10	6	6	8	31	0.8
2	11	11	7	8	9	32	0.8
3	12	12	8	7	10	33	0.8
4	10	10	7	6	11	34	0.8
5	11	11	8	8	12	35	0.8
6	12	12	6	7	13	36	0.8
7	10	10	8	8	14	37	0.8
8	11	11	6	7	15	38	0.8
9	12	12	7	8	12	39	0.8
10	12	12	8	6	13	40	0.8

VIII. MATERIAL SELECTION:

HSS Tool Material :

We have selected HSS material for this project the material is molybdenum group M7 (S400) in this material percentage of molybdenum is more it is good resistance and high toughness material.

Mechanical property:
Modulus of Elasticity: 217 GPa
Component Element properties:
Carbon : 1.02 %
Chromium : 3.8%
Iron : 82.18 %
Manganese: 0.30 %
Molybdenum : 8.6 %
Silicon : 0.40 %
Tungsten : 1.8 %
Vanadium : 1.9 %

Application of material:
Taps, twist drills, reamers, milling tools, broaches tools, cold extrusion dies.

IX. WORKPIECE MATERIAL :

We have selected Mild Steel as a workpiece material. steel which contains only a small percentage of carbon and is strong and easily worked but not readily tempered or hardened.

Mild steel is tough, ductile and malleable. It has good tensile strength but poor corrosion resistance. It is mainly used as an all-purpose engineering material.

Chemical composition:

Carbon: 0.16-0.18%
Silicon: 040% Max
Manganese: 0.70-0.90%
Sulphur: 0.040%Max
Phosphorous: 0.040%Max

X. CONCLUSION:

We have studied previous literature on surface finishing work. And working on surface finishing by changing different cutting angles of single point cutting tool.

XI. REFERENCES:

1. Lungu, N.; Croitoru, S. M.; Borzan, M, “optimization ofcutting tool geometrical parameters using taguchi method,” academic 62 journal of manufacturing engineering, vol. 11, issue 4, pp 62-67, 2013.

2. Y. Kevin Chou, Hui Song, “Tool nose radius effects on finish hard turning”, Journal of Materials Processing Technology 148, pp 259–268, 2004.

3. Engr. Kaisan Muhammad Usman, “Effects of Tool Rake Angle on Tool Life in Turning Tools,” International Journal of Scientific & Engineering Research Volume 3, Issue 4, pp 1-6, April-2012.

4. Ship-Peng Lo, “An analysis of cutting under different rake angles using the finite element method”, Journal of Materials Processing Technology 105, pp 143-151, 2000.

5. Deepak Bhardwaj, B. Kumar Research Scholar, “Study and Analysis of Single Point Cutting Tool under Variable Rake Angle” International Journal of Scientific and Innovative Research 2014; 2(1): 150-157, P-ISSN 2347-2189, E- ISSN 2347-4971.

6. Deepak Lathwal, Mr.Deepak Bhardwaj “Study and analysis of single point cutting tool under variable rake angle.Publication: International journal for research in applied science and engineeringtechnology Volume 1, Issue1, August 2013 ISSN 2321-9653