УДК 621.7.07 : 621.914 DOI 10.36910/775.24153966.2023.76.1

Гао Сінмінь

Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського»

МЕТОДИКА ПОРІВНЯЛЬНИХ ЕКСПЕРИМЕНТАЛЬНИХ ДОСЛІДЖЕНЬ ЛЕЩАТ РІЗНИХ КОНСТРУКЦІЙ

Виконаний аналіз відомих методик і стендів для експериментальних досліджень затискних механізмів. Запропонована методика і оснащення для експериментальних досліджень силових і жорсткісних характеристик лещат різного конструктивного виконання. Наведена методика статистичної обробки результатів експериментальних досліджень.

Ключові слова: *лещата, динамометрична рукоятка, динамометр, сила затиску, жорсткість, методика*

Gao Xinmin

METHOD OF COMPARATIVE EXPERIMENTAL RESEARCH OF VICES OF DIFFERENT CONSTRUCTIONS

The analysis of known methods and stands for experimental research of clamping mechanisms was carried out. The proposed technique and equipment for experimental studies of the strength and stiffness characteristics of vices of various designs. The method of statistical processing of the results of experimental studies is presented.

Key words: *vise, dynamometric handle, dynamometer, clamping force, rigidity, technique*

Formulation of the problem. In mechanical assembly production and repair work, vices of various manufacturers are used to clamp parts of simple and complex shapes. Among them, the main attention is drawn to those vices that allow you to clamp objects with a complex profile without difficulty. Such vices include original designs that have not yet been researched and require experimental testing for operability. Setting tasks. The purpose of this work is to develop a methodology, special equipment for performing experimental studies of vices of various designs and recommendations for statistical processing of the results. Teaching the main material. The analysis of literary sources [1-6] shows that there are various methods and stands for experimental research of clamping mechanisms. Information is provided in [7], in which a technique was developed to confirm theoretical studies of the strength and stiffness characteristics of machine vices produced by the Baranovichi Machine Tool Plant (Belarus) type MTV 140 (UP-616-2), according to which experiments were carried out on a milling machine (Fig. 1, 2). Due to the rotation of the upper part of the vise relative to the longitudinal feed, experiments were carried out under a load at an angle of 45˚ (Fig. 2). The results of the measurements confirmed the difference in prints in different directions of load with force P (on a moving and stationary sponge).

б)

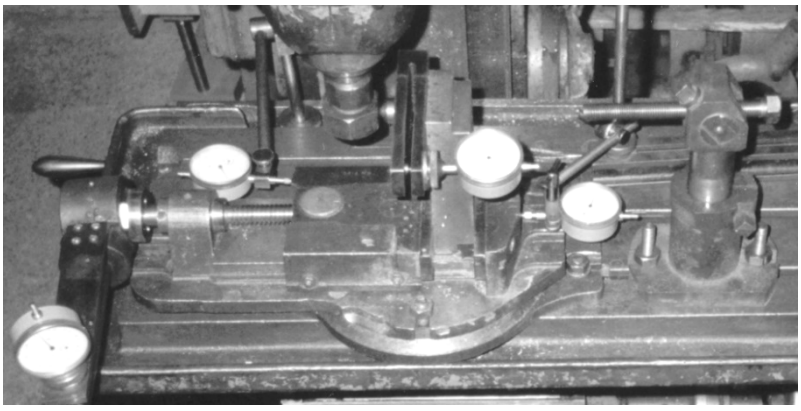

Fig. 1. **The working area of a milling machine with a vice under the load of force P on the moving (a) and stationary (b) jaws with two overhangs H: a – small (30 mm); b – large (100 mm)**

In order to increase the accuracy of measurements and the possibility of directly recording readings on a computer, it is advisable to use Chinese-made electronic torque dynamometers (Fig. 3).

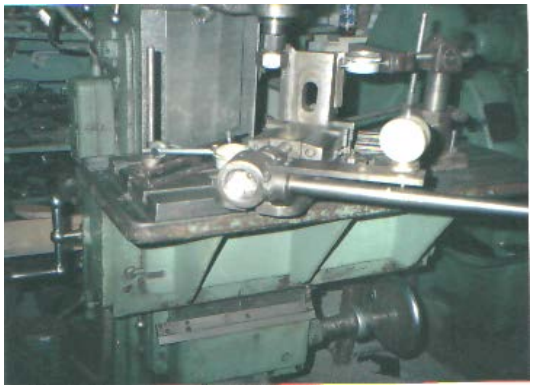

Fig. 2. **General view of the working area of a milling machine with a vice when loaded at an angle to the direction of the longitudinal feed of the table**

Fig. 3. **Chinese-made electronic torque dynamometer**

In addition, a technique for processing experimental data and checking the adequacy of theoretical models was developed. Pre-processing of experimental data is performed by screening out gross errors, or "misses", resulting from malfunctioning measuring devices, or mistakes in the experiment made due to inattention. For this purpose, the values of the characteristics of the vices measured during the experiment are entered into the table, which also includes the values of the calculated (derivative) values obtained on their basis. Gross errors ("misses") when fixing the value of experimental data are anomalous or those that are strongly distinguished by the value in the variation series of homogeneous data. In order to detect "misses" in the array of experimental data, the analysis of the measurement results is carried out, paying attention to the "unnatural" values of the measured value, which are sharply different from the others. For the correct processing of experimental data, it is necessary to take into account their spread (dispersion of points). The presence of such a scatter and the approximation of the obtained data is explained by the fact that the result of any measurement during the experiment by its nature contains an error, therefore the values obtained during the experiment are called the approximate (to some extent random) value of the quantity being studied. This is explained by the presence of factors that affect the result of the experiment, but were not taken into account during the experiment. Examples of such factors include a change in the course of the experiment under the influence of vibrations of the state of the nodes of the test stand (disassembly, change of clearances, etc.), a change in the parameters of the research object under the influence of the external environment, measurement errors or actions on the object, etc. d. Graphs are the most visual display of experimental data. They provide a visual representation of the relationship between quantities, which is important for the interpretation of the obtained data. In connection with the existence of randomness in the character of the magnitude of responses, in order to obtain an approximate experimental dependence and its graph, the processing of experimental data is carried out on the basis of the mathematical apparatus of mathematical statistics. The statistical method makes it possible to detect the dependence of the average

value of some value (characteristics of the vice) on the variation of another and to describe the relationship between them in the form of a polynomial - a segment of the Taylor series, which decomposes the unknown equation of the relationship of factor (factor) and result (feedback) features, which is called the regression equation. The regression equation does not provide an exact relationship between responses and factors, and only its statistical evaluation in the form of an empirical equation is based on the results of the analysis of experimental data. The correlation-regression method is one of the main methods of modern mathematical statistics for identifying implicit relationships between observation data (statistical data). This method allows you to quantitatively measure the strength (absent, weak, moderate, strong) and direction (direct or inverse) of a statistical relationship - correlation analysis, as well as to establish an analytical expression and form of dependence (linear, parabolic, hyperbolic, power, etc. .) – regression analysis. The practice of processing experimental data shows that in most cases, the results of the experiment are sufficiently approximated by a complete cubic polynomial (regression equation of the third degree). Often the third degree of the polynomial is not only sufficient, but also excessive, so the degree and number of terms of the polynomial can be reduced (to simplify calculations) without significant loss of accuracy. The choice of the right type (form) of the regression equation also depends on the knowledge of the problem and experience, therefore, based on the evaluation of the graphical representation of the experimental points (scatter diagram), we choose the regression equation of the second degree to describe the experimental dependence. To assess the quality of the description of the obtained experimental dependence (the completeness of the set of explanatory factors), the coefficient of determination R2 is used by the regression equation, which is the value of the reliability of the approximation, or the level of reliability. The coefficient of determination shows how much of the variation in the strength and stiffness characteristics of the vice (resultant characteristic) is taken into account in the regression equation and is due to the influence of an independent factor characteristic on it, which gives a quantitative estimate of the degree of the analyzed relationship. The closer R2 is to 1, the more (completely) the regression equation explains the relationship between the outcome and factor characteristics. In the absence of a relationship R2=0, if R2=0.9, then it can be assumed that 90% of the changes (variations) in the response (characteristics of vices) are due to the variation of the factor taken into account in the regression equation and only 10% - due to the influence of other unaccounted factors. For the correct interpretation of the results obtained at the "output" of the correlation-regression analysis, it is necessary to take into account the specifics of obtaining these data and take into account the problems associated with their interpretation. Processing of experimental data by the method of correlation-regression analysis is carried out using the Microsoft Excel program, which includes a set of data analysis tools (the so-called analysis package), designed.

Conclusion: The proposed methods of experimental research of vices and statistical processing of experimental results can be successfully applied to other technological equipment and clamping mechanisms.

References

1. Aggregate and modular technological equipment: In 3 parts. Under the editorship Yu.M. Kuznetsova /author V.A. Kryzhanivskyi, Yu.M. Kuznetsov, A.M. Kirichenko. and other. Kirovohrad, 2003. — part 1 — 422 p. — part 2 — 286 p. — part 3 — 507 p.

2. Kuznetsov Yu.M., Radchenko S.G., Khamuyela T.O. Experimental studies of the influence of various factors on the elastic characteristics of machine vices // Bulletin of KPI, series of mechanical engineering, No. 50, 2007. - P.94-104.

3. Kuznetsov Yu.M. Stand for the study of clamping mechanisms of lathes at high rotation frequencies / Kuznetsov Yu.M., Redko R.G., Prydalnyi B.I. // Bulletin of Mykhailo Ostrogradsky KDPU. – 2007. – Issue. 6, Part 1. - pp. 72–77.

4. Kuznetsov Yu.M., Prydalnyi B.I., Gao Xinmin Technological equipment of milling machines: design, theory, practice: Monograph-Lutsk: Vezha-Druk, 2023.-292 p. ISBN 978-966-940-449- 7

5. Kuznetsov Yu.M., Prydalnyi B.I., Gao Xinmin New views and approaches to the creation of automated universal vices for clamping complex-profile objects Section in col. Monographs. Sherman Oaks, California (USA), 2023.-S.239-332 doi: 10.51587/9798-9866-95921-2023-011

6. Self-adjusting clamping mechanisms: Reference book (Y.N. Kuznetsov, A.A. Vachev, S.P. Syarov, A.Y. Tsarvenkov; under the editorship of Y.N. Kuznetsova. - K.: "Technology"; Sofia : State publishing house "Technique", 1988. - 221 p.

7. Khamuyela T. O. Experimental studies of elastic-strength characteristics of machine vices for metal-cutting machines // Bulletin of NTUU "KPI", mechanical engineering series, No. 49, 2007. - pp. 22-25.