International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 08 | Aug 2019 www.irjet.net p-ISSN: 2395-0072

EXPERIMENTAL STUDY OF TAGUCHI vs GRA PARAMETERS DURING CNC BORING IN STEEL PLATE (SS-304)

Dhirendra Pratap Singh[1], Shanti Prakash[2]

[1]M.Tech Student of HEC Jagadhri, Haryana, India
[2]Assistant Professor of HEC Jagadhri, Haryana, India

ABSTRACT:- The present research work has been done for optimization of boring parameters i.e. feed rate, speed and depth of cut for steel pipe (SS-304) on a CNC lathe by using Taguchi method. Carbide tool is used for boring operation. Based on Taguchi Orthogonal Array L9, a series of experiments were designed and performed on steel pipe (SS-304). Analysis of variance, ANOVA, was employed to identify the significant factors affecting the surface roughness and S/N ratio was used to find the optimal cutting combination of the parameters. The main response parameters are material removal rate (MRR) and surface roughness (Ra). These parameters depend upon the value of cutting speed, feed rate and depth of cut. All these control parameters are directly or indirectly co-related with each other. If the depth of cut is increased then MRR increases, but poor surface finishing is achieved. On the other hand by increasing the cutting speed, material removal rate and surface finishing improves simultaneously. It employs that all the parameters are conflicting so we have to select the optimized parameters for the enhancement of the performance. The optimized results are found by using ANOVA technique. This research work indicates towards the practical feasibility of optimized boring in multi response conditions. The optimal values of cutting parameters in CNC boring for steel pipe have been determined which are very useful to obtain minimum roughness to achieve better quality of the products.

Keywords: CNC Boring, SS 304, DOE, ANOVA, GRA, TAGUCHI, MRR, SR

1. INTRODUCTION

Boring is a very important and old machining process in which a single-point cutting tool removes material from the internal surface of a rotating cylindrical work piece or can say enlarging an existing holes. The cutting tool is fed linearly in a direction parallel to the axis of rotation.

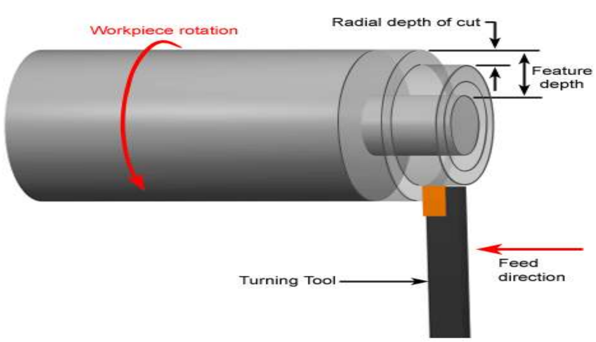

Figure 1.1: Illustrates Cutting Parameters

Boring is carried out on a CNC that provides the power to turn the work piece at a given rotational speed to feed the cutting tool at a specified rate and depth of cut. Therefore, three cutting parameters, i.e. cutting speed, feed rate, and depth of cut are important. [2].

1.2 Taguchi Method

The Taguchi method involves reduction of the variation in the process through robust design of experiments. The overall objective of the method is to produce high quality product at low cost to the manufacturer. The Taguchi method was developed by Dr. Genichi Taguchi of Japan who maintained that variation. Taguchi developed a method for designing experiments to investigate how different parameters affect the mean and variance of a process performance characteristic that defines how well the process is functioning. The experimental design proposed by Taguchi involves using orthogonal arrays to organize the parameters affecting the process and the levels at which they should be varies. Instead of having to test all possible combinations like the factorial design, the Taguchi method tests pairs of combinations. This allows for the collection of the necessary data to determine which factors most affect product quality with a minimum amount of experimentation, thus saving time and resources.

The Steps for Design of experiment:-

1. Define the process objective
2. Determine the design parameters affecting the process
3. Create orthogonal arrays for the parameter design indicating the number of and conditions for each experiment.

4. Conduct the experiments indicated in the completed array to collect data on the effect on the performance measure.
5. Complete data analysis to determine

1.3 Grey Relational Analysis Method:-

Grey relational analysis method uses an exact model of information as it defines situations through no information as black, and those by way of perfect information as white. In actual situations involvement of these extremes can be described as living being grey, hazy or fuzzy. Therefore, a grey system means that a system in which part of information is known and part of information is unknown. With this definition, information quantity and quality form a continuum from a total lack of information to complete information – from black through grey to white. Since uncertainty always exists, one is always somewhere in the middle, somewhere between the extremes, somewhere in the grey area [7].

Grey analysis then comes to a clear set of statements about system solutions. At one extreme, no solution can be defined for any system with no information available. On the other extreme, a system with perfect information has a unique solution. In the middle, grey systems will give a variety of available solutions. Grey analysis does not attempt to find the best solution, but does provide techniques for determining a good solution, an appropriate solution for real world problems.

Let $x_i(k)$ is the value of the number *i* listed project and the number *k* influence factors.

Usually, three kinds of influence factors are included, they are:
1. Benefit – type factor (the bigger the better),
2. Defect – type (the smaller the better)
3. Medium – type, or nominal-the-best (the nearer to a certain standard value the better).

2. LITERATURE SURVEY

Muhammad Munawar et. al. (2016), proposed that the surface roughness is one of the primary objectives in most of the machining operations in general and in internal turning in particular. Poor control on the cutting parameters due to long boring bar generates non conforming parts which results in increase in cost and loss of productivity due to rework or scrap. In this study, the Taguchi method is used to minimize the surface roughness by investigating the rake angle effect on surface roughness in boring performed on a CNC lathe.

S.K. Choudhary et. al. (2016), proposed that is a newly emerging machining process, which tends to make use of the advantages of both turning and milling, wherein both the work piece and the cutting tool are given rotary motion simultaneously. The objective of the present experimental work is to understand the phenomenon of orthogonal turn-milling especially in relation to the effects of work piece revolution, cutter diameter and depth of cut. Surface finish of the machined surface and the optimum work speed at which the surface roughness was minimum has been studied.

Davim et. al. (2015), studied the optimum conditions for the surface finish obtained in turning using design of experiment. The objective of the study was to established correlation between cutting velocity feed and depth of cut with roughness evaluation parameters (Ra).

3. PROBLEM FORMULATION & METHODOLOGY

3.1 Problem Formulation

CNC machines are extensively used in machining industry to maximize production with higher degree of precision and accuracy (Singh and Khanduja, 2011a). In order to achieve this, parametric optimization has been required to be done. Keeping all the literature gap analysis in mind the present work will study the influences of different parameters of CNC machine for Material Removal Rate (MRR) and Surface Roughness (Ra) while boring of Steel SS-304.The detailed methodology adopted for the machining and response measurements is discussed as under.

3.2 Methodology Adopted

The work has been channelized through following adopted procedure

- Check and prepare the CNC Boring Centre ready for performing the machining operation.
- Cut the Steel pipe (SS-304) by power saw and perform initial Boring operation on simple lathe to get desired dimensions of work pieces.
- Calculate weight of each specimen by high precision Digital Balance Meter (DBM) before machining.
- Perform straight Boring operation on specimens in various cutting environments involving various combinations of process control parameters like: spindle speed, feed and depth of cut etc. These experiments are pre designed with Taguchi and

executed as per orthogonal matrix provided by Taguchi Techniques.

- Calculate the weight of each machined bar again by DBM and assessed the material removal rate suitably.
- Measure surface roughness and surface profile with the help of Mitutoyo SJ-400 Surftest.
- Analyse the Taguchi statics through statistical software 'Minitab15' and tried to optimize the considered factors for favourable values of selected responses.
- At the end, One Way Un-stacked ANOVA will be used as a tool to verify and validate the results achieved during optimization by Taguchi method.

4.1 EXPERIMENTAL WORK

Material used for Work piece : SS 304 is use as work material for this research work. It is a high strength steel [19]. It has significant better weld ability and can easily be welded. It has also better strength properties and machinability. SS 304 is the most widely used austenitic stainless steel. Popularly known as 18/8 stainless steel, it has excellent corrosion resistance and forming characteristics

Experimentation is done by considering following parameters. Code A represents Spindle Speed, Code B represents Depth of cut and Code C represent Feed rate.

Table 4.1: Parameters and Levels used for the orthogonal array

Parameter	Code	Level 1	Level 2	Level 3
Spindle speed	A	90	110	130
Depth of cut	B	0.5	1	1.5
Feed rate	C	0.08	0.12	0.16
Tool	Cemented Carbide			

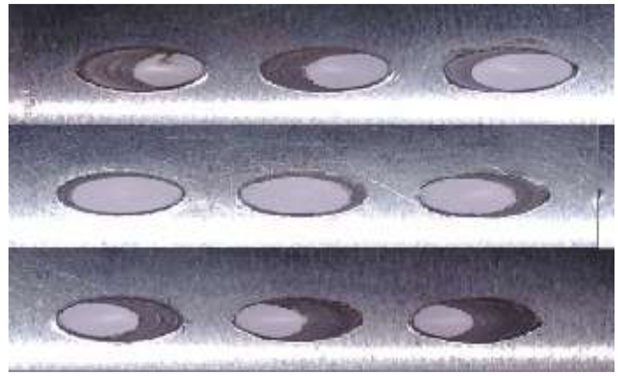

Figure: 4.1 Specimens after machining

4.1 Design of Experiment:

Designs of experiments are prepared for conducting the experiment.

Table 4.2 Design of Experiment

Run	Cutting speed (m/min)	Feed Rate (mm/rev)	Depth of Cut (mm)	Material
1	90	0.08	0.5	SS-304
2	90	0.12	1.0	SS-304
3	90	0.16	1.5	SS-304
4	110	0.08	1.0	SS-304
5	110	0.12	1.5	SS-304
6	110	0.16	0.5	SS-304
7	130	0.08	1.5	SS-304
8	130	0.12	0.5	SS-304
9	130	0.16	1.0	SS-304

4.2 Material Removal Rate (MRR)

Material Removal Rate is a material disposal from the work piece in a certain period in CNC process. The material removal rate (MRR) is the Volume of material /metal removed per unit time and is expressed in mm3/min.

4.5 Main Effect Plots for MRR

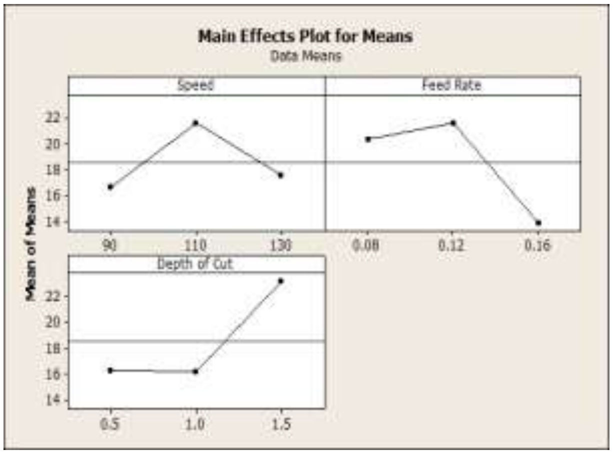

Figure 4.4 Material Removal Rate

4.4 Surface Roughness (SR)

Surface finish was measured using a Mitutoyo SJ-400 surftest device. The work piece after CNC boring were marked at four positions at the inner diameter and four readings were taken for surface roughness (Ra). The average of four readings is taken as value for surface roughness (Ra).

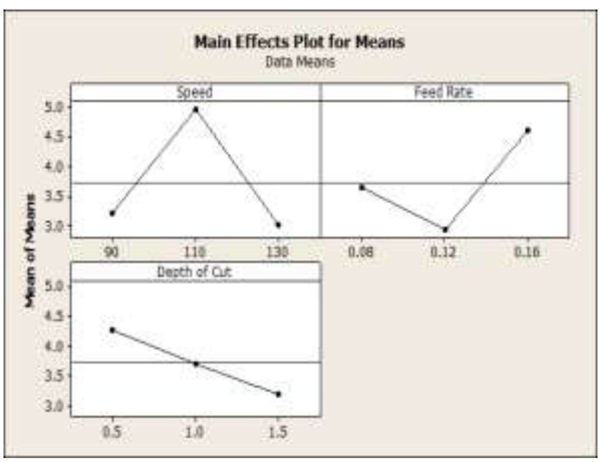

Figure 4.5 Surface Roughness

Table: Result for GRA Grade and Rank

S.No.	A	B	C	Grey Relational Grades	Rank
1	90	0.08	0.5	0.519	4
2	90	0.12	1	0.715	7
3	90	0.16	1.5	0.528	5
4	110	0.08	1	0.488	3
5	110	0.12	1.5	0.813	8
6	110	0.16	0.5	0.361	1
7	130	0.08	1.5	0.814	9
8	130	0.12	0.5	0.652	6
9	130	0.16	1	0.460	2

5.1 Predicting Optimum performance at their levels for Taguchi

MRR_{opt} = MRR_{mean}+ (A_2 – MRR_{mean}) + (B_2 – MRR_{mean}) + (C_3 – MRR_{mean})

= 18.580 + (21.610 – 18.580) + (21.570 – 18.580) + (23.203 – 18.580)

= 29.233 mm^3/min.

SRopt = SRmean+ (A1 – SRmean) + (B2 – SRmean) + (C3 – SRmean)

= 3.728 + (3.210 – 3.728) + (2.943 – 3.728) + (3.200 – 3.728)

= 19.03 µm.

5.2 Predicting Optimum performance at their levels for GRA

Predicting Mean MRR

= 18.580+ (17.516 -18.580) + (21.570 - 18.580) + (23.203 - 18.580)

= 25.126 mm^3/min.

Predicting Mean SR

= 3.728 + (3.100- 3.728) + (2.943- 3.728) + (3.203 -3.728)

= 2.600 µm

5.3 Comparative Study between Taguchi & GRA Method

1. Using Taguchi method we have found that the optimum parameters value for MRR is 29.233 mm^3/min which is obtained at speed of 110 mm^3/min, feed at 0.08 mm/sec & 1.5 mm depth of cut. The optimum parameters value for SR is 19.03 µm which is obtained at speed of 110 mm^3/min, feed at 0.08 mm/sec & 1.5 mm depth of cut.
2. Using GRA method we have found that the optimum parameters value for MRR is 25.126 mm^3/min which is obtained at speed of speed of 130 mm^3/min, feed at 0.8 mm/sec & 1.5 mm depth of cut. The optimum parameters value for SR is 2.600 µm which is obtained

at speed of 130 mm^3/min, feed at 0.08 mm/sec & 1.5 mm depth of cut.

REFERENCES

1. **C. Sanjay, C. Jyothi (2017)**, "A study of surface roughness in drilling using mathematical analysis and neural networks" International Journal Advance Manufacture Technology, Volume: 29, No: 8, PP (846-852).

2. **Gaurav Bartaryaa, S.K.Choudhury (2017),** "Effect of cutting parameters on cutting force and surface roughness during finish hard turning AISI52100 grade steel. Volume: 55, No:2, pp-(651-656).

3. **Qi Shi & Liang Li, Ning He, Wei Zhao, Xiaoli Liu(2016)** "Experimental study in high speed milling of titanium alloy TC21" International Journal Advance Manufacture Technology, Volume:4, No:3, PP (1-6).

4. **Muhammad Munawar, Joseph Ching-Shihn Chen, Nadeem Ahmad Mufti (2016),** "Investigation of Cutting Parameters Effect for Minimization of Sur Face Roughness in Internal Turning" International Journal of Precision Engineering and Manufacturing,Volume-12, No-1, PP(121-127).

5. **Rong-Tai Yang1, Hsin-Te Liao1, Yung-Kuang Yang1, Show-Shyan Lin (2016),** "Modeling and Optimization in Precise Boring Processes for Aluminum Alloy 6061T6 Components" International Journal of Precision Engineering and Manufacturing, Volume-13, No-1, PP (11-16).

6. **Tae Hong Lee1 (2015),** "Development of Theoretical Model to Predict Cutting Forces for Hard Machining" International Journal of Precision Engineering and Manufacturing,Volume-12, No-5, PP (775-782).

7. **Metin Kök (2015),** "Modeling the effect of surface roughness factors in the machining of 2024Al/Al2O3 particle composites based on orthogonal arrays" Volume:55, No:2, PP (911-920).

8. **Saeed Zare Chavoshi, Mehdi Tajdari (2015),** "Surface roughness modelling in hard turning operation of AISI 4140 using CBN cutting tool" International Journal Mater Form, Volume-3, No-2, PP (233-239).

9. **Tongchao Ding, Song Zhang, Yuanwei Wang (20104,** "Empirical models and optimal cutting parameters for cutting forces and surface roughness in hard milling of AISI H13 steel" International Journal Advance Manufacture Technology, Volume: 51, No:2, PP (45-55).

10. **Fatih Senbabaoglu, Ismail Lazoglu, Salih O. Ozkeser (2013),** "Experimental analysis of boring process on automotive engine cylinders" International Journal Advance Manufacture Technology, Volume:48, No:9, PP (11-21).

11. **Anirban Bhattacharya, E Santanu Das P. Majumder , Ajay Batish (2011),** "Estimating the effect of cutting parameters on surface finish and power consumption during high speed machining of AISI 1045 steel using Taguchi design and ANOVA" Prod Engg. Volume:3 , No:2, PP (31-40).

12. **D.I. Lalwani, N.K. Mehta, P.K. Jain(2010),** "Experimental investigations of cutting

    parameters influence on cutting forces and surface roughness in finish hard turning of MDN250 steel" Journal of Materials Processing Technology, Volume 206, Issues 3, PP (167–179).

13. **S.Arvindan, A.Naveen Sait, A.Noorul Haq (2009),** "A machinability study of GFRP pipes using statistical Techniques" International Journal Advance Manufacture Technology, Volume 43 ,No:3 , PP (1069-1081).

14. **Mustafa kurt, Eyup Bagci, Yusuf Kaynak (2007),** "Applicationof Taguchimethod in the optimization of cutting parameters of surface finishing and holes diameters accuracy in dry drilling processes" International Journal Advance Manufacture Technology, Volume 40, No:2, PP (458-469).

15. **S.K. Choudhury, J.B. Bajpai (2005),** "Investigation in orthogonal turn-milling towards better surface finish" Volume 170, No:3, PP (487-493).

16. **Sachine, kohli A (2004),** "Modeling the surface roughness and cutting force for turning of AISI 1040 carbon steel" Journal of Material processing Technology, Volume 108, No:2, PP (286-293).

17. **Hochang, (2004),** "Optimization of Cutting Parameters Based on Surface Roughness and Assistance of work piece Surface Temperature in Turning Process". American journal of Engineering and Applied Sciences Volume 3, No: 1, PP (102-108).

18. **Davim JP (2003)**, "Design of optimization of cutting parameters for turning metal matrix composites based on orthogonal arrays". J Mater Process Technology, Volume 132, PP (340-344).

19. **Lee B.Y., Lin W.S, Wu. C.L. (2001),** "Modelling the Surface roughness and cutting force for turning", Journals of Materials Processing Technology, Volume 108, PP (286-293).