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OPTIMIZATION OF CUTTING FORCE DURING LATHE PROCESSING STEEL 40X

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ABSTRACT

One of the important parameters of the turning metal is the cutting force. This force is the force that occurs during the cutting process and is influenced by various factors, such as tool wear, temperature in the target zone, and surface cleanliness. Cutting force has a significant influence on the cutting process. This paper presents a correlation between cutting force and turning procedure as a result of comparing experimental cutting force to the Advant Edge program's result. Determining the main parameters of turning procudere by the Minitab program were the turning speed V=157 m/min, feed s=0.12 mm/rev, depth t=1 mm, cutting force Pz= 2.02 kN, Py=0.74 kN, and Px=1.77 kN.

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1. Introduction.

AdvantEdge enables users to design turning processes in 2D and 3D environments modeling [3]. AdvantEdge software allows for the analysis of cutting parameters like as temperature, stresses, chip formation, and forces exerted by the cutting tool and workpiece contacts.

Optimal cutting parameters can be derived in a virtual without actual experiment.

Some advantages of using this software:

1. it reduces cutting tests, extends tool life and reduces tool breakage,
2. it uses complex geometries of tools and workpieces, faster machining processes, efficient productivity,
3. it increases material removal rates and machine utilization, etc.

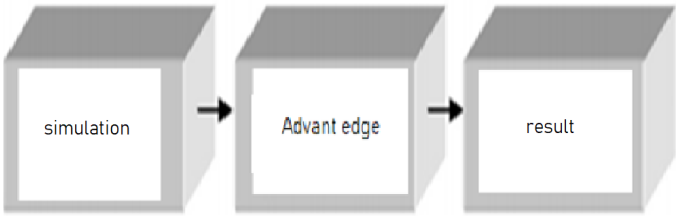

Figure 1. Structure of the program.

The program mentioned in above can be used in following processing:

1. Lathe processing.
2. Planning.
3. Sawing.
4. Milling.
5. Drilling operations.

2. Cutting force in turning operation.

Cutting forces are one of a very significant indicators of the metal cutting process. Because cutting forces are closely linked to factors including self-excited vibrations, tool wear, and the quality of the machined surface, modeling and predicting cutting forces during the turning process is crucial.

Optimizing the large number of interrelated parameters such as cutting speed, feed, depth of cut, cutting edge angles, and nose radius, that influence the cutting forces not only makes it extremely a proper model but also reduce vibrations [1].

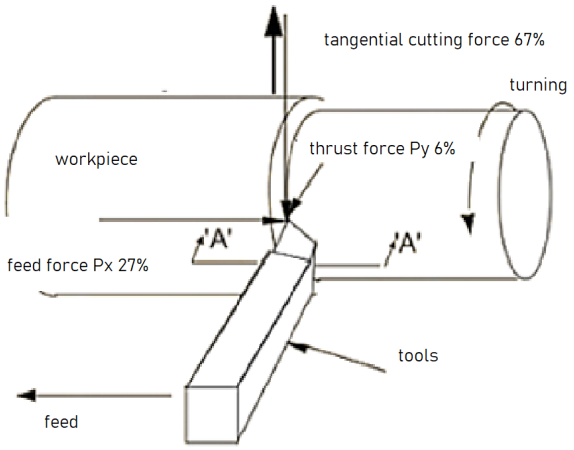

Figure 2. The ratio of the cutting forces.

There are various techniques to determine these cutting forces in research papers, we have used the elastic deformation method to determine the cutting force [5]. Machining experiments have been carried out on the lathe 16B16P and workpiece material used in the experiment was 40X cylindrical bar cutting by the lathe. During cutting we have measured the cutting force and shown results of correlation between the cutting force and turning mode in the Figure 4.

Figure 3. Stand of measuring cutting force turning operation.

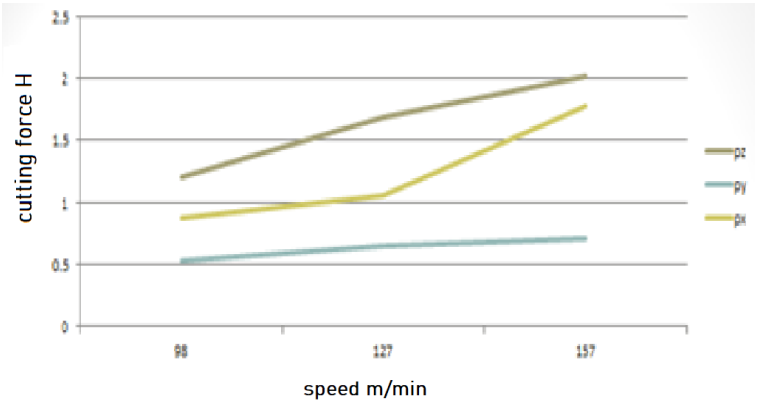

Figure 4. The influence of cutting parameters on cutting force.

The measurement results presented in Figure 4 indicate that the cutting force decreases slightly with increasing speed when depth of cut is t=3 mm and feed s=0.33 mm/rev.

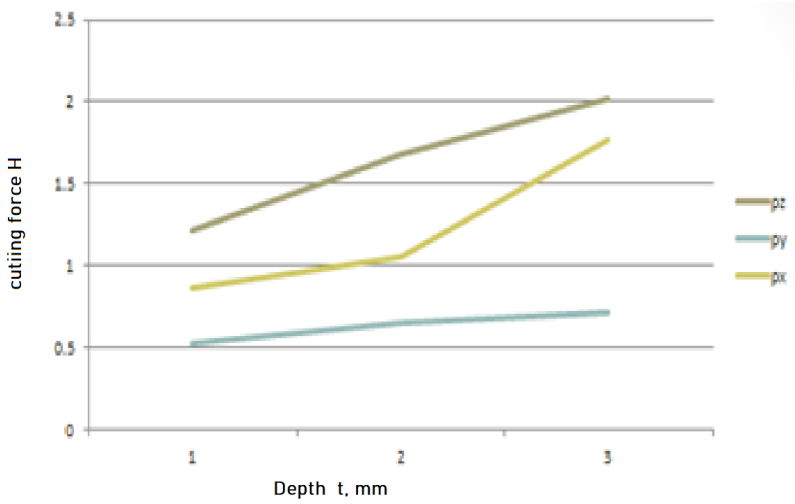

Figure 5. The influence of cutting parameters on cutting force.

The Figure 5 is shown that the cutting force increases with increasing the depth of cut, when feed s=0.33 mm/rev speed v=98 m/min.

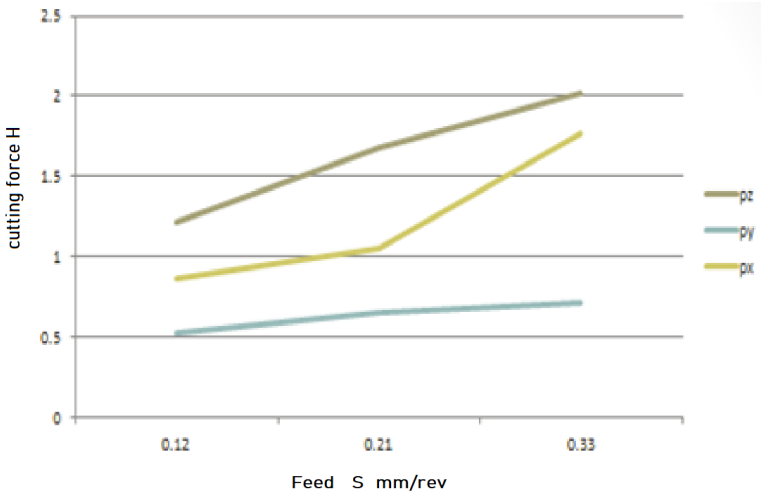

Figure 6. The influence of cutting parameters on cutting force.

From Figure 6, it is obvious that cutting force increaces with increase of feed when depth of cutting t=0.3 mm and speed v=98 m/min.

III. Determination of cutting force based on AdvantEdge.

The following parameters of workpiece and turning mode were used as data for processing in Advant Edge:

- Workpiece diameter and length: D=8 mm, L=12 mm.
- Workpiece material: WNr 1.7007; DIN 37CrB1, Hardness: 250 NB.
- Feed: s =0.12 mm/rev, s= 0.21 mm/rev, 0.33 mm/rev.
- Depth: t = 1 mm, t= 2 mm, t= 3 mm.
- RPM: 630 rpm, 800 rpm, 1000 rpm.

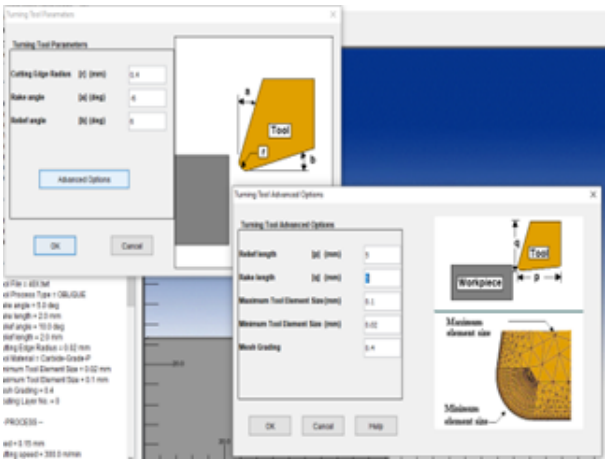

Figure 7. The parameter settings of AdvantEdge.

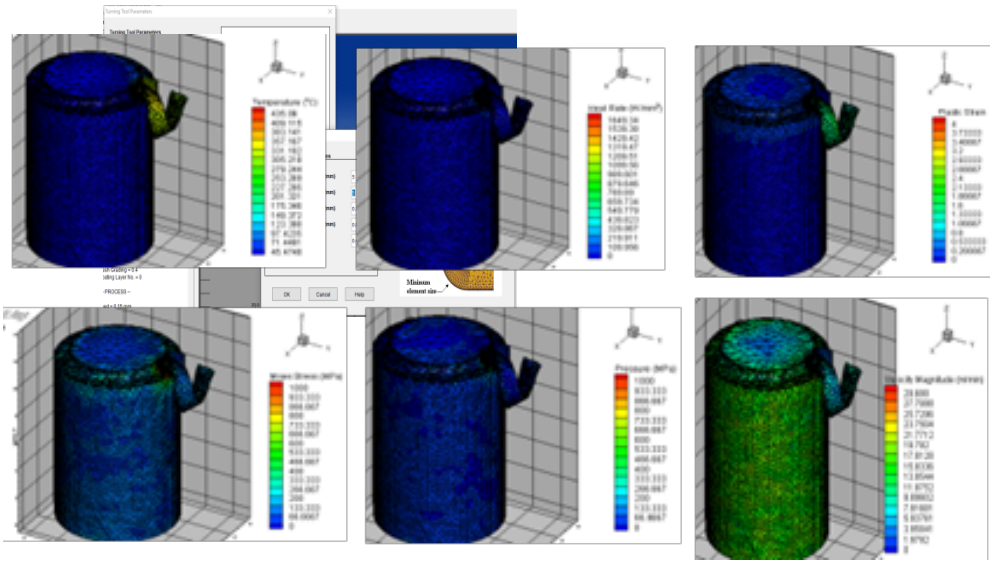

Figure 8. Heat distribution, deformation and voltage values in turning mode.

Our research aim is to determine the cutting force by Advant Edge.

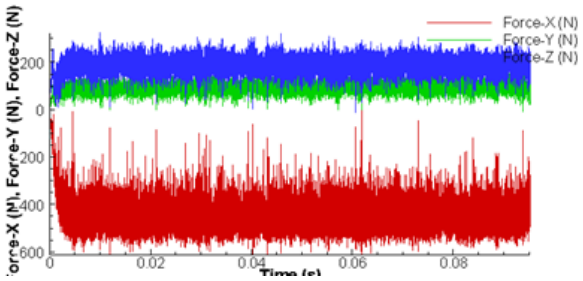

Figure 9. parameters of turning mood.

Figure 9 shows the parameters on cutting force when t=1 mm, s=0.12 mm/r , n= 630.

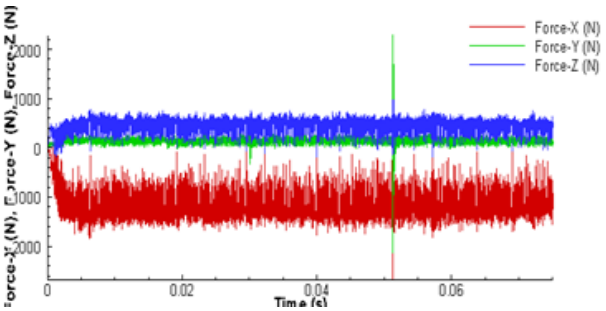

Figure 10. The parameters of turning mood.

Figure 10 shows the parameters of turning mood when t=2 mm, s=0.21 mm/r, n= 800r/min.

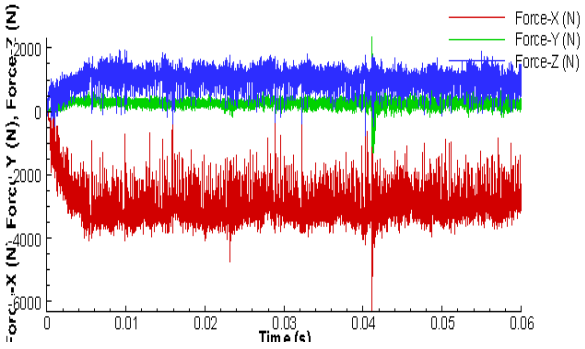

Figure 11. The parameters of turning mood.

From the Fgure 11 is clearly seen that t=3mm, s=0.33 mm/rev, n=1000 rpm.

IV. Optimization of cutting force.

The main aim of the research paper is to determine the lowest parameter of cutting force while optimizing turning mood of 40X steel. The force measurements of the experiment results recorded

with the Minitab program and the mean values of the force components were determined by Japanese scientist Taguti method.

Table 1. Experimentally derived target forces values.

d/d	*V*	*S*	*t*	*Pz*	*Py*	*Px*
1	98	0.12	1	0.51	0.26	0.43
2	98	0.12	2	1.01	0.41	0.77
3	98	0.12	3	1.21	0.53	0.87
4	98	0.21	1	0.83	0.33	0.69
5	98	0.21	2	1.24	0.53	0.90
6	98	0.21	3	1.68	0.65	1.05
7	98	0.33	1	0.90	0.31	0.68
8	98	0.33	2	1.69	0.71	1.29
9	98	0.33	3	2.02	0.74	1.77
10	127	0.12	1	0.44	0.18	0.36
11	127	0.12	2	0.64	0.25	0.43
12	127	0.12	3	0.87	0.31	0.58
13	127	0.21	1	0.45	0.16	0.68
14	127	0.21	2	1.10	0.41	0.80
15	127	0.21	3	1.19	0.48	0.85
16	127	0.33	1	0.65	0.27	0.51
17	127	0.33	2	1.30	0.54	1.06
18	127	0.33	3	1.74	0.67	1.39
19	157	0.12	1	0.31	0.12	0.28
20	157	0.12	2	0.46	0.17	0.36
21	157	0.12	3	0.55	0.22	0.48
22	157	0.21	1	0.50	0.20	0.40
23	157	0.21	2	0.88	0.33	0.71
24	157	0.21	3	1.22	0.49	1.00
25	157	0.33	1	0.65	0.24	0.52
26	157	0.33	2	1.20	0.47	0.76
27	157	0.33	3	1.47	0.57	0.91

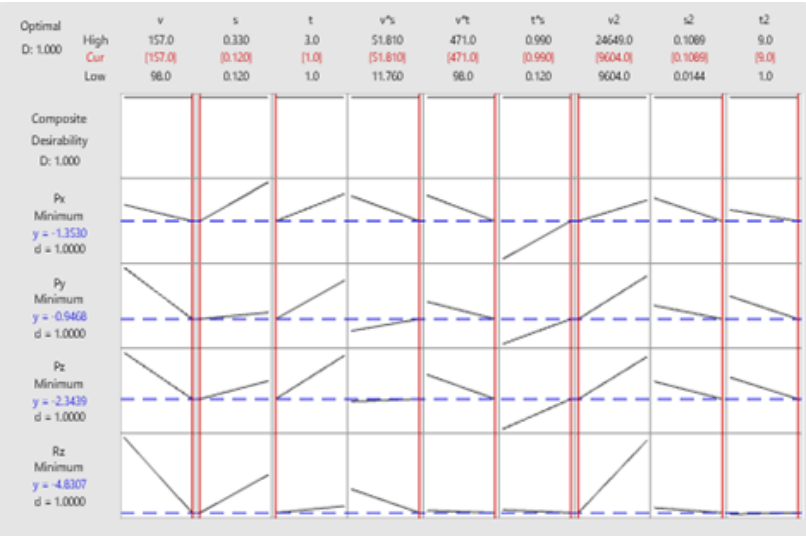

Figure 12. Mean values of the force components.

Conclusion.

Based on the experiments cariied out, we determined correlation between cutting force and turning mood. Also, the effect of cutting parameters such as depth of cut, feed and cutting speed on machining variables is studied.

1. Cutting force increaces with increase of feed when depth of cutting t=0.3 mm and speed v=98 m/ min and the cutting force decreases slightly with increasing speed when depth of cut is t=3 mm and feed s=0.33 mm/rev.

2. There was 5-6% of the difference between the cutting force obtained by the Advant edge program and our experiment.

3. The optimal values for aiming in 40X steel are V=157 m/min, s=0.12 mm/rev, t=1 mm, Pz= 2.02 kN, Py=0.74kN Px=1.77kN.

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