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COMPARATIVE ANALYSIS OF METAL CUTTING TOOLS RELIABILITY DURING PROCESSING BY TURNING IN LABORATORY CONDITIONS AND EXPLOITATION

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ABSTRACT
In this paper the possible differences in reliability of the metal cutting tools during in vitro (in laboratory) processing and exploitation conditions has been analyzed.
The estimation of reliability of metal cutting tools in volume productions is done on the bases of monitoring failure rates of metal cutting tools in a long period of time in order to obtain a large number of samples possible.
Investigations have been realized in theoretical and experimental ways, hereby to get approximately data about failure occurrence of the instrument while metal cutting process from the aspect of consumption, crack and fracture.
In laboratory conditions research as the criteria for determining of reliability the flank wear width consumption of instrument is used, while during the research on exploitation conditions the technological criteria of consumption method is explored.
Keywords: cutting, tool, reliability, failure, consumption

1. INTRODUCTION

The reliability of the metal cutting tools is a relatively new scientific field. This field includes study, analysis and development of the cutting edge characteristics in the definite conditions and time interval of exploitation, that will not change the used parameters of the allowed limits[1].
The aim of the paper is to research, identify and analysis the factors which bring to the failure of the instrument during the cutting process.
If we are limited on the investigation of the reliability of the metal cutting tools, within the processing system one can conclude that its depend the several factors and presents very complex phenomena because the tool could fail during the work. These failures mostly happen cause of consumption, crack and fracture of the cutting instrument.

The cutting process characterized by; material of working piece, the material of instrument and the conditions of the realized processing (cutting regime, geometry of instrument, cooling equipment and lubricators and the dynamic state of system: machine–instrument–equipment-working piece[2]).

The current researches indicate that the probability functions of the cutting instruments failure will relied on the Weibulls disperse [3]:

$$F(t)=1-\exp[-(t/\eta o)^{\beta o}] \quad (1)$$

The reliability is the compliment of the probability;

$$R(t)\ 1-F(t)=\exp[-(t/\eta o)^{\beta o} \quad (2)$$

Frequency of failures is defined as follows:

$$f(t)=dR(t)/dt \quad (3)$$

The intensity of failures:

$$\lambda(t)=f(t)/dt \quad (4)$$

Investigations have been realized in theoretical and experimental ways, hereby to get approximately data about failure occurrence of the instrument while metal cutting process from the aspect of consumption, crack and fracture.

The problem that has been considered in this paper was the determination of reliability of the metal cutting tool at small and medium series by applying the medium rank method.

Table 1. Measured values of instrument consumption[4]

	Order of measurements						
	No.	1	2	3	4	5	6
	T[s]	60	180	300	420	600	900
	H[mm]						
SCM 105	1	0,16	0,24	0,29	0,30	0,31	0,33
	2	0,12	0,20	0,26	0,27	0,29	0,30
	3	0,10	0,15	0,19	0,23	0,24	0,26
	4	0,11	0,18	0,21	0,24	0,26	0,28
	5	0,10	0,17	0,23	0,27	0,29	0,32
	6	0,80	0,15	0,20	0,23	0,25	0,28
Cutting plate	Order of measurements						
	No.	7	8	9	10	11	12
	T[s]	1200	1500	1800	2100	2520	2640
	H[mm]						
SCM 105	1	0,16	0,24	0,29	0,30	0,31	0,33
	2	0,12	0,20	0,26	0,27	0,29	0,30
	3	0,10	0,15	0,19	0,23	0,24	0,26
	4	0,11	0,18	0,21	0,24	0,26	0,28
	5	0,10	0,17	0,23	0,27	0,29	0,32
	6	0,80	0,15	0,20	0,23	0,25	0,28

Table 2. Resistance of the cutting plate edge [5]

	Resistance of cutting plate T [s] SCM 105	5%	MR%	95%
1	2570	0,9	10,9	39,3
2	2620	6,3	26,4	48,2
3	2650	15,3	42,1	72,9
4	2680	27,1	57,9	84,7
5	2700	41,8	73,6	93,7
6	2750	60,7	89,1	99,1

2. EXPERIMENTAL CONDITIONS

a) Laboratory Conditions

The reference material for work piece is rolled steel CM45 (according to ISO). The initial work piece diameter is 20,2 mm and the length is 360 mm.

The experiments have been performed by using the similar processing parameters in volume productions of the piston of shock absorber at the shock Absorber Factory in Pristina, Kosovo.

During the experiment there have been used the hard metal plates TNMGS04 10 FR according the ISO standard No.1832 the product from “Sintal”-Zagreb, of the quality SCM-105 (covered by three layers TiC-Al2O3-TiN on the hard metal base P25) .

The plate is attached mechanically to the holder PSBNR2020K12 with the fastening system PROMAX-C.

The testing has been realized on PA 22 machine Morando [4] .

b) Exploitation Conditions

The research has been realized on processing conditions of the piston of absorber Factory for Absorbers in Pristina, where the data for the technologic consumption, crack and fracture of the instrument failure are gathered.

Data is gathered:

- verifying the number of processed pieces between two instrument substitution,

- the good pieces are identified measuring control dimensions (in every 5 pieces),
- the processing process is interrupted after identification of the first piece over the allowed tolerances after what the instrument is replaced,
- the work of the instrument is monitored visually estimating the reasons for replacement of the cutting plate; normal consumption of the edge, cracks or instrument fractures,

The criteria for defining the effective duty of the instruments:

- the exactness of dimensions in the work part (it is realized through special control metering) serves as a principal criteria,
- monitoring the edge (it is done in a visual way) and serves as preventive criteria,
- the form of the chip (monitoring in a visual way) and serves as preventive criteria,
- the conditions for monitoring the instruments are the same for all instruments,
- the examinations are done through regular technological process in conditions of exploitation.

The change of instruments:

- the change of instruments is done one by one, in the moment of failure of any crack, fracture or consumption according to the criteria mentioned above,
- the sharpening is done in the tool room, for the cases of normal consumption or if the instrument is cracked or fractured,
- if the edge is broken the entire instrument should be changed, when there should be done the repair of the base handler,
- the machine paused during the sharpening of the instrument.

The plan for executing the instrument:

- the monitoring of duty of instrument is realized according to the existing state and the existing technological process,
- the lowest number of the monitored samples between two cuttings is 36, the data of monitoring of the work of instruments are done in (Tab.1.

During the experiment there have been used approximately the same hard metal plates of the quality SCM-105.
The testing has been realized on automatic 6 axis machine Wickman .

3. EXPERIMENTAL RESULTS

a) Laboratory Conditions

In laboratory conditions research as the criteria for determining of reliability the flank wear width consumption of instrument is used (VB=0.30 mm).
The recovered data from the sustained average lifetime of the cutting edge between two changed instruments, from the monitored samples according to the experimental conditions, ordered in 6 value groups, medial rank and the reliability limit of exactness $\alpha_z = 0.05$ (5% and 95% respectively), are shown in (Tab. 2). The graphical presentation of Weibull functions according the results based of the graphic -analytical calculations are shown in (Fig.1.).

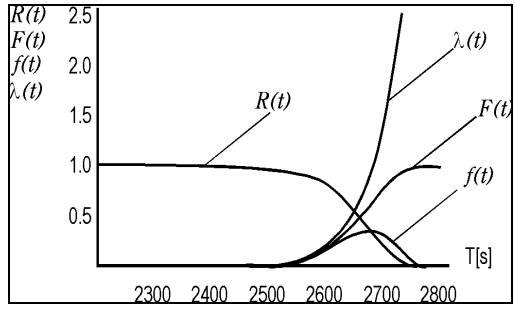

Figure 1. Graphical presentation of Weibull's functions[5]

b) Exploitation Conditions

The recovered data from the sustained average lifetime of the cutting edge between two changed instruments, from the monitored samples according to the experimental conditions, ordered in 9 value groups, medial rank and the reliability limit of exactness $\gamma_z = 0.05$ (5% and 95% respectively), are shown in (Tab.1). The graphical presentation of Weibull functions according the results based of the graphic -analytical calculations are shown in (Fig. 2).

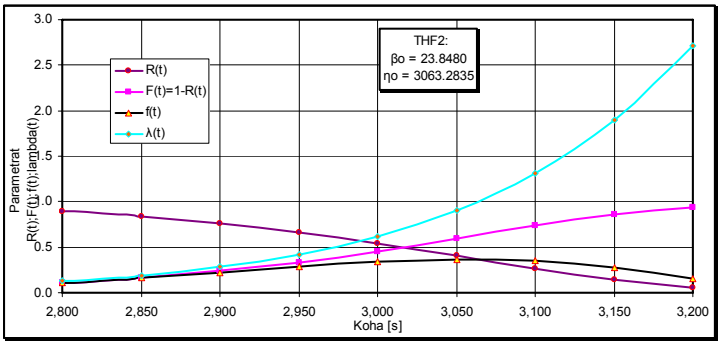

Figure 2. Graphical presentation of Weibull's function

4. CONCLUSION

According to the theoretical researches and experiments carried earlier and the analysis based on diagram in fig.1, can be concluded that the reliability of cutting tool during the work under exploitation conditions is 10-15% higher comparing to laboratory/vitro conditions.

This difference is supposed to be for these reasons:

- During the work in laboratory conditions the expedients for cooling and lubrication are not used;
- The working period of cutting blade has been longer for several hundred of seconds, compared to the exploitation conditions of tens of seconds, so the cutting blade has been overloaded in terms of temperature;
- Cutting chips, during labor in vitro conditions have been longer influencing the durability of cutting blade;

The working machine under exploitation conditions has been newer and had smooth work.

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