OPTIMIZATION OF PARAMETERS AFFECTING THE PERFORMANCE OF CNC MACHINE

[1]Ramdas Kharade,[2]Nilesh Yewale,[3]Ambadas Shelke,[4]Vishal Jadhav
[1,2,3,4]Department of Mechanical Engineering,
[1,2,3,4]G.H.Raisoni College Of Engineering And Management, Ahmednagar, India

Abstract: Computer numerical control CNC machine are widely used in manufacturing industry. There are different types of CNC machine such as Central lathe, vertical milling machine, shaping machine, turning machine used by trained engineers for quickly and effective setup of manufacturing process. Work study on the optimization of parameters affecting the performance of CNC machine and milling machine. The machining parameters in CNC turning and milling machine performance for operations consists of cutting speed, depth of cut, feed rate, number of passes. These machining parameters affecting on the cost productivity and quality of machining parts. In optimization of process parameters of CNC machine we use the Taguchi method. The Taguchi method are statistical method or sometimes called robust design method developed by genichi Taguchi to improve the quality of manufacturing goods or more recently also applied to manufacturing engineering. This optimization study is important for discuss the effect of cutting parameters on machining time and surface finish.

Index Terms **- Optimization, Taguchi method, Feed rate, Cutting parameters.**

I. INTRODUCTION

The progress of present day innovation and new generation of manufacturing equipment, especially computer numerical control (CNC) machine, have conveyed enormous changes to the manufacturing sector. For the most part, the handbook or human experience is utilized to choose helpful machine parameters in manufacturing industry. In process arranging of traditional milling, choosing sensible processing parameters is important to fulfill necessities including machining economics quality and safety. The machining parameters in milling operations comprises of cutting speed depth of cut, feed rate and number of passes. These machining parameters essentially affect on the cost, productivity and nature of machining parts. The effective improvements of these parameters influence dramatically the cost and generation time of machined components and in addition the quality of final products. The turning and milling operation is an essential metal machining operation that is utilized broadly in businesses managing metal cutting. The choice of machining parameters for a turning and milling operation is a vital undertaking with high performance. By high performance, we mean great machinability, better surface finish, lesser rate of tool wear, higher material removal rate, speedier rate of production and so forth. The surface finish of an item is normally estimated as far as a parameter known as surface roughness. It is considered as a index of product quality.

Better surface finish can achieve enhanced quality properties, for example, protection from corrosion, protection from temperature, and higher weariness life of the machined surface. Notwithstanding quality properties, surface finish can influence the functional behavior of machined parts as well, as in friction, light reflective properties, warm transmission, capacity of circulating and holding a lubricant and so on. Surface finish additionally influences production costs. For the previously mentioned reasons, the minimization of the surface roughness is fundamental which thus can be accomplished by enhancing a some of the cutting parameters.Tool wear is a inherent marvel in each conventional cutting operation. Specialists endeavour towards elimination or minimization of tool wear as tool wear influences quality and in addition production costs. Keeping in mind the end goal to enhance tool life, broad examinations on the tool wear characteristics must be directed. A portion of the elements that influence tool wear and surface roughness are machining parameters like cutting rate, feed, depth of cut and so on., tool material and its properties,

II. LITERATURE REVIEW

[1] **N.V.MAHESH BABU TALUPULA:** .It says that Computer Numerical Control (CNC) machines are broadly utilized as a part of manufacturing industry. Conventional machines, for example, vertical millers, centre lathes, shaping machines, routers etc... Worked by a prepared engineer have, much of the time, been replaced by control machines. Since the beginning of the CNC (Computer Numerical Control) machines presentation in the machining part, they have been praised for being precise, quick, steady and adaptable. Despite the fact that CNC machines are not absolutely free, a great deal of real industries relies upon these wonder machines. Basic CNC-subordinate enterprises incorporate the metal business and the carpentry business. Profitability and in addition quality the two similarly affects last product. In this exploration work, milling tests are completed on Mild Steel. Full factorial experimentation is adjusted for directing pilot analyses to consider the impacts of cutting parameters on machining time and roughness.

[2] **N.S. POHOKAR:**In this paper to appraise the tool life choice of ideal parameters. It is important to decide them at first for the given machining circumstance. There are a few strategies accessible to decide the ideal estimations of these parameters, in this paper machining parameters, utting speed, feed, depth of cut, and one geometric parameter rake angle are considered for optimization. The Genetic calculation was produced for foreseeing the outcomes. To approve the outcomes tentatively trials are then done a CNC milling utilizing HSS tool by ceaseless running condition under dry keep running on the AISI 1040 MS plate of 140 X 120 X 10 mm work piece. The anticipated outcomes coordinate 95 % including the mistakes. In this manner demonstrates the hereditary genetic is utilized for optimization of geometric and machining parameters for the estimation of tool life.

[3] **NAGAANJENEYULU. K:** Our work centers around the optimization of cutting tool life of a CNC milling machine and end milling operation is performed on it by utilizing Poly Crystalline cubic Boron Nitride (PCBN) as the cutting device material and En8 steel (HRC 46) as work piece material topredict the tool life. Information is gathered from CNC milling machine which is controlled by various examples of tests utilizing programming. The contribution of the model comprises of feed rate, cutting speed and depth of the cut while the yield from the model is the Tool life which is ascertained by Taylor's device life condition. This exploration is to test the gathering information by Taguchi strategy. The model is approved through a correlation of the trial esteems with their anticipated partners. The improvement of the tool life is concentrated to analyze the relationship of the parameters included. The aftereffect of the examination demonstrates that depth of cut was the main parameter observed to be noteworthy. The investigation likewise demonstrates that the anticipated qualities and ascertained qualities are close, that obviously shows that the created model can be utilized to decrease the cost of machining.

[4] **NEERAJ KUMAR:** This paper talk about of the writing audit of advancement of processing machining process parameters for composite materials. Machining process has attributes that portray their execution with respect to productive utilization of machine instruments by setting ideal cutting parameters. The conventional optimization methods are not appropriate on the grounds that processing machining activity is exceedingly compelled in nature. Consequently we propose an adjusted optimization approach in view of up to this point inquire about examination for processing machining parameters.

[5] **MR.DHRUV H. PATEL:**In this paper we have study on CNC Router, impact of different machining parameters like, instrument speed (rpm),tool feed(mm/min), and depth of cut (mm). In the present examination, tests are led on Composite material of Acrylic gum and AluminiumTriHydrate with three levels and three variables to improve process parameter and surface unpleasantness. A L9 (3*3) Taguchi standard orthogonal exhibit (OA) is decided for outline of trials and the primary impacting factor are resolved for each given machining criteria by utilizing Analysis of difference (ANOVA). The surface finish have been distinguished as quality attributes and are thought to be straightforwardly identified with productivity. In this test we were discovered that request of critical of fundamental parameter decreasing order Tool feed, Tool speed and Depth of cut.

[6] **V S THANGARASU :**This study highlights optimization of CNC fast milling process parameters to give better surface finish and also high material expulsion rate. The surface finish and material expulsion rate have been distinguished as quality credits and are thought to be straightforwardly identified with profitability. Keeping in mind the end goal to develop an extension amongst quality and profitability, and attempt made to upgrade previously mentioned quality attributes in little and medium size organizations required with heterogeneous product request. This welcomes a muti-target enhancement issue which has been solved by DOE based genetic algorithm optimization strategy. The response surface technique for Box-Benkhen method has been adjusted to get multi target optimization issue. The technique observed to be helpful in simultaneous optimization of more number of reactions.

III. MACHINING PARAMETERS

The turning operation is represented by geometry factors and machining factors. This examination comprises of the three essential movable machining parameters in a basic turning task viz. speed, feed and depth of cut. Material evacuation is acquired by the mix of these three parameters. Other information factors impacting the output parameters, for example, surface roughness and tool wear wear exist, yet the last are the ones that can be effortlessly changed by the operator over the span of the operation.

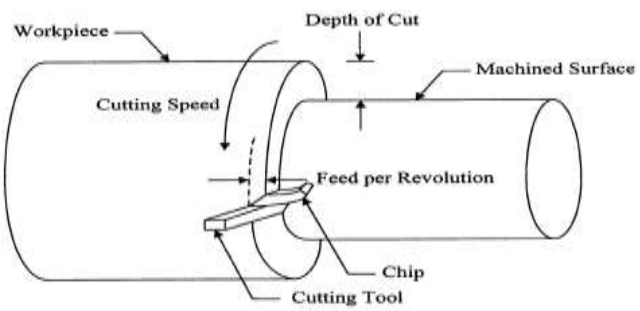

Fig 1: The adjustable machining parameters

3.1 Cutting Speed:

Cutting rate might be characterized as the rate at which the uncut surface of the work piece passes the cutting tool. It is frequently referred to as surface speed and is usually expressed in m/min, however ft./min is additionally utilized as a satisfactory unit. Cutting speed can be obtained from the spindle speed. The spindle speed is the speed at which the spindle, and henceforth, the work piece, turns. It is given as far as number of revolutions of the work piece every moment i.e. rpm. In the spindle speed is N rpm, the cutting speed Vc (in m/min) is given as

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

Where, Vc = Cutting Speed

D = Diameter of the work piece in mm

N= Spindle Speed in rpm

3.2 Feed:

Feed is the distance moved by the tool tip along its way of movement for each unrest of the work piece. It is indicated as f and is expressed in mm/rev. Once in a while, it is additionally expressed as far as the shaft speed in mm/min as

Fm = f N

Where, f = Feed in mm/rev,

N = Spindle speed in rpm

3.3 Depth of cut:

Depth of cut (d) is characterized as the separation from the recently machined surface to the uncut surface. In other words, it is the thickness of material being expelled from the work piece. It can likewise be characterized as the depth of penetration of the tool into the work piece estimated from the work piece surface before turn of the work piece. The diameter across in the wake of machining is decreased by twice of the depth of cut as this thickness is removed from the two sides owing to the turn of the work.

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

Where, D1 = Initial dia of job

D2= Final width of job

3.4 Cutting Tool:

A cutting tool can be characterized as a part of a machine tool that is in charge of expelling material from the work piece by direct mechanical abrasion and shear deformation. Efficient cutting tool should to have the accompanying attributes .

1. **Hardness:** The tool material ought to be harder than the work material.

2. **Hot hardness**: The tool must keep up its hardness at elevated temperatures experienced during the machining process.

3. **Wear Resistance:** The tool should to have served to its adequate level of life before it wear and should be replaced.

4. **Toughness:** The material should to be sufficiently strong in order to withstand shock and vibrations. During interrupted with cutting, the tool should not chip or break.

IV. MACHINE SELECTION

With a regularly increasing demand for a greater hole count per panel, the new high power straight motor offer a huge decrease in the drilling process duration.

Fig 2: Jyoti Huron CNC machine

It consists of
1. Robust, interlocked base unit
2. High accuracy mechanical linear guides in all 3 axes
3. High dynamic Linear motors for the X- and Y-axes, (Z-axes as option)
4. CNC control systems
5. Variable clamping systems
6. Micro drilling pressure foot
7. Constant dill breakage monitor
8. Laser drill check system

Specifications:

1. Granite bed with length 1600mmX 800mm.
2. Magazine capacity is 16 tools.
3. Vacuum cleaner for dust removes.

V. WORK MATERIALS AND INITIAL PREPARATION:

5.1 Work Material:

The work piece utilized for the finished up try was AISI 202 review Austenitic stainless steel. There are two arrangement of Austenitic stainless steels – 300-arrangement and 200-arrangement. 300 arrangement steels find most wide use the world over yet 200 arrangement have turned out to be exceptionally well known in the Asian subcontinent as an other option to the 300 arrangement to counter the expansion in costs of Nickel . Review 202 steel can be made into plates, sheets and curls and finds broad use in eatery hardware, cooking utensils, sinks, car trims, engineering applications, for example, entryways and windows, railroads autos, trailers, railway and so forth.

Table 1: Chemical composition (wt %) of AISI 202 Steel

Element	Wt %
Iron, Fe	68
Chromium, Cr	17-19
Nickel, Ni	4-6
Manganese, Mn	7.5-10
Silicon, Si	1
Nitrogen, N	0.25
Carbon	0.15
Phosphorous, P	0.06
Sulphur, S	0.03

Table 2: Chemical composition (wt %) of AISI 202 Steel

Property	Value
Tensile Strength	515 MPa
Yield Strength	275 Mpa
Elastic Modulus	207 Gpa
Poisson's Ratio	0.27-0.30
Elongation at break	40%

5.2 Insert material:

The tool insert selected was a covered carbide tool (Kennametal make) whose function are demonstrated as follows. Covered carbide devices are found to perform superior to uncoated ones .

Table 3: Specification of Cutting Tool

ISO Catalog Number	ANSI Catalog Number	Grade	Dimensions									
			D		L10		S		R_ε		D1	
			mm	in	mm	in	mm	in	mm	in	mm	in
SNMG 120408	SNMG 432MS	KCU25	12.70	0.5	12.70	0.5	4.76	0.1875	5.16	0.203		

The tool insert was rotatable and reversible so an aggregate number of 8 cutting edges can be created. KCU25 takes 22 advantage of PVD covering innovation including unique surface treatment that enhance machining performance in high-temperature materials. The coating on the insert is TiAlN (Titanium Aluminum Nitride).

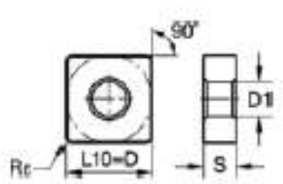

Fig 3: Coating on the insert

5.3 Process Sheet

5.3.1 Part name: plate sample

Part weight –90kg
Part material – MS
Part quantity – 4
Part size -200x 200 mm

Table 4: Plate Sample

Sr. No.	Operation	Machine	Tool	Time
1	Cutting the material as per our required size.	CNC	Flame torch	20 min
2	Cutting the sample as per program given from engineering department	CNC	CNC machine	20 min

5.3.2 Used materials and their properties:

Table.5 Materials and their Properties

Materials Properties	MS
Density	7860 g/cm^3
Thermal conductivity	1.17×10^{-5} w/(m.k)
Young's modulus	$2.1 \times 10^{11} N/m^2$
Yield strength	$3.7 \times 10^{8} N/m^2$
Poisson's ratio	0.28

VI. SELECTION OF MATERIALS

Table 6: Material selection

Sample	Picture	Thickness	Size
Mild Steel		20 mm	200mmX200mm

Mild Steel		20 mm	200mmX200mm
Mild Steel		**20 mm**	**200mmX200mm**
Mild Steel		20 mm	200mmX200mm

VII. MACHINE PARAMETERS

7.1 Operating Parameter used by industry thickness (20mm):

Table.7 Operating Parameter use By Industry

Industry Used Parameter				
Sample no	**Cutting Speed(mm/min)**	**Chip load**	**Feed rate**	**Retract**
1	400	0.12	0.11	1.5
2	500	0.12	0.12	1.6
3	600	0.11	0.13	1.8
4	700	0.13	0.14	1.9

7.2 Operating Parameter (machine provider) 20 mm thickness:

Table.8 Operating Parameter (Mass cutting system)

Machine Supplier Parameter				
Sr. No.	**Cutting Speed(mm/min)**	**Chip load**	**Feed rate**	**Retract**
1	400	0.10	0.111	1.2
2	500	0.12	0.12	1.5
3	600	0.13	0.12	1.6
4	700	0.12	0.12	1.8

7.3 Operating Parameter (Nozzle provider (ESAB)) 25 mm thickness:

Table.9 Operating Parameter (ESAB)

Tool Nozzle provider				
Sr. No.	**Cutting Speed (m/min)**	**Chip load**	**Feed rate**	**Retract**
1	400	0.12	0.111	0.13
2	500	0.12	0.12	0.12
3	600	0.12	0.12	0.12
4	700	0.12	0.12	0.1

7.4 Operating Parameter (R & D optimized parameter) 25 mm thickness:

Table.10 Operating Parameter (R&D Dept)

Parameter taken by (operator and company expert as per expertise)				
Sr. No.	**Cutting Speed(m/min)**	**O_1(bar)**	**LPG(bar)**	**Air Gap (bar)**
1	400	0.12	0.11	1.3
2	500	0.12	0.11	1.3
3	600	0.11	0.10	1.2
4	700	0.10	0.09	1.1

VIII. Result Analysis

In CNC flame cutting machine give variation when the machine parameter variation .so our aim to select different parameter according to machine provider and nozzle provider and company, and taken trail on work piece and calculate the variation

8.1 Sample Testing:-
Testing Name:-Dimensional accuracy
Machine Name:-Vernier calliper

Fig.4 Vernier Calliper

8.1.1 Dimensional Analysis Report

Table.11. Dimensional Analysis Report

Reading no	Sample 1	Sample 2	Sample 3	Sample 4
1	100.33	100.55	100.50	100.20
2	100.50	100.60	100.55	100.23
3	99.99	100.45	100.45	100.20
4	100.60	100.10	100.10	100.01
5	100.10	100.09	100.09	100.02
6	99.91	99.97	99.99	99.99
7	100.45	99.90	99.95	99.98
8	100.60	100.20	100.10	100.03
9	100.70	99.95	99.98	99.99
10	99.89	100.11	100.01	100.01
Mean	**100.307**	**100.192**	**100.172**	**100.066**

8.1.2 Comparative statement graph

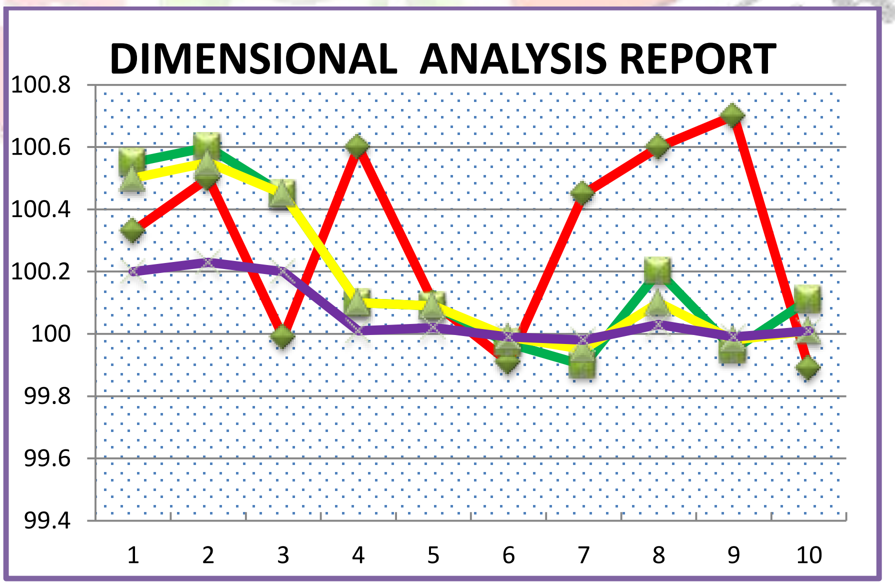

Fig.5 Dimensional Analysis Report

8.2 Testing Name:-Surface Roughness

Machine Name:- Surface Roughness Tester

Fig.6 Surface Roughness Tester

8.2.1 Machine specification:-

Roughness parameter:-Ra, Rz, Rq, Rp, Rv
Profile recording magnification: Vv: 200x - 20000x Vh: 20x, 50x, 200x
Measuring system: -Metric imperial
Display resolution: 0.001 µ m / 0.04 µ inch
Display:-LCD 128 x 64 dot - matrix, with Back light
Dimensions of LCD: 50 x 30 mm screen Pickup stylus position indicator Battery level indicator
Range:-Ra, Rq : 0.01-40 µ m Rz, Ry, Rp, Rt, R3z: 0.02 - 160 µ m Rsm, RS: 2-400 µ m Rmr: 1-100%

8.2.2 Roughness parameter

Table.12 .Roughness parameter

Roughness valve	Sample no1	Sample no2	Sample no3	Sample no4
Ra	**0.04**	**0.039**	**0.03**	**0.025**
Rz	**0.02**	**0.021**	**0.025**	**0.02**
Rq	**0.03**	**0.026**	**0.02**	**0.02**

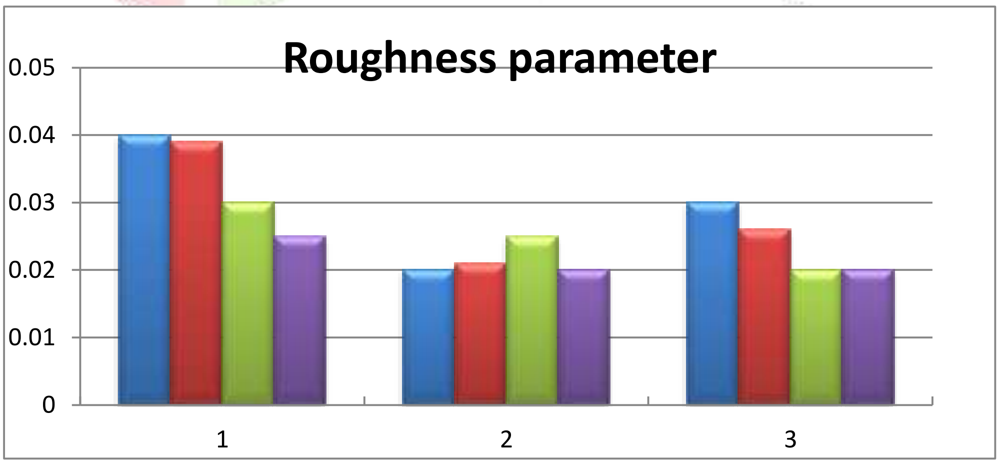

Fig.7 Roughness Parameter

8.3 Testing Name:-Amount of material removes

Machine Name:-Weighbridge

Fig.8 Weighbridge

8.3.1 Amount of Material Remove

Table.13 Material Removal

Sample no	Sample 1	Sample 2	Sample 3	Sample 4
Amount of Material remove	**0.040**	**0.037**	**0.028**	**0.020**

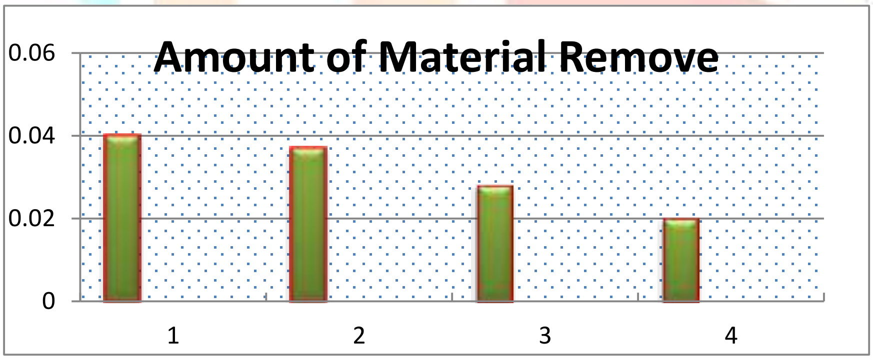

Fig.9 .Material Remove

IX. CONCLUSION

From the discussion so far it has been concluded that R&D parameter is better material cutting than other parameter. Al will help in lessening in material removal rate burr, plain surface finishing and preferred cutting quality over other parameter like machine supplier, tool supplier and so forth material Removal rate minimization procedures can be effortlessly executed in material. The general conclusions from the examinations are:

1. Burr decrease with optimize parameter speed.
2. Better surface finish with optimize parameter.
3. Significant reduction of exit burr with properly constructed system.

X. REFERENCES

1. N. V. Mahesh BabuTalupula, NersuRadhika, Experimental Investigation of Optimal Machining Parameters of Mild Steel in CNC Milling Using Particle Swarm Optimization, *IPASJ International Journal of Computer Science*, January 2015,PP (13-28).

2. Nagaanjeneyulu.K, Avinash.M , Shanmuka Srinivas., Optimization of Cutting Tool Life Parameters by Application of Taguchi Method on A CNC Milling Machine, *International Journal of Innovative Research in Science, Engineering and Technology*, Feb. 2015,PP (285-294).

3. N.S. Pohokar, L. B. Bhuyar, Estimation of Tool Life and Optimization of Parameters for a CNC Parallel Shank End Mill Tool Using Genetic Algorithm Approach,*International Journal of Emerging Technology and Advanced Engineering*, Feb. 2014, PP(434-442).

4. Neeraj Kumar, Prof. K.K. Chhabra, An Overview of Optimization Techniques forCNC Milling Machine, *International Journal of Engineering*, *Management & Sciences*, May 2014, PP (13-16).

5. Balindersingh, Rajesh Khanna, et. al., Optimization of input process parameters in CNC milling machine of EN24 steel, *International Journal of Research in Mechanical Engineering & Technology*, April 2014, PP(40-47).

6. Mr.Dhruv H. Patel, Prof. V. N. Patni**,** An Investigation Effect of Machining Parameters on CNC ROUTER, *International Journal of Engineering Development and Research*,Jan. 2014, PP (1583-1587).

7. Avinash A. Thakre, Optimization of Milling Parameters for Minimizing Surface Roughness Using Taguchi's Approach,*International Journal of Emerging Technology and Advanced Engineering*, June 2013, PP (226-230).

8. M. Yaswanth Kumar, Dr. G. Shankaraiah, Cutting Parameters Optimization in Milling Of P – 20 Tool Steel And EN31B, *IOSR Journal of Mechanical and Civil Engineering*, (Sep. - Oct. 2013), PP (38-47).

9. M.Sayuti1, Ahmed A. D. Sarhan, M. Hamdi, Optimizing the Machining Parameters in Glass Grinding Operation on the CNC Milling Machine for Best Surface Roughness,*Advanced Materials Research*, Feb. 2011, PP (721-726).

10. V S Thangarasu and R Sivasubramanian, High Speed CNC Machining of AISI 304 Stainless Steel ; Optimization of Process Parameters, *International Journal of Mechanical Engineering and Robotics Research*, October 2012, PP (9-21).