MEASUREMENT OF RANDOM SIGNALS IN INDUSTRIAL CONDITIONS WITH NEW INSTRUMENTS AND THEIR ANALYSIS

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Abstract

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.This all requires a further improvement of the method of designing and strength checking of a construction.
In some transportation machinery and equipment, or their elements, as e.q. 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.

Keywords: Specific measuring instruments, transmission groups, gear transmission, tower cranes,statistical characteristic, fatigue curve.

The ways how to reach the solution goals:

Transmission groups

The use of loading date from rotating machinery to determine machine health has a long history. A practical example of loading transmission system analysis in presented which demonstrates the use of distribution the forces and torsion moments in cardan shaft for control purposes, as shown in Fig. 1.
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 cardan 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.

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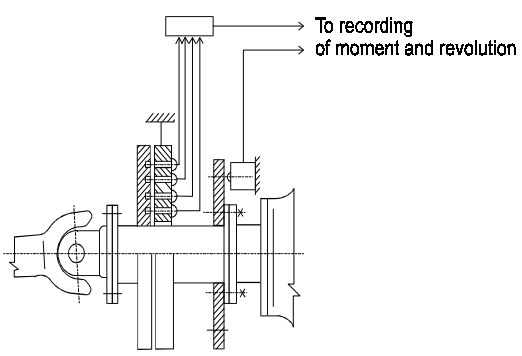

Fig. 1 Schematic drawing of specific measuring instrument

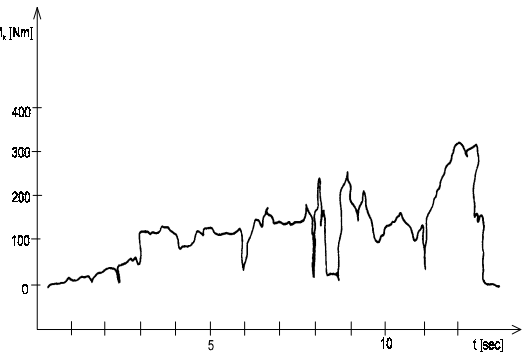

Fig. 2 Drawing distributed exit torsion moment for the timings values

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.
Fig. 2 shows the outward appearance of the load cell, which is designed for specific measuring of the pure cardan shaft characteristic.

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 in 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. 3.
Higher up in the frequency range components originating from the toothmesh in the gearbox will be found and are in this context referred to as medium frequency components.

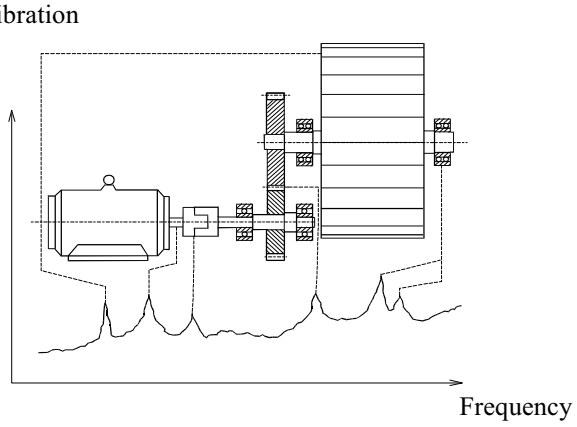

Fig. 3 Schematic drawing of an electric motor-driven gearbox, driving a ball-mill

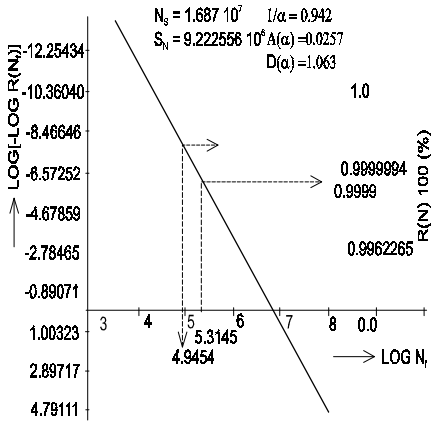

Fig. 4 The graphical function of failure- free probability

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 an 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 programme /2/, 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.. 4.
It is a dependence of the reliability estimation expressed by means of the function of failure-free probability for the particular testing system.

Tower cranes

The principle measurement of random signals is make 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 star of the recording equipment. The instrument can be installed on the critical points of the tower cranes, as shown in Fig. 5.
Long-time tests can be ruined independently from climatic conditions. Very valuable results of experimental tests of the tower cranes make for recording of signals of random loads under long-time operating state to render possible the special measuring instrument.

Analysis of random signals

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 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.
Weibull's model /5/, can serve a theoretical point for further solution. 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.

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

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

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):

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

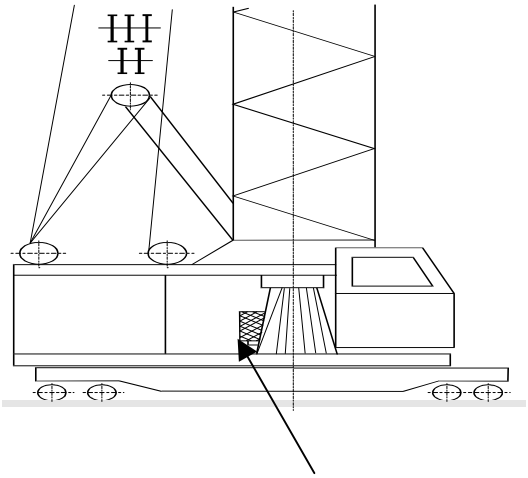

Fig. 5 The view of the special measuring instrument

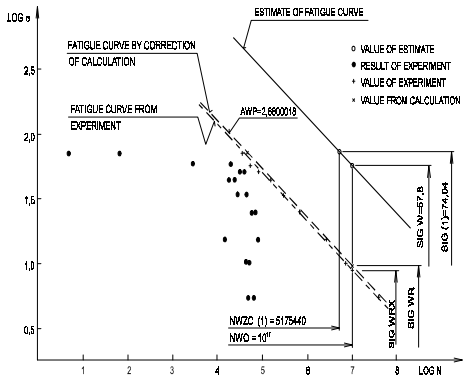

Fig. 6 Fatigue curve reduced for tower crane

Conclusion

This system control of random signals has been conceived independently of climatic conditions.
The application of these methods, which this paper will be showed, has been made upon the special-purpose machine in a laboratory and in industrial conditions directly.
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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