Improvement of Cutting Parameters for Surface Roughness in CNC Turning Using Taguchi and Regression Approach

First Author :-Md. Zuber Khan[1], Co Author 1 :- Surbhi Misha[2], Co Author 3 : Mahendra kumar salvi
Assistant Professor, Department of Mechanical Engineering, Geetanjali Institute of Technical Studies, Udaipur

Abstract - Conceptual Prediction of surface harshness and dimensional mistakes is a basic essential for any unmanned PC numeric controlled (CNC) hardware. This forecast procedure is likewise critical for enhancement of machining process. In the present work, it is watched that, utilizing Taguchi approach, the nature of surface complete can be anticipated inside a sensible level of exactness by considering the triaxial cutting powers. Surface unpleasantness and cutting powers are the basic elements which impact the nature of the machined parts.
In this examination paper, an endeavor has been made to streamline the slicing conditions to get anticipated surface unpleasantness in turning of Mild Steel. The analysis was outlined utilizing Taguchi full factorial approach and 27 exploratory runs were directed for different blends of cutting parameters. The flag to commotion proportion and investigation of fluctuation (ANOVA) were utilized to contemplate the execution qualities at various conditions. Keeping in mind the end goal to break down the reaction of the framework, tests were done at different axle speeds, profundity of cut and sustain rate. The outcomes acquired by this examination will be helpful for different enterprises and scientists working in this field.
File Terms-CNC; Surface unpleasantness; Taguchi strategy; ANOVA, Rank Table.

1.Introduction

Over the most recent three decades, there have been gigantic specialized upsets in the assembling fragment, in particular PC incorporated assembling businesses [1]. In today‟s worldwide assembling condition, every one of the organizations are contending to deliver great item at most minimal cost. Keeping in mind the end goal to accomplish this

objective, there is a pattern of organizations towards specialized unrest or modernization. The organizations are tending towards mechanized unmanned CNC cells for expanding the creation rate and diminishing work cost. In any case, because of absence of ceaseless administrator observing it can cause deserts in the machined parts.

Turning is the most widely recognized machining task which is extraordinarily being utilized for the completing of machined parts. In a regular turning task, certain machine parts may require indicated surface unpleasantness .It is an imperative parameter in mechanical applications that impact broadly the execution of the parts and it is one of the significant quality trait of the machined parts. Such parts might bear surfaces, fixing surfaces and so forth which require persistent administrator observing else that may lead deserts. In turning activity, it is critical assignment to choose cutting parameters for accomplishing better execution. For the most part, these parameters are resolved based on understanding or by the utilization of machinery‟s handbook. Apparatus wear is a main consideration which influences the surface unpleasantness however the administrator can hear the prattling sound of the well used out instrument and see the device condition or can utilize device condition observing framework to quantify the device wear. Analysts and designers are as of now endeavoring to develop an exceedingly solid cutting apparatus condition checking framework [2].

Various surface unpleasantness expectation frameworks have been outlined utilizing assortment of sensors including dynamometers for power and torque [3], accelerometer based vibration observing sensors [4], current tests for estimating energy of the axle [5], acoustic emanation sensors [6] and so on. The uses of these sensors are to foresee the surface harshness as indicated by the gathered information from the sensors. A more definite dialog was exhibited on surface harshness expectation which was displayed by Benardos and Vosniakos[7].

Vigorous plan for the designing is a superior system for acquiring best arrangement of results which are insignificantly delicate to the various reasons for variety to create best quality items at any rate cost. Taguchi and ANOVA parameter is imperative device for such sort of vigorous plan which offers straightforward and orderly way to deal with streamline the outline information [8-13]. These procedures can be utilized for advancing the coveted outcomes by controlling the outline parameters in a few trial runs. Taguchi configuration can upgrade the outcomes through setting of plan parameters according to necessity [14]. Then again, ANOVA is utilized to perceive the most critical factors and their cooperation impacts alongside their rate commitment [15]. A decent exchange off between quality, cost and execution with greatest dependability and least time will be proposed from in process advancement of machining parameters amid turning utilizing cutting power detecting.

There were three targets of this exploration. The first was to lead efficient trial runs and in process and also post process information accumulation. The second was to uncover a precise method of utilizing Taguchi parameter plan for distinguishing proof of ideal parameters. The third was to dissect the outcomes to get wanted surface harshness with a specific blend of cutting parameters in turning activity.

Along these lines, the paper is sorted out in the accompanying way. Right off the bat, a review and past examinations to the applicable work has been talked about. At that point, trial setup and information accumulation frameworks alongside their specialized particulars have been talked about. In the following segment, strategy for trial information gathering and the information tables to the applicable work is incorporated. From that point onward, the investigation of the gathered information is talked about utilizing Taguchi approach, ANOVA approach and their expectation runs are performed to check the precision of the exploratory setup. At last, the paper closes with a rundown and dialogs of this investigation.

2. MATERIAL & METHOD

This section presents a meticulous description of the material which involves chemical composition and mechanical properties of the material and the experimental procedure being used for this experimentation

2.2.1 Material and its determinations

The work piece material for this investigation was Mild Steel. It is the normally utilized created compound in every one of the enterprises for assembling of tough, light weight and consumption resistive parts. Mechanical properties and concoction organization of Mild Steel is as appeared in Table 1 and 2 individually. The work pieces were cut from 30mm (0.03 m) distance across bar. Each work piece was generally sliced before the last complete slice with a specific end goal to keep up dimensional errors and legitimate estimation of vibrations at different cutting parameters

2.2 Experimental Design and Setup

This test includes an essential Taguchi plan in which an orthogonal exhibit configuration is utilized to perform test keeps running at different cutting parameters. The examination includes three controlled elements and two reaction factors. The controlled components are shaft speed, profundity of cut and sustain rate while the reaction factors are surface harshness and cutting powers along three tomahawks.

As appeared in Table-3, all the three controlled elements i.e. axle speed (SS), profundity of cut (DC) and nourish rate (FR) has three levels. This outcomes altogether of 27 rushes to be directed to test every one of the blends of the parameter level as per Taguchi L27 orthogonal exhibit configuration as appeared in Table-4 as indicated by full factorial plan. In full factorial outline every parameter blend is utilized for exploratory run i.e. 3^3 runs, which brings about a bigger number of investigations in contrast with the randomized calendar of runs yet give exact outcomes.

All the required information are gathered from the trial setup for singular run. The exploratory setup incorporates CNC Lathe, test work pieces, surface unpleasantness estimation setup and cutting power information accumulation framework.

The analysis was performed utilizing CNC turning on HMT CNC advances Series incline bed CNC machine. This is a bi-directional turner machine which joins a 30° inclination bed setup and some other extraordinary highlights that assistance in better machining and surface wrap up. The significant specialized determinations of the CNC Turning focus are given in Table-5. So as to keep up steady machining and vibration condition, this test was performed with dry cutting i.e. without utilization of coolant.

The machining procedure was led utilizing another precious stone molded carbide apparatus embed.

The in procedure cutting power information gathering framework was utilized which measures the triaxial cutting powers at different cutting parameters. The framework was involved a tri-hub advanced dynamometer which measures and opens up the cutting power motions in the three tomahawks of the machine i.e. X, Y and Z tomahawks. The tri-pivotal cutting power sensor was utilized which increases the flag. All the flag information were recorded and digitized for investigation reason.

Table 1: Mechanical Properties of Mild Steel Alloy

Sr. No.	Properties	Value
1	Hardness	65 BHN
2	Elongation	26-47 %
3	Tensile Strength	345-580 MPa
4	Yield Strength	250-395 MPa
5	Young‟s Modulus	200-250 GPa
6	Thermal Conductivity	138 W/mK
7	Fatigue Strength	25.9 GPa
8	Density	7800-7900kg/m3

Table 2: Experimental Levels of Cutting Parameter

Cutting Parameters	Units	No. of Levels	Values For Each Level
Level 1			
SS	rpm	3	1500
DC	mm	3	0.20
FR	mm per rev.	3	0.075

SS: Spindle speed; DC: Depth of cut; FR: Feed rate

2.3 Experimental Procedure

A calendar of runs was made at different mixes as indicated by Taguchi plan of analyses as appeared in Table-4.The work pieces from the bar were cut and turned with determined cutting conditions. The dry turning was performed for each kept running to get exact cutting power signals. Amid the complete the process of turning cutting power information were gathered on every hatchet utilizing information accumulation framework. After finishing of the considerable number of runs, the surface unpleasantness of all the work pieces was estimated. Surface unpleasantness was estimated at each 90° augmentation around the circuit i.e. four times for each work piece lastly their normal esteem is put away in the information table. Information handling and its investigation were performed through MINITAB-17 factual programming. The parameters and aftereffects of every individual run which incorporates comparing SN proportion as appeared in Table-3

Table-3: Signal to Noise Ratios for Various Parameters-(Smaller-is-better)

S.N.	Ra	S/N	F-1
1	0.56	5.036239	152.56
2	0.57	4.882503	217.73
3	0.63	4.013189	309.23
4	0.82	1.723723	179.85
5	0.84	1.514414	249.23
6	0.89	1.0122	329.56
7	0.98	0.175478	191.24
8	1.03	-0.25674	277.62
9	1.24	-1.86843	392.42
10	0.51	5.848596	123.21
11	0.54	5.352125	196.25
12	0.53	5.514483	236.26
13	0.61	4.293403	131.85
14	0.64	3.876401	202.85
15	0.65	3.741733	239.52
16	0.82	1.723723	139.63
17	0.84	1.514414	228.41
18	0.85	1.411621	286.74
19	0.49	6.196078	103.54
20	0.51	5.848596	149.57
21	0.52	5.679933	193.47
22	0.59	4.58296	115.46
23	0.62	4.152166	175.54

24	0.6	4.436975	211.47
25	0.71	2.974833	126.78
26	0.73	2.733543	118.41
27	0.83	1.618438	264.47

Table 3.1: General Linear Model: F1 versus SS, FR & DC

Source	DF	Adj SS	Adj MS	F	P	% Contribution
SS	2	71.581	35.7903	44.47	0.000	29.10%
FR	2	8.988	4.4939	5.58	0.012	3.65 %
DC	2	149.272	74.6360	92.74	0.000	60.69%
Residual error	20	16.096	0.8048			6.54%
Total	26	245.937				
S = 0.8971 R-Sq = 93.5% R-Sq (adj) = 91.5%						

3. RESULTS

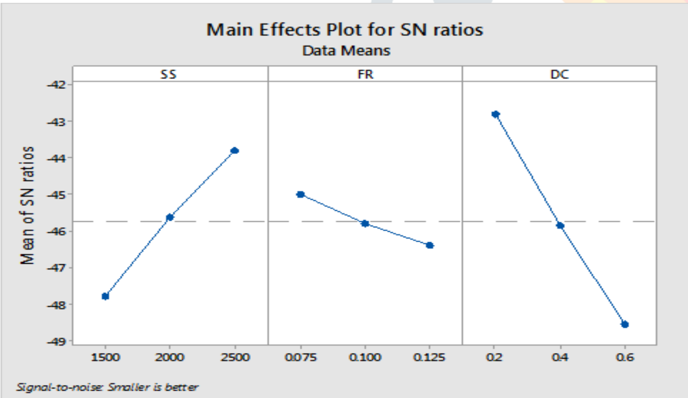

Fig. 1: Main Effect Plot for SN Ratios Corresponding To F1

The results acquired from the respective tables 3 & 3.1 are as follows:

- It can be seen from the Tables 6 & 6.1; Spindle speed, Feed rate and Depth of cut all appear to significantly affecting the values of force signal i.e. F1. Each factor has their effect on the force amplitude in different manner explored from the results.
- As seen from the Table 6.1, the amplitude of force i.e. F1 is strongly affected by Depth of cut because from the ANOVA table DC has highest F-value (92.74) which is much greater than four indicating its strong level of significance. Spindle speed and feed rate also have their significant effect on F1 because their F- values are more than four. This model has the coefficient of determination (R-Sq) of 93.5%, which also indicates a strong relationship between the significant factors and response and shows that model fit on higher side of acceptable limit because value of R2 is more than 90%.

4 CONCLUSION

At long last, the accompanying conclusions might be drawn for full factorial outline of test:

 It is difficult to accomplish surface unpleasantness in controlled way by „Trial and Error" technique. It needs a top to bottom parameters (i.e. SS, FR and DC) have exceptionally non-direct connections among them for full factorial DOE.
The full factorial run is ended up being a best decision since it includes all the conceivable blend of parameter esteems and gives least blunder rate henceforth demonstrates exactness of the exploratory setup and factual model and harshness esteems can be anticipated up to close level of precision and accuracy.

 While breaking down the power signals utilizing ANOVA system, F1 is ended up being firmly influenced by all the cutting parameters

 Depth of cut is profoundly influencing parameter which influences F1 Thus, to limit the estimations of power signals DC ought to be set to its exact esteem.

REFERENCES

[1] Chelladurai H., Jain V.K., Vyas N.S., Development of cutting device condition observing framework for fast turning activity by vibration and strain examination. Int J. of AdvManufTechnol, Springer 37 (2008) 471-485.

[2] Kriby D.E, Zhang Z., Chen J.C. Improvement of an accelerometer-based surface unpleasantness forecast framework in turning activities utilizing various relapse systems. J. of IndTechnol 20(4) (2004) 1– 8.

[3] AzouziR.and GuillotM.,On-line forecast of surface complete and dimensional deviation in turning utilizing neural system based sensor fusion.Int.J.Mach.ToolsManufact.,37: (1997)1201-1217.DOI:10.1016/S0890-6955(97)00013-8

[4] Abouelatta O.B. furthermore, Madl J., Surface unpleasantness forecast in light of cutting parameters and apparatus vibrationsinturningoperations.J.Mater.Process.Technol.,118(2001)269-277.DOI:10.1016/S0924-0136(01)00959-1

[5] Sundaram,S.,SenthikumarP.andManoharanN.,Studyofacousticemissionsensortechniquesformonitoringmachiningprocesses.J.Eng. AppliedSci.,2(2007)1581-1586.

[6] BenardosP.G. what's more, Vosniakos G.C., Predicting surface harshness in machining: Areview. Int.J.Mach.Tools Manufact.,43:(2003) 833844.

[7] ParkS.H.,Robust outline and examination for quality engineering,Chapman&Hall,London,1996.

[8]GhaniJ.A.,ChoudhuryI.A.,Hassan H.H.,"ApplicationofTaguchimethodintheoptimizationofendmillingparameter",J.ofMate.ProcessingTechnol.,145,(2004),pp.84– 92.

[9]KopacJ.,KrajnikP.,"Robustdesignofflankmillingparametersbasedongrey-Taguchimethod",J.ofMate.ProcessingTechnol.,191,(2007),pp.400– 403.

[10] BendellT.,Taguchimethods,in:ProceedingsoftheEuropeanConferenceonTaguchiMethod,Elsevier,Amsterdam (1988)

[11]JulieZ.Zhang,ChenJ.C.,KirbyE.D.,"Surfaceunpleasantnessadvancementinanend-millingoperationusingtheTaguchidesignmethod",J.ofMate.ProcessingTechnol., 184,(2007),pp.233– 239.

[12] KuramE.,SimsekB.T.,OzcelikB.,DemirbasE.,andAskinS."OptimizationofthecuttingfluidsandparametersusingTaguchiandANOVAinmilling"WorldCongressonEngineering,2,(2010),pp.978-988

[13] Berger P.D. what's more, Maurer R.E., Experimental plan with applications in administration, designing and the sciences.1stEdn.,DuxburyPress,USA.,(2001)ISBN:10:0534358225,pp:496.

[14]HendersonG.R.,2006.SixSigma:QualityimprovementwithMINITAB.JohnWileyandSons,England,ISBN:10:0470011556,pp:452

[15] Sundaram R.M., Lambert B.K., Mathematical model to anticipate surface complete in fine turning of steel, Part-I. Int. J. of Prod. Research 19. (1981). 547-556

[16] Sundaram R.M., Lambert B.K., Mathematical model to anticipate surface complete in fine turning of steel, Part-I. Int. J. of Prod. Research 19. (1981). 547-556

[17] Lascoe O.D., Nelson C.A., and Porter H.W. (1973). Machine shop activities and setups. Alsip, IL: American Technical Publishers.