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TOOL WEAR AND SURFACE FINISH WITH COATED CARBIDE TOOLS DURING HARD TURNING OF DIE STEEL UNDER DRY CUTTING CONDITION

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Abstract- Manufacturers of modern industries required higher production rate with required surface finish value and low tool wear so that the cost of manufacturing can be minimized combination with the reduced manufacturing time. In this paper hard turning of AISI H13 steel with coated tools have been done at different cutting conditions. From the experimental data obtained it concluded that the coated carbide tools very economical because of low tool wear but the surface roughness value.
Keywords – Hard Turning, Surface roughness, HRc,

1. INTRODUCTION

IJLTET paper format font should be 10 in times new roman with single spacing.In recent years, the accessing of multimedia data or digital data has become very easy because of the fast development of the Internet. In other words, this development makes unauthorized distribution of multimedia data. For the protection of multimedia data, a solution known as watermarking is used. After the approximate 20 years' research, different kinds of watermarking algorithm based on different theory concepts were introduced [1-3]. A digital watermark encodes the owner's license information and embeds it into data. Watermarking may be used to identify the image of owners' license information and to track illegal copies.
The rest of the paper is organized as follows. Proposed embedding and extraction algorithms are explained in section II. Experimental results are presented in section III. Concluding remarks are given in section IV.

1.1. INTRODUCTION

Hard turning is a turning operation done on various alloy steel having hardness value 45 to 65 HRc to obtain surface roughness values that are close to those obtained in grinding (Ra ~ 0.1 _m). There are different materials which is hard turned like alloy steels, tool steels, case-hardened steels, super alloys, nitrided irons and hard-chrome-coated steels, and heat-treated powder metallurgical parts.(Aslantas 2011). Hard turning is of great interest of today's manufacturing industries because it produces desirable surface quality in lesser time as compare to grinding process, estimates of reduced machining time are as high as 60% for conventional hard turning (Huddle 2001).
Ji Xiong et. al., (2012) experimentally studied tool wear and tool life of AISI H13 tool steel during hard turning with WC–5TiC–10Co ultrafine cemented carbides. In this study it was established that WC–5TiC–10Co ultrafine cemented carbides possess higher hardness and transverse rupture strength, and showed better cutting performance than conventional insert with the same cutting condition. Uhlmann et. al., (2010) had investigated the tool wear of CVD diamond coated cemented carbide tools in the machining of aluminium silicon alloys and found that the softer, hypo-eutectic G-AlSi9 Cu4Mg alloy has a high tendency to adhere to the rake face of the tool, causing built-up edge to be formed. The harder and more brittle hyper-eutectic alloy G-AlSi17 Cu4Mg is highly abrasive and so surface fatigue and abrasive wear led to fretting of the coating, spontaneous coating delamination as well as displacement of the cutting edge. Noordin et. al., (2007) experimentally performed hard turning under dry cutting conditions with constant depth of cut in order to investigate the usability of coated TiCN based cermet (KT 315) and coated carbide (KC 9110) cutting tools to turn tempered martensitic stainless tool steel. They concluded that that dry turning of hardened, stainless tool steel could be performed using coated TiCN based cermet and coated carbide cutting tools. Prasad et. al., (2011) experimentally performed hard turning with high speed steel tool and carbide insert tools to analyze the surface texture. They concluded that the carbide cutting tools provide better performance than high speed cutting tools. Quiza et.al., (2008) had investigated the tool wear in hard machining D2 AISI steel using neural networks. In this study they concluded that neural network model has shown better capability to make accurate predictions of tool wear under the conditions studied.

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2. EXPERIMENTAL DETAILS

The details of experimental conditions, instrumentations, measurements and the procedure adopted for the study are described in following sections section.

2.1 Workpiece Material

The material used for the experiments was grade AISI H13 is one of the hot work, chromium type tool steels. It also contains molybdenum and vanadium as strengthening agents. The chromium content assists this alloy to resist softening if used at higher temperatures. Secondary hardening steels with good tempering reistance. It maintains high hardness and strength at elevated temperatures. Good resistance to thermal fatigue, erosion and wear. Steel with very high toughness and good ductilityand hardenability. Tools can be water cooled. H13 finds applications for hot die work, die casting and extrusion dies, wear resisting tools, pressure die casting tools, pressing tools for light and heavy metal. The chemical compositions of the workpiece material are given in Table 1.

Table-I Chemical Composition of AISI H13 steel

Alloying element	C	S	P	Si	Ni	Cr	Mo	V
Percentage by weight	0.370	0.014	0.019	0.800	–	5.100	1.450	0.910

2.2 Cutting Conditions

The Carbide inserts of Kyocera company, TNGA 160408S01525 (ISO Designation) PVD coated and Taegutec company, TNMG 160408TT3500 (ISO Designation) having nose radius 0.8 mm were employed. The tool holder MTJNL 2525 M16 was used during hard turning. The machine tool employed for turning was BATLIBOI make CNC turning centre, model SPRINT 16TC with Fanuc 0i T Mate Model, Fanuc Motors & Drives and φ165 x 3 jaw Hydraulically operated.

2.3 Tool Wear Measurements

The Mitutoyo’s Microscope TM-500 series was used to measure the width of flank wear. It is designed with measurement of work piece contours and inspection of surface features. The magnification and the least count of the instrument used is 30 X and 0.001 mm respectively.

2.4 Surface Roughness Measurements

The stylus type surface roughness tester (Surftest SJ-3010) having stroke length, 12.5 mm and evaluation length of 4 mm was used to evaluate the surface texture.

3. DESIGN OF EXPERIMENTS

The response surface methodology (RSM) is a collection of mathematical and statistical techniques that are useful for the modeling and analysis of problems in which a response of interest is influenced by several variables and the objective is to optimize this response (Montgomery, 2001).

The machining experiments and analysis were conducted based on response surface methodology (RSM) and the BOX-Behnken Design of experiments. Response-surface methodology comprises a body of methods for exploring for optimum operating conditions through experimental methods. The BOX-Behnken Design is one of many that can minimize the number of results required for three factor experimental design. The levels of the cutting parameters have been selected by taking into account, according to the recommendations of Kyocera and literature survey.

Table-II Cutting parameters and there levels for coated carbide

Cutting parameters	Low level (-1)	Middle level (0)	High level (+1)
V_c (m/min)	65.00	82.50	100.00
f (mm/rev)	0.05	0.10	0.15
a_p (mm)	0.20	0.35	0.50

Table-III Experimental design and cutting conditions for coated carbide

Run	Vc m/min	F mm/rev	D.O.C mm	Surface roughness(Ra) µm	Tool wear (V_B) Mm
1	0.35	0.05	82.5	1.27	0.267
2	0.35	0.05	100.0	1.58	0.133
3	0.35	0.05	65.0	1.28	0.287
4	0.35	0.10	82.5	1.98	0.145
5	0.35	0.10	100.0	1.65	0.138
6	0.35	0.10	65.0	1.63	0.123
7	0.35	0.15	82.5	1.98	0.145
8	0.35	0.15	100.0	0.91	0.186

9	0.35	0.15	65.0	1.53	0.126
10	0.20	0.05	82.5	0.89	0.153
11	0.20	0.05	100.0	1.15	0.237
12	0.20	0.05	65.0	1.26	0.278
13	0.20	0.10	82.5	1.52	0.168
14	0.20	0.10	100.0	1.15	0.237
15	0.20	0.10	65.0	1.74	0.133
16	0.20	0.15	82.5	0.89	0.147
17	0.20	0.15	100.0	1.25	0.246
18	0.20	0.15	65.0	1.48	0.122

The total 17 numbers of experiments were conducted under different cutting conditions and levels. The Table 3 shows the list of tests conducted with various combinations of cutting parameters and levels. Finally, regression models have been obtained and analyzed using analysis of variance (ANOVA).

4. RESULTS AND ANALYSIS

In the present study the table IV shows the suggested models for response, minimum and maximum ranges of response and cutting parameter. Adequacy of the model was checked by conducting three differ tests and results was tabulated as below:
Signal To Noise Ratio - Parameters that affect the output can be divided in two parts: controllable (or design) factors and uncontrollable (or noise) factors. The value of controllable factors can be adjusted by the designer but the value of uncontrollable factors cannot be changed because they are the sources for variation because of operational environment. The best setting of control factors as they influence the output is determined by performing experiments. Smaller-the-Better is used for surface roughness and Tool Wear is used because minimum values for the surface roughness and tool wear are desirables for minimize the cost and maximizing the profit.

4.1 Calculations Of S/N Ratios For Tool Wear Of Table IV and V

Table-IV Response Table for Means

Level	D O C (mm)	FEED (mm/rev)	SPEED (m/min)
1	0.1912	0.2258	0.1782
2	0.1722	0.1573	0.1708
3		0.1620	0.1962
Delta	0.0190	0.0685	0.0253
Rank	3	1	2

Table-V Response Table for Signal to Noise Ratios

Level	D O C (mm)	FEED (mm/rev)	SPEED (m/min)
1	14.73	13.29	15.66
2	15.71	16.28	15.58
3		16.08	14.42
Delta	0.98	2.99	1.24
Rank	3	1	2

A greater S/N value corresponds to a better performance. Therefore, the optimal level of the machining parameters is the level with the greatest S/N value. The S/N ratio response graphs plotted in Figure 1. Based on the analysis of the S/N ratio graphs, the optimal machining performance for the tool wear at 65.00 m/min cutting speed (level 1), 0.10mm feed (level 2) and 0.35 mm depth of cut (level 2)

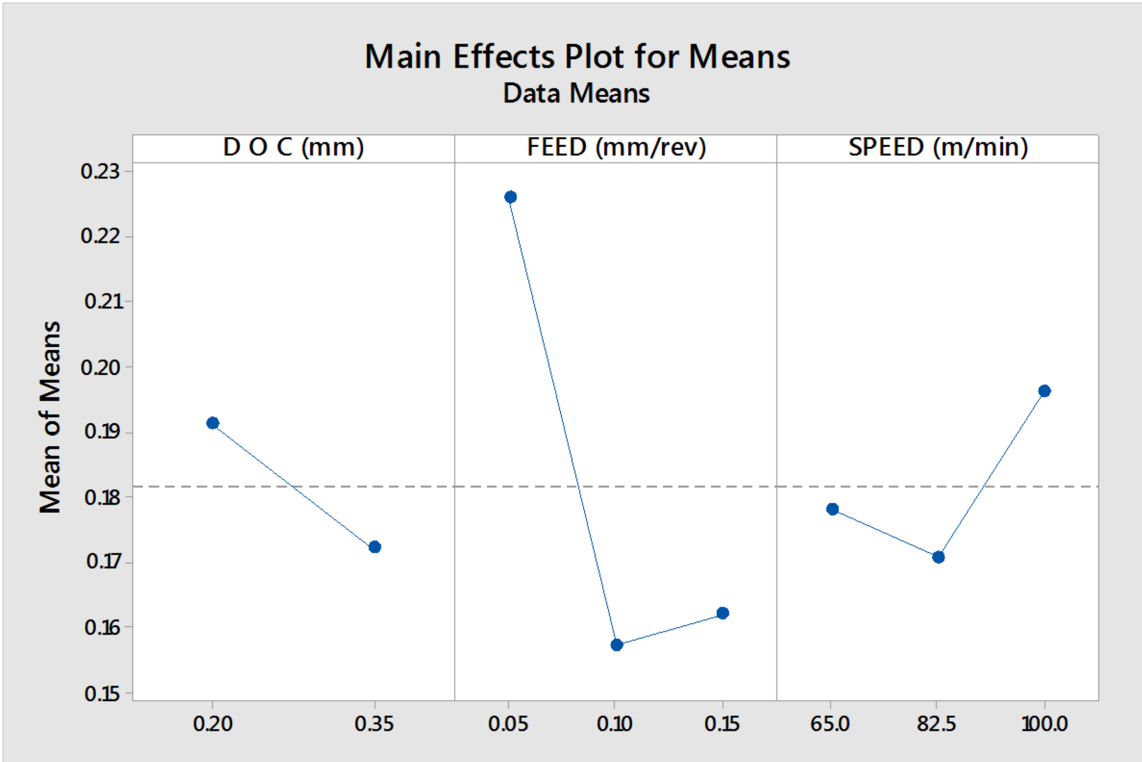


Figure-1.Main effects plot for S/N ratios for Tool wear

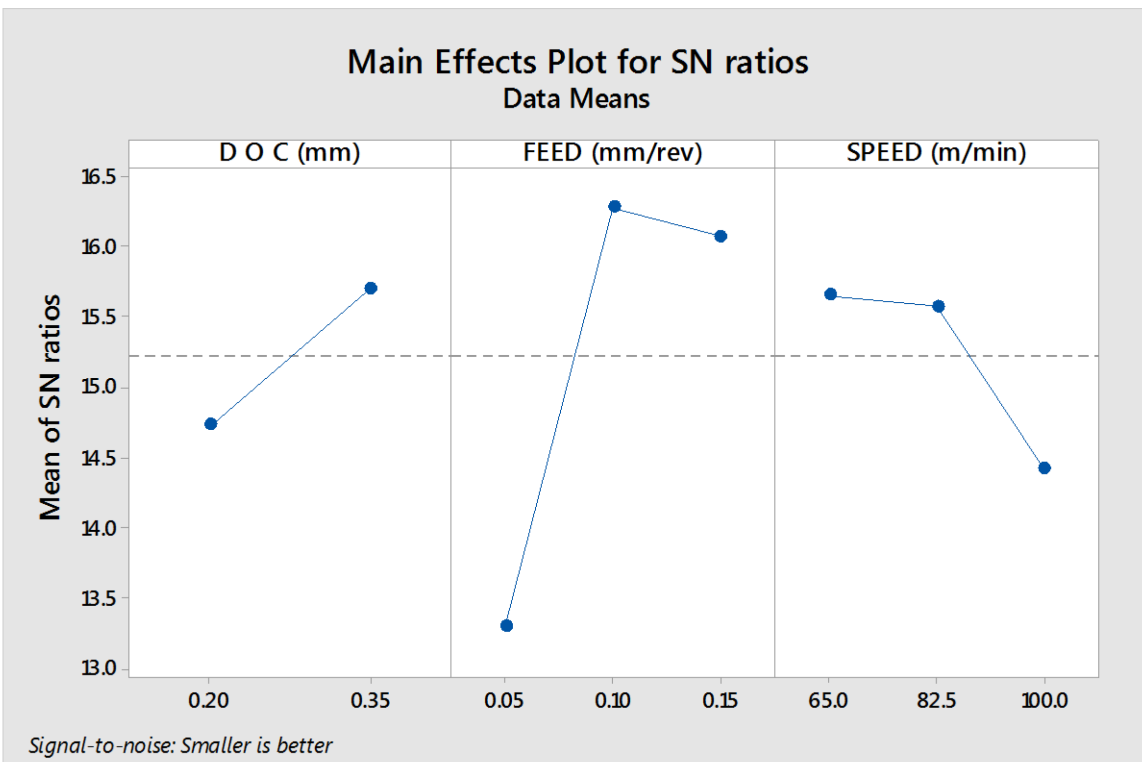


Figure-2. Graphical Representations of S/N Data vs. Depth of Cut, Feed and Speed

4.2 Calculations Of S/N Ratios For Tool Wear Of Table VI and VII

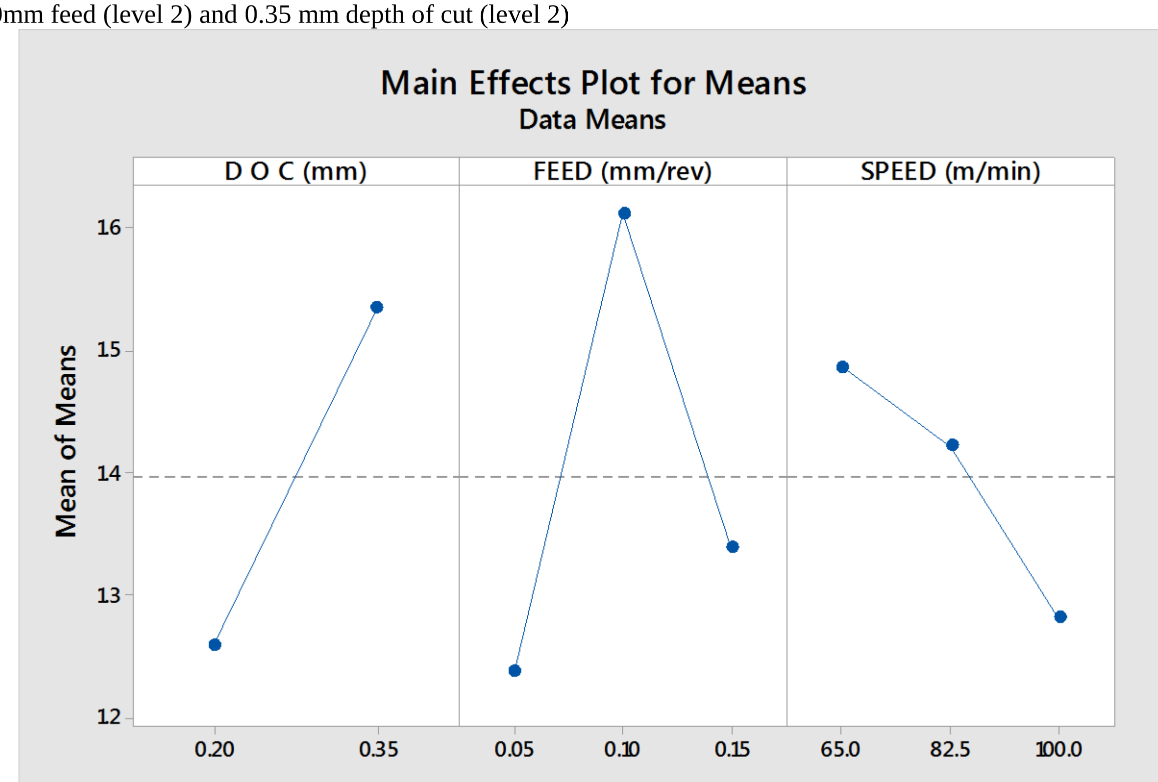
Table-VI Response Table for Means

Level	D O C (mm)	FEED (mm/rev)	SPEED (m/min)
1	1.259	1.238	1.487
2	1.534	1.612	1.422
3		1.340	1.282
Delta	0.276	0.373	0.205
Rank	2	1	3

Table-VII Response Table for Signal to Noise Ratios

Level	D O C (mm)	FEED (mm/rev)	SPEED (m/min)
1	-1.800	-1.734	-3.384
2	-3.503	-4.031	-2.593
3		-2.190	-1.978
Delta	1.703	2.298	1.406
Rank	2	1	3

As greater S/N value corresponds to a better performance. Therefore, the optimal level of the machining parameters with the greatest S/N value is also the optimum machining parameters for Surface roughness. The S/N ratio response graphs plotted in Figure 3. Based on the analysis of the S/N ratio graphs, the values for surface roughness at 65.00 m/min cutting speed (level 1), 0.10mm feed (level 2) and 0.35 mm depth of cut (level 2)



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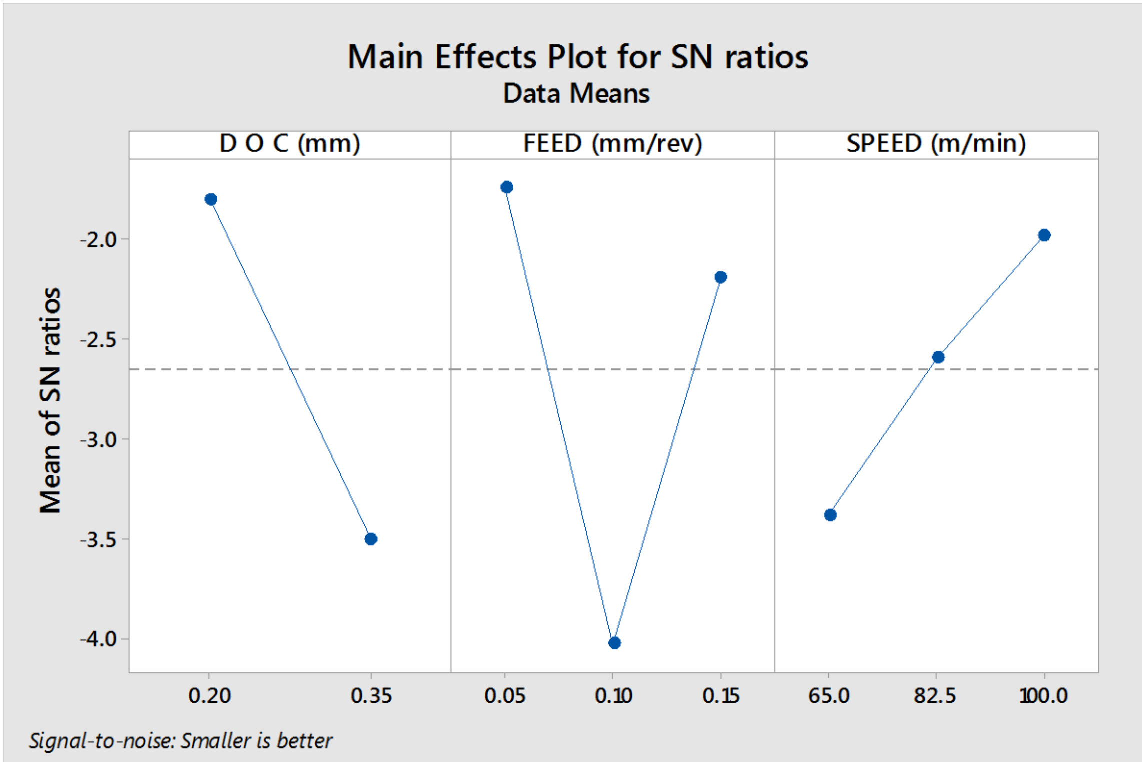

Figure-2. Graphical Representations of S/N Data vs. Depth of Cut, Feed and Speed

5. CONCLUSION AND FUTURE SCOPE

The following sections give the conclusions as obtained from the results of the analysis of S/N Ratio.

6. CONCLUSIONS

It has been found that feed rate is found to be the most significant factor contribution to surface roughness and tool Wear. The best results for surface roughness (lower is better) would be achieved when AISI H13 work piece is machined at Cutting Speed 65.00 m/min (Level 1), Feed 0.10mm (Level 2)
and depth of cut of 0.35 mm(Level 3). The Surface roughness is mainly affected by feed rate, depth of cut and speed. With the increase depth of cut increases the surface roughness first increase and decrease and as the spindle speed increase surface roughness decreases.
The percentage contributions of the parameters have revealed that the influence of the Feed is significantly larger than that of Depth of Cut and cutting speed. Traditional optimization techniques have very limited scope because of the complexity of the problems since they require a very large number of experiments. But Taguchi Technique requires very less number of experiments to optimize quality characteristics.

6.1 Future Scope

In this present study only three parameters have been considered in accordance with their effects on tool wear and cutting speed. There are some other important parameters such as Nose radius, Types of Inserts, etc. can also be studied. Also, the other outputs like power consumption, tool life, cutting forces etc. can also be added.

7. REFERENCES

[1] Aslantas, K., Ucun, I., Cicek, A., (2012) “Tool life and wear mechanism of coated and uncoated Al2O3/TiCN mixed ceramic tools in turning hardened alloy steel”, international journal on science and technology, vol. 274-275, p.p. 442– 451

[2] Huddle, D., (2001) “New Hard Turning Tools and Techniques Offer a cost-effective Alternative to Grinding”, Tooling and Production Magazine.

[3] Montgomery, D. C., , 2001 “Design and Analysis of Experiments, 5th ed.,” John Wiley & Sons.

[4] Uhlmann, E., Reimers, W., Byrne, F., and Klaus, M., (2010) “Analysis of tool wear and residual stress of CVD diamond coated cemented carbide tools in the machining of aluminium silicon alloys”, Prod. Eng. Res. Devel, Vol. 4, p.p.203–209

[5] Noordin, M.Y., Venkatesh, V.C., Sharif, S., (2007) “Dry turning of tempered martensitic stainless tool steel using coated cermet and coated carbide tools”, Journal of Materials Processing Technology, Vol. 185, p.p. 83–90

[6] Quiza, R., Figueira, L.& Davim, J. P., (2008) “Comparing statistical models and artificial neural networks on predicting the tool wear in hard machining D2 AISI steel”, International Journal of Advance Manufacturing Technology, Vol. 37, p.p. 641–648

[7] Ji Xiong, ZhixingGuo,n, MeiYang, WeicaiWan, GuangbiaoDong, (2013) "Tool life and wear of WC–TiC–Co ultrafine cemented carbide during dry cutting of AISI H13 steel", Ceramics International, vol. 39, pp. 337–346.

[8] Verma, N.K., Sikarwar A.S., "Optimizing Turning Process by Taguchi Method Under Various Machining Parameters" International Research Journal of Engineering and Technology, Volume: 02 Issue: 06

[9] Aouici, H., Yallese, M. A.,Chaoui, K., Mabrouki, T.,and Riga,l J.F.,(2012) "Analysis of surface roughness and cutting force components in hard turning with CBN tool: Prediction model and cutting conditions optimization", Measurement, Vol.45, No.3, p.p. 344-353

[10] Bartha, B.B., Zawadzki, J., Chandrasekar, S., and Farris, T.N., (2005) "Wear of Hard-Turned AISI 52100 Steel", Metallurgical And Materials Transactions A, Vol. 36, Issue 6, p.p. 1417-1425

[11] Chen, C.C., Chiang, K., Chou, C.C. and Liao, Y.C., (2011) "The use of D-optimal design for modeling and analyzing the vibration and surface roughness in the precision turning with a diamond cutting tool", International Journal of Advanced Manufacturing Technology, Vol. 54 Issue 5-8, p 465