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Experimental investigation of optimization of CNC turning process parameters for aluminium materials

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Abstract: *Applications of this project is aerospace alloys, marine alloys, cycling alloys, automotive alloys, air and gas cylinders. Metal cutting process is one of the complex process which has numerous factors contributing towards the quality of the finished product .CNC turning is one among the metal cutting process in which quality of finished product mainly depends upon the machining parameters such as speed, feed, depth of cut ,type of inserts used etc. similarly work piece material plays an important role in metal cutting process .Soft material such as aluminum, aluminum alloys are easy to machine due to their high accuracy. While machining their soft materials, optimized machining parameters results in good surface finish, tool wear, MRR etc. This study involves in identifying the optimized parameters in CNC turning of aluminum. The optimization technique numerical optimization used in this study is response surface methodology. These optimization techniques are very helpful in identifying the optimized control factors with high level of accuracy.*

Keywords: Lathe, computer Numerical Machine, operating parameters, Response surface methodology ,ANOVA, optimization

1.INTRODUCTION

In this competitive world, the customers perceive the most reliable, high quality with low cost product. In order to satisfy the customers demand, the manufacturing industries are being forced to continuously optimize their process parameters .Metal cutting is one of the most important and widely used manufacturing processes in engineering industries and in today's manufacturing scenario ,optimization of metal cutting process is essential for a manufacturing unit to respond effectively to severe competitiveness and increasing demand of quality which has to be achieved at minimal cost. The challenge of modern machining industries is mainly focused on the achievements of high quality in terms of work piece dimensional accuracy, surface finish, high production rate, less wear on the cutting tool ,economy of machining in terms of cost saving and increasing the performance of the product with reduced environmental impact .surface roughness plays an important role in many areas and is factor of great importance in evaluation of machining accuracy.

2.LITERATURE SURVEY

Kalpakjian,Schmid et al(2008). Above researcher conduct experiments on manufacturing engineering and technology and give details regarding turning operation and properties and compositions of aluminium metal. Aluminium is the most widely used in manufacturing industry. Aluminium is a good thermal and electrical conductor, by weight better than copper.

A.Djebara et al(2011): Above researcher conduct experiments on machining and machinability of aluminium alloys. Aluminium alloys are among the most commonly used lightweight.

Harsimran singh sodhi et al(2011): Above researcher conduct experiments on behavior study of cutting parameters on metal removal rate for a non-ferrous material while turning on a CNC turning center. In the present study ,work is done to capture the effects of cutting parameters on material removal rate (MRR) for a aluminium alloy while turning on a CNC turning center.

Ravirajshtty et al (2009): Above researcher conduct experiments on application of response surface methodology in cylindrical grinding of metal matrix composites .In the grinding process ,a maching parameter such as hardness ,flow rate and depth of cut were chosen for evaluation by the response surface methodology.

Research Gap: Above researcher is not done research with the significance of the both mathematical models were analyzed the significance level of the model was confirmed by ANOVA and not researched over the desirability of the optimization is 0.7692.

3. EXPERIMENTAL DETAILS:

3.1 CNC lathe settings

Fig .1.KDCK-25 CNC lathe machine specification

Product Feature

- The machine adopts CNC system with full function and high reliability. The machine design adopts mechanical-electronic and hydraulic integration method with a compact structure.
- Flat bed and slant slide structure, with high rigidity and fluent chip removal.
- X and Z axis adopt precision linear rolling guide with no backlash to result high rigidity and accuracy.
- The spindle component is of high rigidity construction to provide variable speed to realize constant linear speed cutting and high speed cutting
- Automatic centralized lubrication with full sufficiency and reliability.

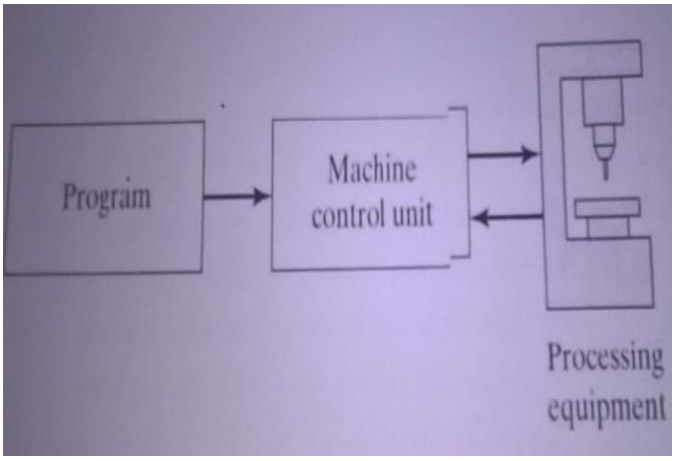

Fig.2. Block diagram of CNC lathe

The process of CNC lathe is in various steps adapted by program goes to the machine control units and controls the activity by machine control unit and then the processing equipment will do the process activity.

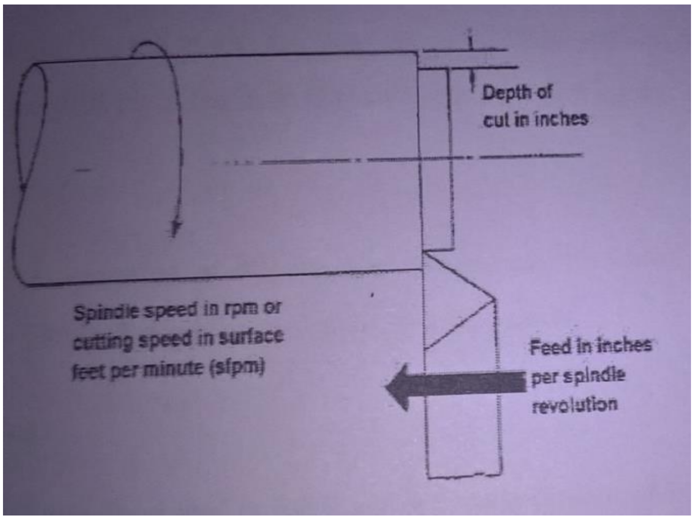

Fig.3. Turning operation

The turning operations are discussed over the reduction of diameter of work piece material.According to the spindle speed the job revolves and cutting tool turn the work piece material

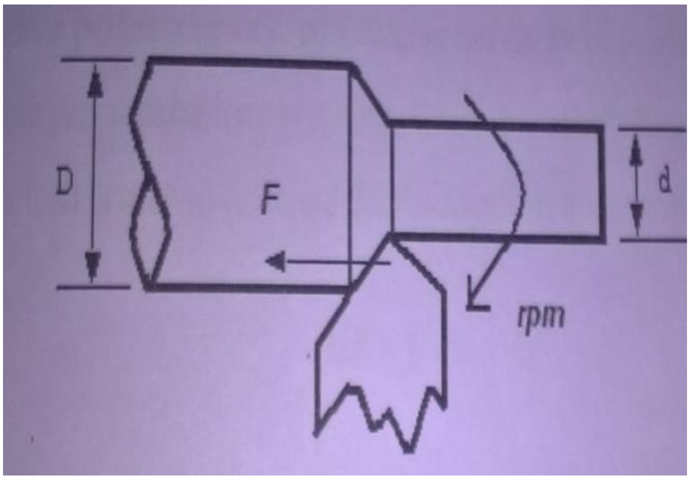

Fig.4. MRR operation

mTT=($\Pi D^2/4 - \Pi d^2/4$) x F x rpm
Where
D=diameter of the workpiece before cutting
d=diameter of workpiece after cutting

3.2 WORK PIECE MATERIAL

Fig.5. 99.4%Aluminium material turning

The aluminium material turning occurs shown in above figure .5.

Table. 1. composition of aluminium

Cu	Si	Fe	Zi	Mn	Al
0.05	0.3	0.4	0.10	0.05	99.4

4.METHODOLOGY

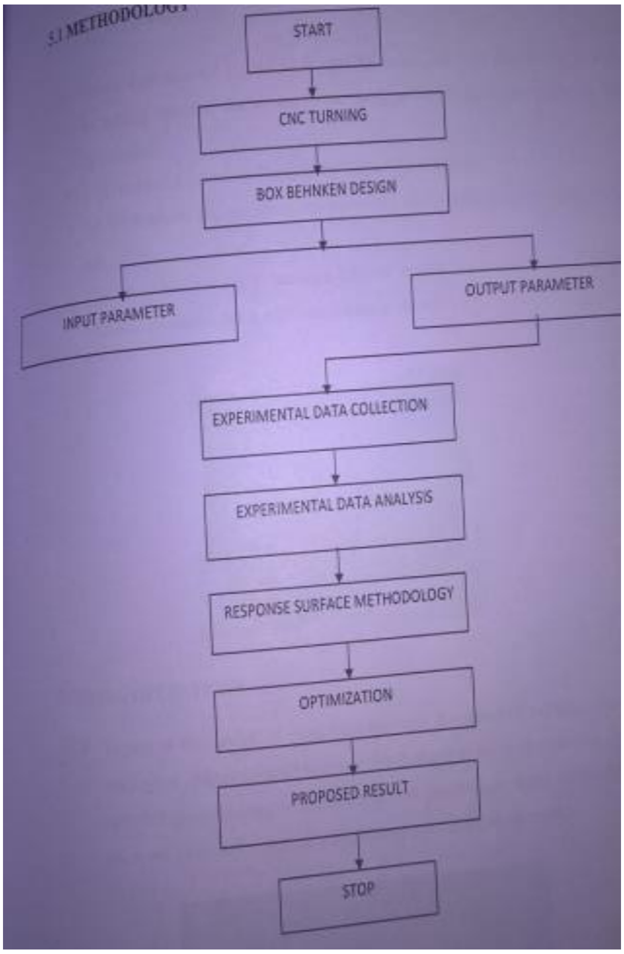

Fig. 6.methodology for turning operation

RESEARCH METHODOLOGY

- Selection of process
- Turning operations
- Turning parameter

Table 2. Input parameter

Parameter	Level1	Level2	Level3
Speed(rpm)	500	750	1000
Feed(m/min)	0.1	0.2	0.3
Depth of cut(mm)	0.5	1	1.5

5. RESULT AND DISCUSSION

Turning formulas
Cutting speed V=ΠDN/1000
Cutting force =K*f*d

Table.3. Anova Table for cutting force

Std.Dev	73.951	R-Squared	0.8413
Mean	207.94	Adj R-Squared	0.6373
C.V%	207.94	Pred R-Squared	-0.073
PRESS	207.94	Adeq precision	5.3995

Table.4. Anova Table for MRR

Std.Dev	2044.2206	R-Squared	0.9282
Mean	7733.3859	AdjR-Squared	0.8359
C.V%	26.433708	Pred R-Squared	-0.149
PRESS	468029854	Adeq precision	11.516

Table.5. Anova Table for hardness

Std.Dev	4.7094	R-Squared	0.8314
Mean	46.235	Adj R-Squared	0.6376
C.V%	10.186	Pred R-Squared	-0.623
PRESS	1588.9	Adeq precision	7.0945

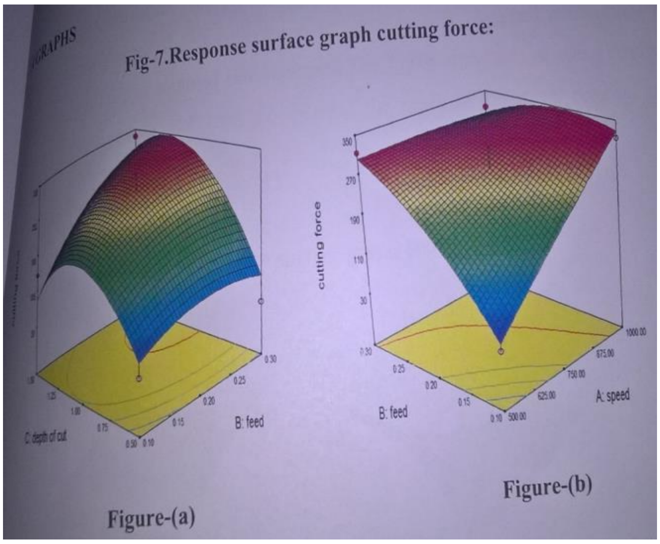

Fig.7.Response surface graph for cutting force

The graph is drawn for cutting force and the graph drawn with depth of cut in x-axis and cutting force on y axis and feed on z-axis as shown in fig 7(a) and The graph is drawn for cutting force and the graph drawn with feed in x-axis and cutting force on y axis and speed on z-axis as shown in fig 7(b)

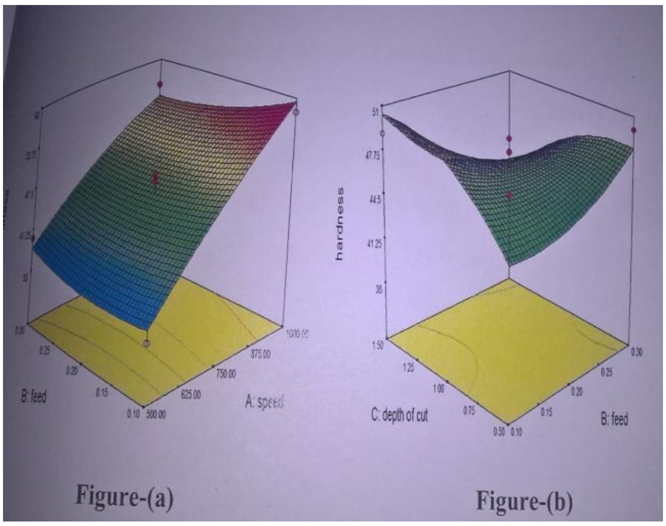

Fig.8. Response surface graph for hardness

The graph is drawn for cutting force and the graph drawn with feed in x-axis and hardness on y axis and speed on z-axis as shown in fig (a) The graph is drawn for cutting force and the graph drawn with depth of cut in x-axis and hardness on y axis and feed on z-axis as shown in fig (b)

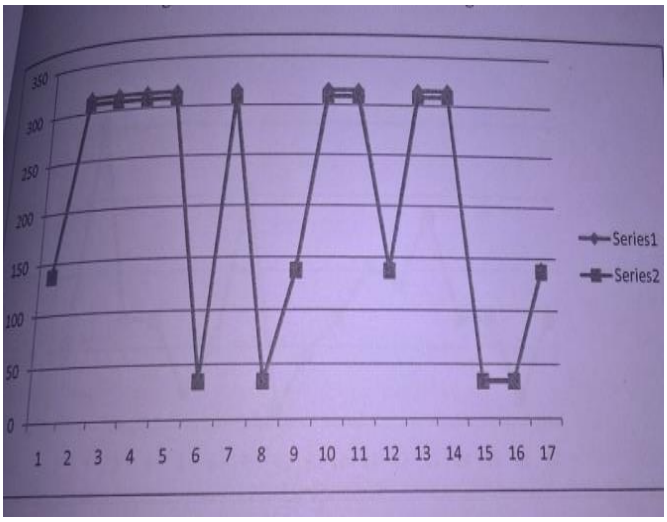

Fig.9. cutting force Vs metal cutting force

The graph drawn for cutting forces and metal cutting force is shown in above figure 9.

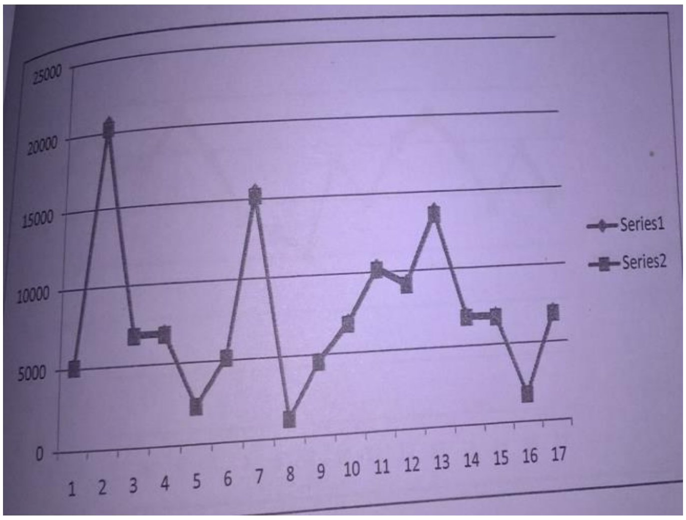

Fig.10. metal removal rate Vs model metal removal rate

The above graph drawn for metal removal rate and model metal removal rate.

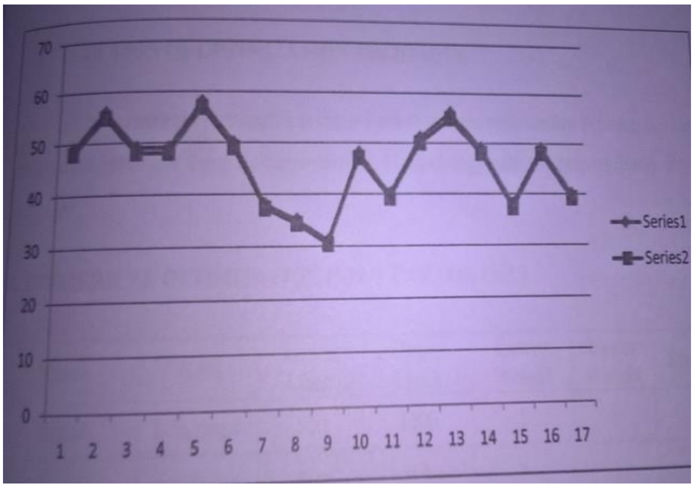

Fig.11. Hardness Vs Model hardness

The above graph drawn for hardness and model hardness is shown in figure.

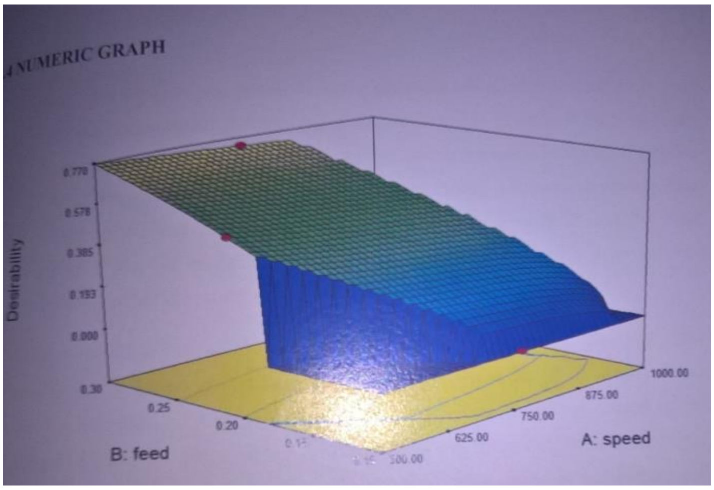

Fig. 12.Numeric graph

The above graph is drawn feed in x axis and destrability in y axis speed in z axis .

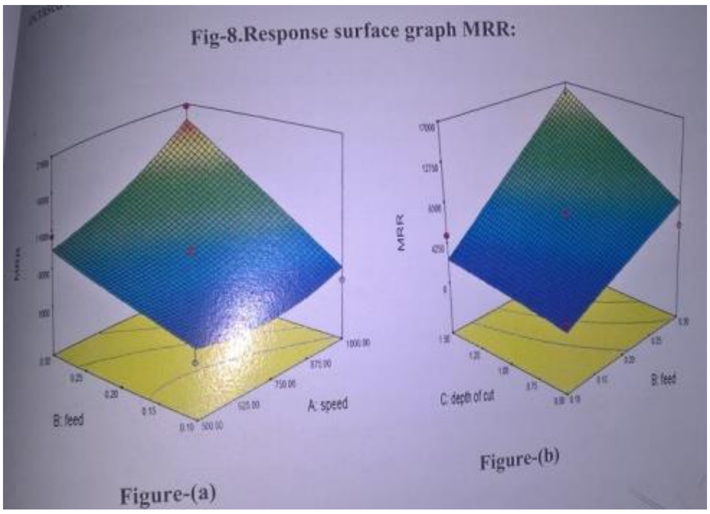

Fig.13. Response surface graph MRR.

Fig 13(a) shows that feed in x axis MRR in y axis speed in z axis.Fig 13(b)Shows that depth of cut in x axis MRR in y axis and feed in z axis.

6.CONCLUSION

1) The significance of the both mathematical models were analyzed by ANOVA.
2) The desirability of the optimization was 0.7692.
3) The optimum parameters values are speed 500rpm,feed 0.3mm,depth of cut 1.5mm.
4) The optimum cutting force is 214.38 N.
5) Optimum material removal rate is 12312mm^3/min.
6) Optimum hardness value is 34.125HRB.

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