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CONSTRUCTION AND PREDICTION MODELS OF MEHANICHNOYINADIYNOSTI degradation Disclaimer

O.S. Grinchenko, PhD
Kharkiv National Technical University of Agriculture Petro Vasilenko

The general approach to the problem of constructing stochastic models invertuyemyh mechanical reliability parametric degradation in case of failures. The methods are illustrated with real examples forecasting durability to wear.

Degradation failure, reliability analysis, stochastic model.

Formulation of the problem. Parametric degradation failure, manifested in the operation of mobile machines, mostly classified as partial, ie those that immediately after the occurrence did not result in the inability of the object, but violate its performance. Examples of parametric failures in the machines are different rozrehulyuvannya, loosening threaded connections; Numerous failure due to wear and other combinations. Kozhnataka rejection associated with the release of one or more parameters of an object outside the established regulatory and technical documentation. Owing to the nature of parametric failures in the practice commonly used in rapid assessment of reliability discrete control parameters accurately capture the moment they enter the threshold is generally not possible. In addition, the widespread way of gathering information by single-party inspections of vehicles in use, and especially

for repair shops, pairwise correspondence between the parameter values and achievements in the control may not always be established. Statistical data in this case are related to each other sample pairs of unrelated parameters and operating time. In the presence of such data construction and parameter estimation of reliability forecasting models can not be performed traditional regression methods applied statistics and requires special analysis.

The problem of rapid assessment and forecasting reliability of machines to parametric failures not limited to issues of improving methods of statistical analysis of discrete data with the above characteristics. Equally important issues of complex use of the forecast results of the tests of prototypes and operational data on the degradation of structural analog predecessor, produced commercially. This requires the construction of appropriate stochastic models that address both direct resource allocation problem of predicting the design element and perform the inversion, estimating characteristics degradation processes about the reliability parametric analogue.

Analysis of recent research. The issue of Applied analysis of discrete data deterioration, which is the main degradation processes in machines, considered in many studies [1-4]. The purpose of this article is to improve methods of construction invertyruyemyh forecasting models parametric reliability, allowing efficient use of complex and heterogeneous discrete data monotone degradation processes, integrating information from the areas of operation, repair and testing of prototypes.

Results. Invertyruyema parametric model of reliability in case of failure of one parameter that defines the technical condition can include three components: non-stationary random function describing the one-dimensional process of degradation of the parameter; random allocation limit of U, which finalizes the object; random distribution of working hours to achieve the object parameters of random ceiling. Formation developments t assume that is the result of the first implementations of random intersections degradation processes random residual level parameter U.

Consider degradation processes with monotone implementations (only increasing or only decreasing) and as the main probabilistic characteristics using conventional one-dimensional density parameter $f_1\left(U/t\right)$Corresponding to a constant value of time between t = const. The conventional one-dimensional density developments, the appropriate constant value parameter U = const, denoted $\bar{f}_1\left(t/U\right)$. With monotonous implementations degradation processes for any pair of fixed values t and U fair value:

- While increasing implementation:

$$\int_o^U f_1\left(U/t\right)dU = 1 - \int_o^t \bar{f}_1\left(t/U\right)dt\ ; \qquad (1)$$

- With decreasing implementations:

$$\int_o^U f_1\left(U/t\right)dU = \int_o^t \bar{f}_1\left(t/U\right)dt\ .$$

If we assume that the implementation of degradation processes do not depend on the random parameter threshold level having density f2 (U), then the growing degradation processes implementations density developments subject to random parameter threshold level determined by the expression

$$f_3(t) = -\frac{d}{dt}\left\{\int_o^{\infty} f_2(U)\left[\int_o^{U} f_1\left(U/t\right)dU\right]dU\right\}. \tag{2}$$

It is assumed that the conditional density parameter status $f_1\left(U/t\right)$ is a function of operating time to be differentiation.

Consider the problem of density distribution option $f_1\left(U/t\right)$ Weibull law with positive monotonically increasing function of scale parameter a (t):

$$f_1\left(U/t\right) = \frac{в}{a(t)}\left(\frac{U}{a(t)}\right)^{в-1}\cdot e^{-\left(\frac{U}{a(t)}\right)^{в}}. \tag{3}$$

Then, as the (1) corresponding conditional density operating time to achieve a fixed parameter value will be determined expression Up

$$\bar{f}_1\left(t/U_п\right) = в\left[1 - e^{-\left(\frac{U_п}{a(o)}\right)^{в}}\right]^{-1}\left[\frac{U_п}{a(t)}\right]^{в}\cdot e^{-\left(\frac{U_п}{a(t)}\right)^{в}}\cdot\frac{d}{dt}\left[\ln a(t)\right], \tag{4}$$

where: and (e) - the value of parameter scale at t = 0.

If considered as a combination of parameters of wear, the function of the scale parameter can be set as $a(t) = c\cdot t^{\nu}$ Where the exponent ν depending on the type of connection for many of friction close to unity and well-known [5]. Then from (4) that the density $\bar{f}_1\left(t/U_п\right)$ looks like:

$$\bar{f}_1\left(t/U_п\right) = \frac{в\cdot\nu}{t}\left(\frac{U_п}{c\cdot t^{\nu}}\right)^{в}\cdot e^{-\left(\frac{U_п}{c\cdot t^{\nu}}\right)^{в}} \tag{5}$$

and meet the famous law juice.

In this law mean value $\bar{t}$ and the coefficient of variation Vt determined by the expressions

$$\bar{t} = \left(\frac{U_п}{c}\right)^{1/\nu}\Gamma\left(1 - 1/в\cdot\nu\right),\quad \text{при } в\nu > 1; \tag{6}$$

$$V_t = \left[\Gamma\left(1 - 2/в\nu\right) - \Gamma^2\left(1 - 1/в\nu\right)\right]^{1/2} \Big/ \Gamma\left(1 - 1/в\nu\right),\quad \text{при } в\nu > 2 \tag{7}$$

Gamma-percent developments in this case is given by:

$$t_{\gamma} = \left(\frac{U_п}{c}\right)^{1/\nu}\left[\ln\left(1/(1-\gamma)\right)\right]^{-1/в\nu}, \tag{8}$$

where γ - Given the probability of not exceeding Up.

If a constant threshold parameters of Up and ratios with and ν function scale parameter set and the famous setting form in characterizing the degradation processes of dispersion, the formula (6), (7) and (8) can solve the problem of direct prediction, counting the main indicators of longevity by parametric failures. However, at the design stage assessment values with and in many cases difficult. In this regard, consider other components invertyruyemoyi parametric model of reliability. Provided that the random threshold parameter has a generalized gamma distribution with density:

$$f_2(U) = \frac{в}{\Gamma(\alpha) \cdot a_u} \left(\frac{U}{a_u} \right)^{\alpha в - 1} \cdot e^{-\left(\frac{U}{a_u} \right)^{в}}, \tag{9}$$

from (2) with (3) the $a(t) = c \cdot t^{\nu}$ obtain an expression for the density distribution developments as:

$$f_3(t) = \frac{\alpha \, в \nu \left(c / a_u \right)^{в\alpha} \cdot t^{в\nu\alpha - 1}}{\left[\left(c / a_u \right)^{в} \cdot t^{в\nu} + 1 \right]^{\alpha + 1}}. \tag{10}$$

Density (10) meets one of the options allocation Berra described in [6]. As the expressions (9) and (10) the density distributions of random parameters and corresponding developments have all the characteristics degradation processes, allowing them to conduct statistical evaluation using sample pairs of unrelated values U and t. This reflects the property invertyruyemosti considered stochastic model parametric reliability. Practically, this makes it possible to share in the construction of heterogeneous data derived from different sources. So, with the sample pairs of unrelated data Ui and ti on analog derived from the field of repair, you can combine them in pairs of related results (U_i^*; t_i^*) Reduced testing prototypes of new (upgraded) object, through a joint likelihood function of the form:

$$L = \Sigma \ln f_1 \left(U_i^* / t_i^* \right) + \Sigma \ln f_2 (U_i) + \Sigma \ln f_3 (t_i) \tag{11}$$

In assessing invertyruyemoyi model parameters to use direct search for the maximum likelihood function (11) using, for example, of computer mathematical package Mathcad, which includes a built-Open implementing numerical gradient search method extremum.

This method was evaluated characteristics of the process of wear slots semiaxes rear axle tractor T-150K according to the one-time screening for repair shops, which are not bound sample pairs developments ti (in thousands. Moto hours): 2; 3.36 (3); 3.5 (5); 3.64 (2); 4 (2); 4.4; 4.5; 5; 5.2; 6; Ui positives and slots (in mm): 0.16; 0.18 (3);

0.24 (4); 0.26 (7); 0.28 (3); 0.32 (2); 0.33; 0.34 (2); 0.35 (2); 0.36. In parentheses indicate the number of values that are repeated.

For a given exponent ν = 1, numeral Search maximum of (11) in the other four parameters distributions (9) and (10) gave the following results:

au = 0.319 mm; a = 8.3; p = 0.0778 mm / thousand. operating hours; α = 0.6346.

The calculation formulas (6) and (8) gives at Up = 0,76 mm longevity estimates, the average life $\bar{t} = 10{,}6$ thousand. operating hours; 90% resource t0,9 = 8,84 thousand. Operating hours.

Conclusion. Construction invertyruyemyh stochastic models parametric reliability of machines in monotone degradation processes makes it possible to use a complex heterogeneous discrete statistical information obtained by one-time inspections and tests at reduced output stage prototypes. Development and improvement of the proposed approach should enable the effective conduct parametric forecasting reliability at the design stage.

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Rassmotren Sharing solutions approach for building a ynvertyruemыh problems stohastycheskyh mehanycheskoy reliability of models in sluchae parametric dehradatsyonnыh otkazov. Predlozhennыe methods yllyustryruyutsya realnым example of prediction Durability at yznashyvanyy.

Dehradatsyonnыy refusal, reliability of forecasting, stohastycheskaya model.

General approach to the decision of problem of construction of the inverted models of mechanical reliability in the case of degradation refusals is considered. The offered methods are illustrated by the real example of prognostication of longevity at the wear.

Degradation refusals, *reliability of forecasting, stochastic model.*

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DEVELOPMENT METHODS QUALITY threaded connections GRAIN seeders

VD Voytyuk, VI Rublev, PhD
VG Opalko, applicant

In the article the method of assessing the quality of performance of threaded connections grain seeders type SZ-3,6A and presents the results of research.

Grain drills, screw connections, regulations, quality.

Formulation of the problem. The main focus is agriculture of Ukraine grain production, the stability of which depends largely on the support. One of the key parts of increasing the yield of grain crops, return on investments of labor and means of equipping households are modern high performance machines for sowing in accordance with the requirements of cultural practices. High-quality farm equipment including drills and provide a high level of development of agriculture of Ukraine in the current market conditions.

Analysis of recent research. Quality is one of the determining factors of competitiveness of agricultural machinery. In the open market of products of domestic agricultural engineering proved uncompetitive. It was established [3], including indicators such as price, delivery, service, quality determines 70% solution of choice products. As a result, the share of domestic equipment in the amount of its implementation has decreased in the last three years is less than 30% [1]. Therefore, Ukraine's economy annually loses 4-6 billion. UAH that agricultural producers invest in the purchase of imported technology [2].

Analysis of research mashynovyprobuvalnyh stations [4] shows that 95-97% of cars produced samples with deviation from the