

A VIEW ON THE WAYS DESIGN OF RELIABILITY CRITERIA IN STRUCTURAL MECHANICS

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ABSTRACT

Contemporary intensive development of technology puts ever-increasing demands on the reliability of products. The increase in the reliability level is emphasised also in transport machines and equipment. This all requires a further improvement of the method of designing and strength checking of a construction. The methods described in this paper are the ways to reach the solution goals with the maximum use of computer technology. A practical example of loading system analysis is presented which demonstrates use the special instrument to measurement of distribution the force and torsion moment in card an-joint for control purposes and uses the special instrument to generally measurement of distribution random loading parameter.

The application of this methodology shortens knowledge of the time to failure of mobile machine components and contributes to the safety and economy of mechanical systems. The results of its application would be presented to mobile facility elements.

Keywords: Four or five Keywords shall appear here.

1. INTRODUCTION

A characteristic feature of new trends in development of new aggregates of mobile machinery is a continuous increase in manufacturing and operating costs.

Simultaneously, transmitted outputs are also higher and a sufficient reliability has to be maintained. There is a tendency towards a higher use of materials, i.e. a relatively higher stress on particular parts of the aggregate. At the same time, a real safety of operation against the maximum admissible stress decreases.

In some transportation machinery and equipment, or their elements, as e.g.. transmission groups, gear transmissions, also in tower cranes and others, the problem of strength reliability is, due to the present day, regulations conditioned by a fatigue process and by knowledge of a vibration conditions.

Random operational loading creates a stochastic process of excitation forces. A successful reproduction of the response of this random loading depends on the technical facilities.

2. THE WAYS HOW TO REACH THE SOLUTION GOALS

2.1 Transmission groups

The use of loading data from rotating machinery to determine machine health has a long history. It is intended to show how to get and interpret good results from analyses, with particular reference to points, which arise in transmission systems, applications.

Two major difficulties occur in performing this system:

- since the values of forces and moments cannot be directly measured, they are inferred from strain measuring of the card a shaft; foil strain gauges are used,
- however they are only the pure data in a research laboratory, and it would be very interesting to compare them with the data obtained on actual mobile machine wheel-type tractor.

The outward appearance of the load cell, which is designed for specific measuring of the pure cardan-joint characteristic, as shown in Fig. 1.

The load cells are installed on the cardan-joint for measuring the timing values of torsion moment. They are also installed on the cardan-joint of the axle caster, as well as, of the axle casing for measuring the timing values of exit torsion moment, (Vavro 2001).

The signals generated from the load cells are put into the digital data memory mounted in the laboratory or e.g. in the wheel-type of tractor. The signal will be subject to interference correction, operation and co-ordinate conversion and will be put into memory. We have obtained satisfactory data from the experimental carried out with a special note on maximum force and torsion moment.

We think it would be quite interesting to carry out analysis of wheel-type of tractor movements with four load cells installed in each of the cardan-joint.

They are found from this experiment, that the load cells and the digital data memory combines to provide very useful data to promote the performance of the wheel-type tractor and the gearing system, and will contribute greatly to the development of new products of mobile machine and gearing system.

The districted torsion moment parameters by measuring instrument as for the timing values of exit torsion moment are shown in Fig. 2.

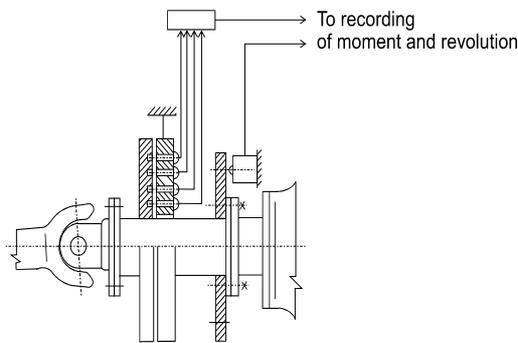


Fig. 1. *Schematic drawing of specific measuring instrument*

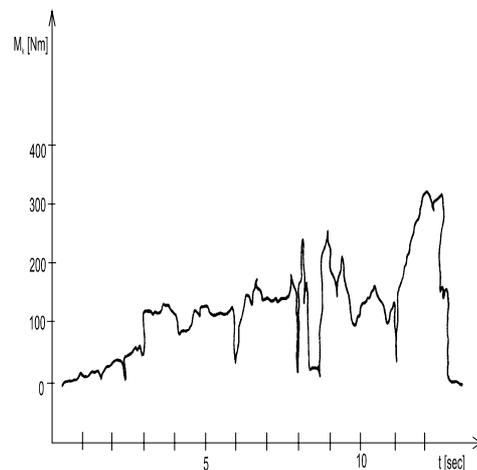


Fig. 2. *Drawing distributed exit torsion moment for the timing values*

The detail view on the specific measuring instrument is shown in Fig. 3 and Fig. 4.

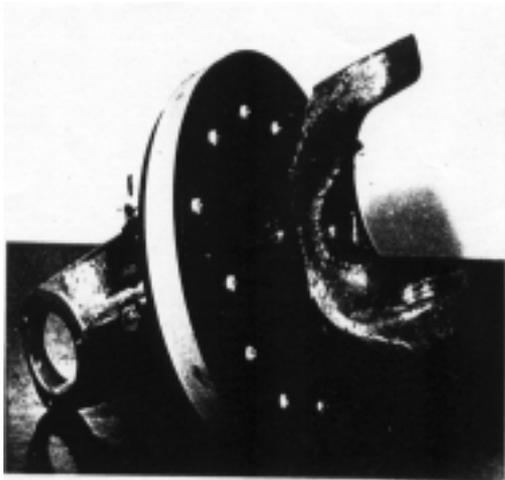


Fig. 3. *The general view on the specific measuring instrument*

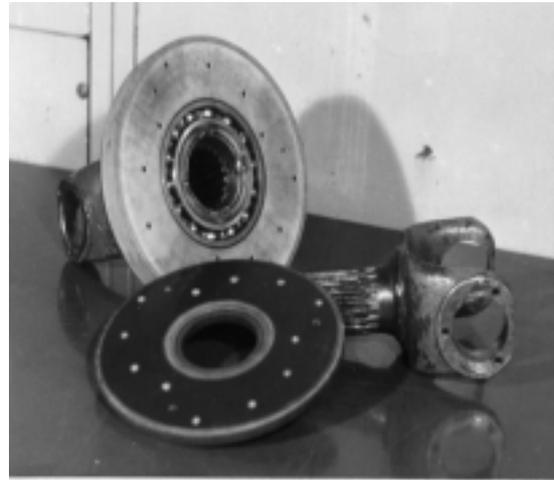


Fig. 4. *The detail view on the specific measuring instrument*

This system control has been conceived independently of climatic conditions. Prototype wheel-type tractor or transmission system of mobile machine can be more closely evaluated.

2.2 Gear transmissions

The use of vibration data from rotating machinery to determine machine health has also long history.

A practical example of gearbox vibration frequency analysis is presented, which demonstrates the use of high-resolution frequency analysis using zoom FFT for diagnostic purpose. It is intended to show how to get and interpret good results from analysis, with particular reference to points, which arise in gearbox applications.

Vibration signals from a simple epicyclical gearbox between a motor and compressor were used for all the analysis presented, shown in Fig. 5.

Higher up in the frequency range components originating from the tooth mesh in the gearbox will be found and are in this context referred to as medium frequency components.

They will be at a frequency corresponding to rotational speed multiplied by the number of teeth on the gear, and referred to as the tooth-meshing frequency.

This application note examines a particular set of measurements mainly in order to show what effect analysis techniques have on the results obtained. The application of this method which this paper will be showed has been made upon the special-purpose machine in a laboratory.

The signal of the gear vibration was recorded both digitally and graphically. By means of a control of the vibration for simulated operating conditions we selected a sample to meet the required life of the testing gear system. The sample takes into consideration all the working activities, which are characteristic for any operation of the mobile machine aggregate during the required life of its transmission section.

The basic values of the loading sample sets served as input data for the WMVM program, (Kopecky 1993), which enables the processing of statistical characteristics of the set as: a correlation function, a power spectral density and, further, a calculation of a distribution function, probability density, a function of the phenomenon occurrence intensity and characteristic life expressed by means of a function of failure-free probability for reliability estimation.

The output data expressing one of the statistical characteristic of loading in a graphical way can be seen in Fig. 6. It is a dependence of the reliability estimation expressed by means of the function of failure-free probability for the particular testing system.

Vibration

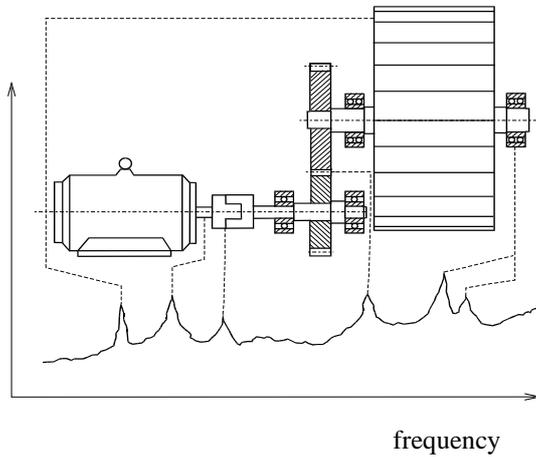


Fig. 5. Schematic driving of an electric motor-driven gearbox, driving a ball-mill

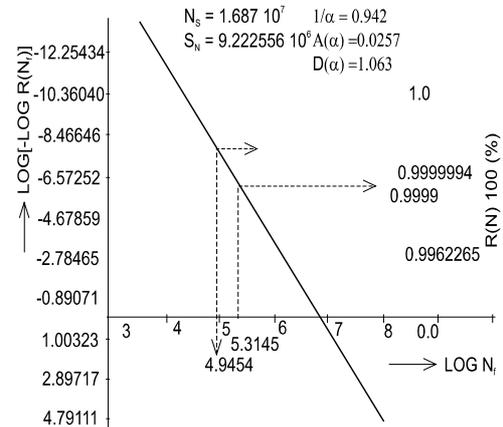


Fig. 6. The graphical function of failure-free probability

2.3 Tower cranes.

The principle measurement of random signals is made by the special measuring instrument. The substance of construction makes up the mechanical gauge connected with the indicator. The instrument works together with photocell, which take effect to start of the recording equipment. The instrument can be installed on the critical points of the tower cranes, as shown in Fig. 7. The detail views on the specific measuring instrument shown in Fig. 8.

Long-time tests can be run independently from climatic conditions. Very valuable results of experimental tests of the construction make for recording of signals of random loads under long-time operating state to render possible the special measuring instrument.



Fig. 7. The general view on the specific measuring instrument



Fig. 8. The view of the specific measuring instrument

3. ANALYSIS AND SOLUTIONS

The signal of response may be analysed by statistical characteristic of stochastic function. The output data expressing one of the statistical characteristic of loading in a graphical way. The dependence between random loads and life, N_f , of components must be completed by a variable, $R(N_f)$, which expresses digital guarantee in the probability form. Parameter distribution may be expressed as

$$R(N_f) = \exp. - (N_f - N_{min} / N_{sig} - N_{min})^k \quad (1)$$

. where: N_{min} is a minimum of the longevity,
 N_{sig} is a modal value of the longevity,
 k is a parameter of distribution

The determination of the parameters of this distribution are achieved by the moments of function numerically, (Letko 1994).

Results of the measurement of torsion moment have expressed the statistical curve, as shown in Fig. 9.

Results of the measurement of tower crane have expressed the reduced fatigue curve, as shown in Fig. 10.

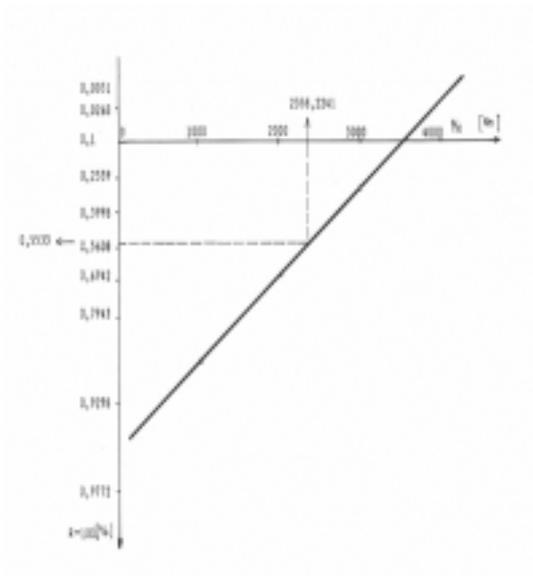


Fig. 9. Statistical curve for wheel-type tractor

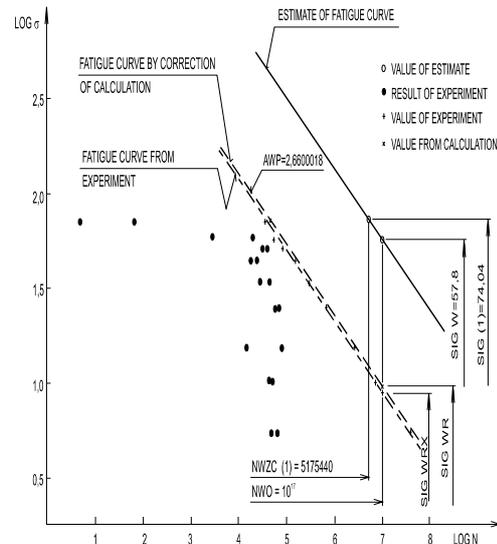


Fig. 10. Fatigue curve reduced for tower crane

The values of functions $B(k)$, $C(k)$ and $D(k)$, are introduced for the practical application in Eq.(1) for variables $1/k$.

With parameters of distribution, we may define the result by the statistical curve of longevity, which in a form of probability characterised the longevity form Eq.(1):

$$\ln(-\ln R(N_f)) = k [\ln(N_f - a) - \ln b + \ln \ln e] \quad (2)$$

4. CONCLUSION

The applications of these methods, which this paper will be showed, have been made upon the special-purpose machine in a laboratory and in industrial conditions directly. This system control has been conceived independently of climatic conditions. Conditions can be exactly reproduced to compare and to evaluate new designs or redesigns and good approximation to system control was expected and achieved.

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