

## EVALUATION OF DISTRIBUTION PARAMETERS FOR CUTTING TOOLS RELIABILITY ANALYSIS

To simulate the reliability of any technical object and the metal-cutting tool in particular, including: prediction of the failure probability or that of the no-failure operation during certain time; prediction of the no-failure time; determination of the mean time between failures or time to failure; planning of the test programs etc., it is necessary to establish what kind of theoretical distribution law describes available empirical (selective) data. referring to the operation time to failure.

One of the mostly wide used distribution laws is Weibull distribution. This law, or rather a family of distributions, describes a wide range of processes such as yield stress of steel distribution [1] as well as failures in the reliability theory.

Based on Weibull distribution properties, the following equation can be obtained

$$V = \sqrt{\frac{\Gamma\left(1 + \frac{2}{\alpha}\right)}{\Gamma^2\left(1 + \frac{1}{\alpha}\right)} - 1}, \quad (1)$$

where  $\Gamma(x)$  – general gamma function.

As it can be seen from Eq.3 – variation coefficient is the function only of the shape factor and thus vice-versa. Shape factor from variation coefficient  $V$  - can be approximated by the following empirical regression:

$$\alpha = b_0 V^{b_1}. \quad (2)$$

Eq. (2) can be modified into simplified form that gives quite close results for  $V \geq 0.15$  or  $\alpha \leq 6.5$  that covers the main part of Weibull distribution application domain for reliability analysis [2]:

$$\alpha \approx \frac{1}{V}. \quad (3)$$

It is interesting to check possibility of usage equations received for technical objects reliability analysis. Work [3] contains experimental data establishing dependence between variation coefficient and gamma-percent time-to-failure factor  $G$  for the wide range of metal cutting tools such as: cutters, drills, multiflute drills, screw taps and threading dies – totally 43 lots when  $\gamma=0.9$ , that taking into account eq. (3) is:

$$G = \frac{0.105^V}{\Gamma(1+V)}. \quad (4)$$

Statistical analysis shows determination factor for eq. (4) and experimental data equal to 0.76 and adequacy of above model

### REFERENCES

1. Weibull analisys handbook [Text] / R.B.Abernethy et all. – West Palm Beach, FL: Pratt & Whitney Aircraft, 1983. – 228 p.
2. Nielsen M.A. Parameter Estimation for the Two-Parameter Weibull Distribution [Text]: All Theses and Dissertations, paper 2509 / M.A.Nielsen. – Provo: Brigham Young University, 2011. – 99 p.
3. Кацев П.Г. Статистические методы исследования режущего инструмента [Текст] / П.Г.Кацев. - М.: Машиностроение, 1974. – 231 p.