OPTIMIZATION OF MACHINING PARAMETERS IN A TURNING OPERATION

G.Prsasnna Kumar[1],NBV Lakshmi Kumari[2] ,
[1,2]Assistant Professor, Mechanical Engineering Muffakham Jah College of Engineering and Technology, India

ABSTRACT

The present work concerned an experimental study of turning on Stainless steel of grade & aluminum by a HSS tool. The primary objective of the ensuing study was to use the response Surface Methodology in order to determine the effect of machining parameters, cutting speed, feed, and depth of cut, on the surface roughness of the machined material and the metal removal rate (MRR) of the tool. The objective was to find the optimum machining parameters so as to minimize the surface roughness and maximize the metal removal rate (MRR) for the selected tool and work materials in the chosen domain of the experiment. The experiment was conducted in an experiment 18runs .Surface Roughness was measured using a Taylour Hobson .The data was compiled to for analysis. The relationship between the machining parameters and the response variables (surface roughness and MRR) were modeled and analyzed.

Key Words : Cutting Speed,Feed,Metal Removal Rate,Talysurf

1.INTRODUCTION

The turning operation is a basic metal machining operation that is used widely in industries dealing with metal cutting. The selection of machining parameters for a turning operation is a very important task in order to accomplish high performance. By high performance, we mean good machinability, better surface finish, lesser rate of tool wear, higher material removal rate, faster rate of production etc. The surface finish of a product is usually measured in terms of a parameter known as surface roughness. It is considered as an index of product quality.

Better surface finish can bring about improved strength properties such as resistance to corrosion, resistance to temperature, and higher fatigue life of the machined surface. In addition to strength properties, surface finish can affect the functional behavior of machined parts too, as in friction, light reflective properties, heat transmission, ability of distributing and holding a lubricant etc.Surface finish also affects production costs. For the aforesaid reasons, the minimization of the surface roughness is essential which in turn can be achieved by optimizing some of the cutting parameters.

Productivity play significant role in today's manufacturing market. The manufacturing industries are continuously challenged for achieving higher productivity within lesser time. Turning process is one of the most fundamental and most applied material removal operations in a real manufacturing environment.

The process of turning is influenced by many factors such as Cutting speed, Feed rate and Depth of cut. The challenge that the engineers face is to find out the optimal parameters for the preferred output and to maximize the output by using the available resources.Higher material removal rate is desired by the industry to cope up with mass production without sacrificing product quality in short time. Higher material removal rate is achieved through increasing the process parameters like Cutting speed, Feed and Depth of cut.

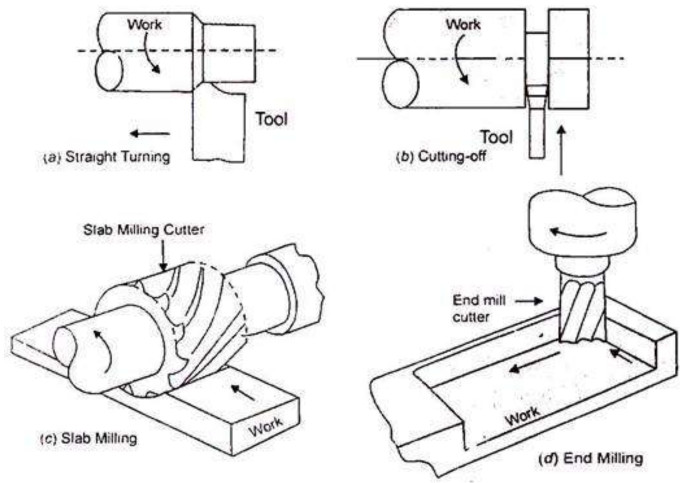


Fig : Common Cutting Process

1.1The Turning Operation

The turning operation is a basic metal machining operation that is used widely in industries dealing with metal cutting [1]. This operation is carried out in a Lathe Machine either manually under an operator's supervision or by a controlling computer program. There are two types of motion in a turning operation. One is the cutting motion which is the circular motion of the work and the other is the feed motion which is the linear motion given to the tool.

The basic turning operation with the motions involved is shown in Fig 1 and Fig 2, figures from [14]. Fig 3 from [15] shows a single point cutting tool and its nomenclature.

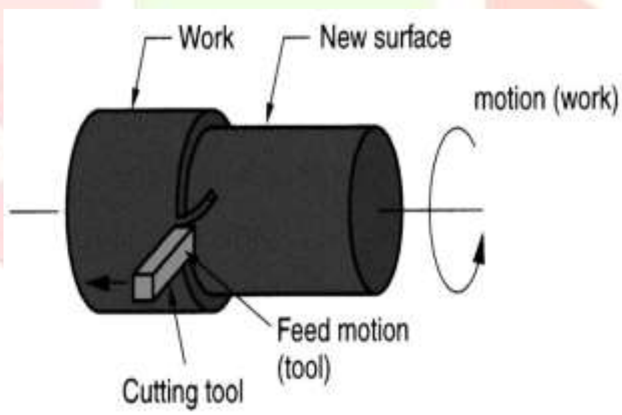


Fig 2: Motions in turning operation

2.METHODOLOGY

2.1. Machining Parameters

The turning operation is governed by geometry factors and machining factors. This study consists of the three primary adjustable machining parameters in a basic turning operation viz .speed, feed and depth of cut. Fig 4 from [2] shows these three parameters. Material removal is obtained by the combination of these three parameters [14]. Other input factors influencing the output parameters such as surface roughness and tool wear also exist, but the latter are the ones that can be easily modified by the operator during the course of the operation [15]

2.2 Cutting Speed

Cutting speed may be defined as the rate at which the uncut surface of the work piece passes the cutting tool [1]. It is often referred to as surface speed and is ordinarily expressed in m/min, though ft./min is also used as an acceptable unit [1,16]. Cutting speed can be obtained from the spindle speed. The spindle speed is the speed at which the spindle, and hence, the work piece, rotates. It is given in terms of number of revolutions of the work piece per minute i.e. rpm. If the spindle speed is „N" rpm, the cutting speed V c (in m/min) is given as

$$V_c = \frac{\pi DN}{1000}$$

where, D = Diameter of the work piece in mm

2.3 Feed

Feed is the distance moved by the tool tip along its path of travel for every revolution of the work piece. It is denoted as 'f' and is expressed in mm/rev. Sometimes, it is also expressed in terms of the spindle speed in mm/min as

Where f = Feed in mm/rev

N = Spindle speed in rpm

2.4 Depth of cut

Depth of cut (d) is defined as the distance from the newly machined surface to the uncut surface. In other words, it is the thickness of material being removed from the work piece. It can also be defined as the depth of penetration of the tool into the work piece measured from the work piece surface before rotation of the work piece. The diameter after machining is reduced by twice of the depth of cut as this thickness is removed from both sides owing to the rotation of the work.

$$d = \frac{D_1 - D_2}{2}$$

where, D1 = Initial diameter of job

D2 = Final diameter of job

2.5 Cutting Tool

A cutting tool can be defined as a part of a machine tool that is responsible for removing the excessive material from the work piece by direct mechanical abrasion and shear deformation [13,17]. According to Choudhury et. al [16] and Schenider [18], an efficient cutting tool should have the following characteristics –

a) Hardness: The tool material should be harder than the work material.

b) Hot hardness: The tool must maintain its hardness at elevated temperatures encountered during the machining process.

c) Wear Resistance: The tool should have served to its acceptable level of life before it wears out and needs to be replaced.

d) Toughness: The material should be strong enough so as to withstand shock and vibrations. During interrupted cutting, the tool should not chip or fracture.

2.6 Surface Roughness

The quality of machined surface is characterized by the accuracy of its manufacturing with respect to the dimensions specified by the designer. Every machining operation leaves characteristic evidence on the machined surface. This evidence in the form of finely spaced micro irregularities left by the cutting tool. Each type of cutting tool leaves its own individual pattern which therefore can be identified. This pattern is known as surface finish or surface roughness. Surface roughness, often shortened to roughness, is a measure of the texture of a surface. It is quantified by the vertical deviations of a real surface from its ideal form. If these deviations are large, the surface is rough; if they small the surface is smooth.
Roughness is typically considered to be the high frequency, short wavelength component of a measured surface. It is denoted by (Ra).

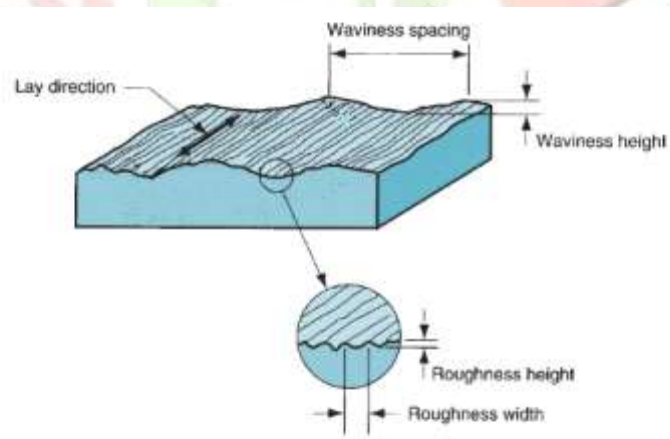


Fig 3. “Surface Roughness

2.7.TALYSURF METHOD TO FIND THE ROUGNESS

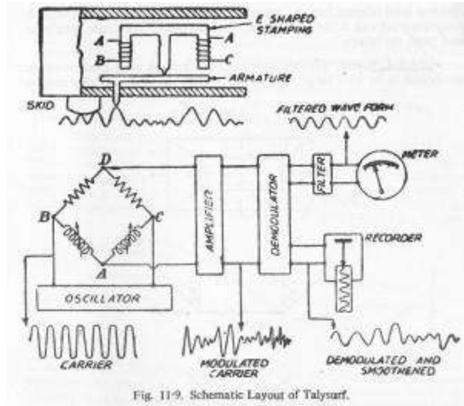


Fig 4: Schematic Layout of Talysurf

3.MATERIALS USED FOR EXPERIMENTATION

3.1 Mild Steel (En8)

The work piece used for the concluded experiment was Mild steel (EN8) round bars.**EN8** is a medium carbon steel usually supplied untreated. EN8 has good tensile strength and is often used in applications such as: shafts, gears, stressed pins, studs, bolts, keys etc. **EN8** is a very popular grade and is readily machinable in any condition. It can be further surface-hardened to produce components with enhanced wear resistance, typically in the range 50-55 HRC through induction processes. It is also available in a free-machining versions, **EN8DM** and **EN8M** (212A42)

EN8 (080M40) – Mechanical Properties

Max Stress	700-800 n/mm^2	
Yield Stress	465 n/mm^2 Min	(up to 19mm LRS)
0.2% Proof stress	450n/mm^2 Min	(up to 19mm LRS)
Elongation	16% Min	(12% if cold drawn)
Impact KCV	28 Joules Min	(up to 19mm LRS)
Hardness	201-255 Brinell	

3.2 Aluminiun 6082 alloy

Al	Bal
Si	0.7-1.3
Fe	0.50 max
Cu	0.10 max
Mn	0.40-1.00
Cr	0.25 max
Mg	0.06-120

Zn	0.20 max
Ti	0.10 max

Fig . Mild Steel (EN8) round bars.

Fig . Aluminium round bars.

3.3 Single point cutting tool (HSS)

Material **vanadium 1%, chromium 4% and tungsten 18%**

The cutting tool used for experimentation with the standard specification HSS 18-4- 1

Fig . Single point cutting tool (HSS)

3.4 Centre Lathe.

Fig . Kirloskar Lather Machine.

A centre lathe was used to carry out the machining. The cutting tool fixed on the tool post. The job was held rigidly by the chuck of the lathe. Centre drilling was done and the job was held at the other end by the tail stock and turning was carried out.

3.5 Cutting Condition :

Cutting experiments are conducted considering three cutting parameters: Cutting Speed (m/min), Feed rate (mm/rev), Depth of Cut (mm) and Overall 36 experiments were carried out.

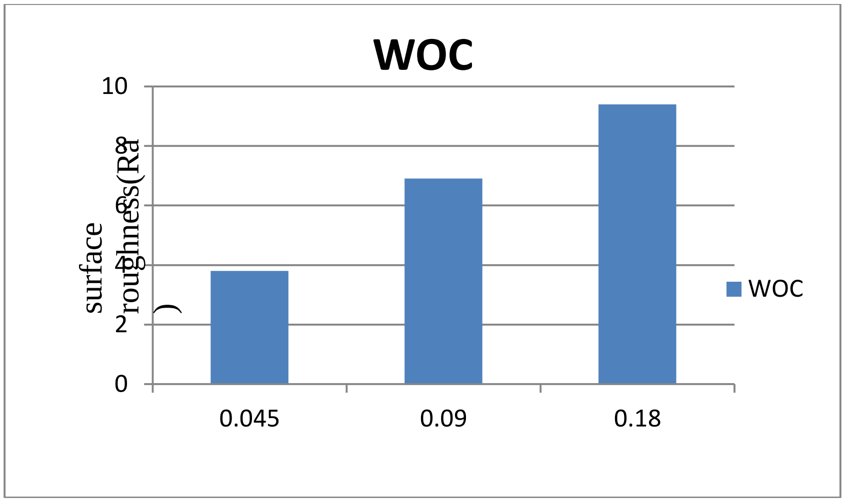
4.RESULTS

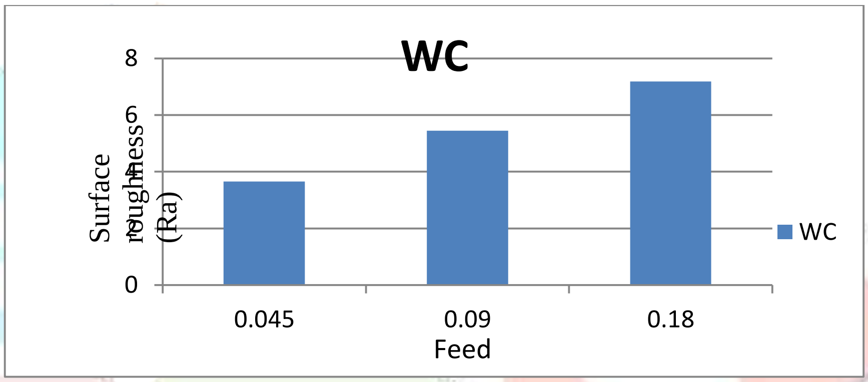
At Spindle Speed 315 (rpm)

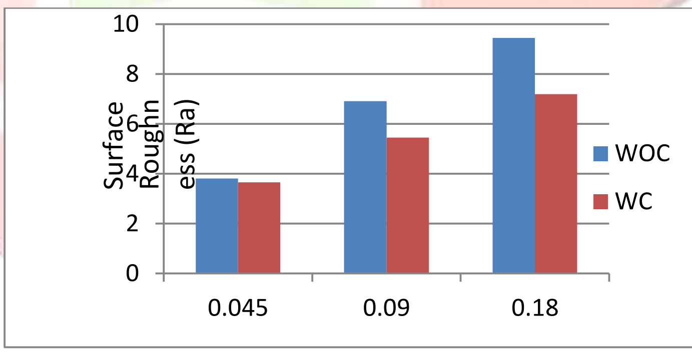
TABLE: 1

SURFACE ROUGHNESS VALUE MILD STEEL AT VARIABLE FEEDS

MILD STEEL		
FEED	WOC (Ra) (μm)	WC (Ra) (μm)
0.045	3.8	3.65
0.09	6.91	5.45
0.180	9.4	7.19



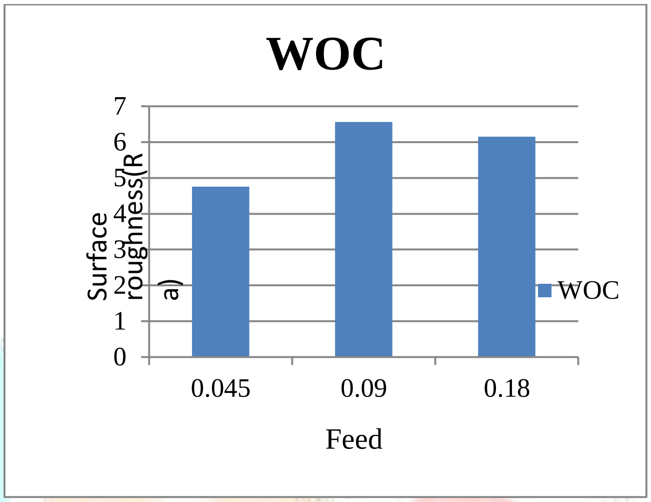


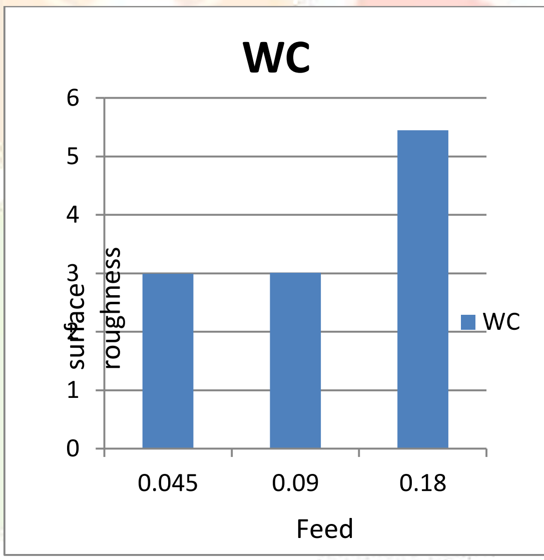


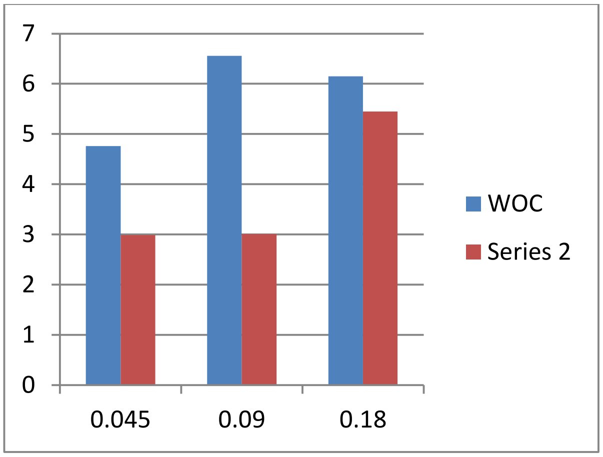
At Spindle Speed 500 (rpm)

MILD STEEL		
FEED	WOC (Ra) (µm)	WC (Ra) (µm)
0.045	4.76	2.99

0.09	6.56	3.01
0.180	6.15	5.45





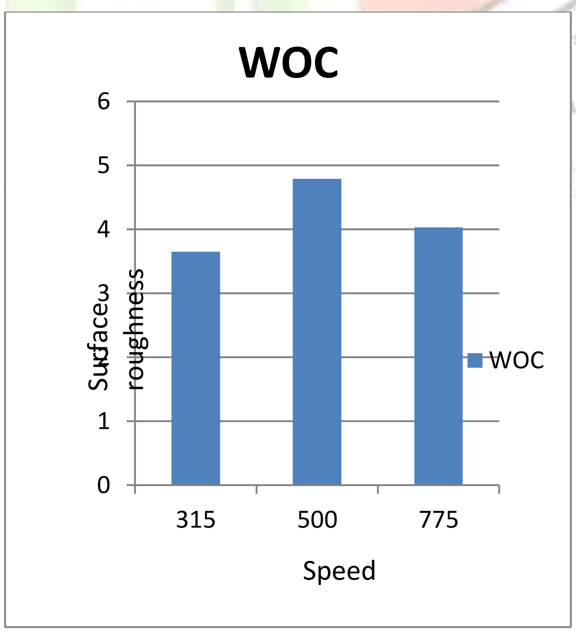


At Feed Rate 0.045 mm/rev

TABLE:

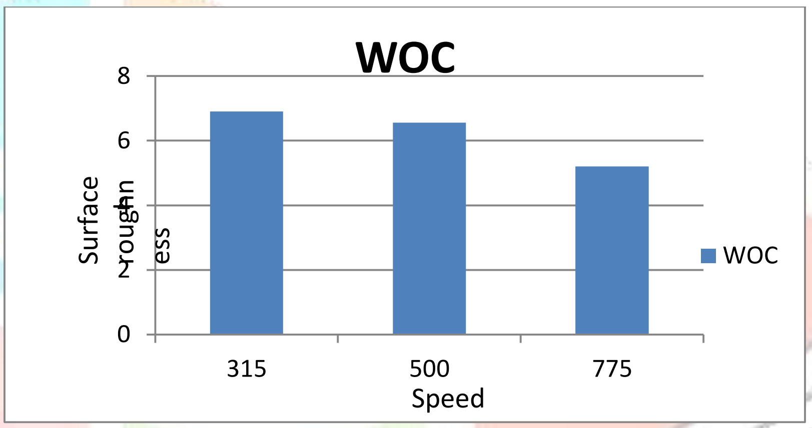
SURFACE ROUGHNESS VALUES AT VARIOUS SPEEDS

MILD STEEL		
SPEED	WOC (Ra) (µm)	WC (Ra) (µm)
315	3.65	3.58
500	4.79	2.99
775	4.03	2.89



At Feed Rate 0.09 mm/rev

MILD STEEL		
SPEED	WOC (Ra) (µm)	WC (Ra) (µm)
315	6.91	5.45
500	6.56	3.01
775	5.2	2.8



5.RESULTS

1.) In mild steel at spindle speed 315 rpm when feed increases surface roughness values also increases.

2.) In mild steel at spindle speed 500 rpm initial feed gives good surface roughness values

3.) In mild steel at spindle speed 775 rpm initial feeds good surface roughness value is obtained.

4.) In aluminium at spindle speed 315 rpm with cutting fluid surface roughness is improved.

5.) In aluminium for both N1 and N2 remarkable surface roughness is obtained.

6.) When speed increases surface roughness is reduced in mild steel for both cases.

7.) With cutting fluid for differential cutting speed surface roughness is improved nearly 50%.

8.) In aluminium when speed increases surface roughness.

6.REFERENCES

1. P H Joshi, "Jigs and fixtures" Tata McGraw-Hill Education, 2010

2. Edward Hoffman "Technology & Engineering" Cengage Learning, 21-Aug-2003

3. Cyril Donaldson, V. C. Goold Machine-tools -Tata McGraw-Hill Education,