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EXPERIMENTAL IDENTIFICATION OF RUBBER-WATER BEARINGS DYNAMIC PARAMETERS

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Summary: *In this work the problems of identification of rubber-water bearings dynamic parameters were investigated. The results of experiments on laboratory stand and fatigue device were presented. At the end of the work results of researches were estimated.*

1. Introduction

The issue considered in this work is a part of research on diagonal pumps dynamics. These devices are used in Anvil Works in Włocławek and make up an important element of the technological process. They are a complex system consisting of two subsystems: an electrical motor and the main pump. The machine height is 6.5 m. Due to its size the device is set on two foundations. Fig. 1 shows the pump from an upper level.

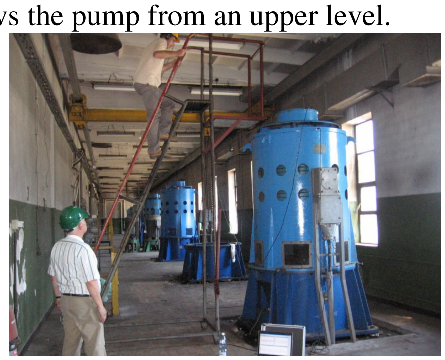

Fig. 1. Picture of the pump electrical motor

2. Specificity of research object

For full dynamic analysis of the problem is necessary to define equals of the motion which base on structural models (figure 2).

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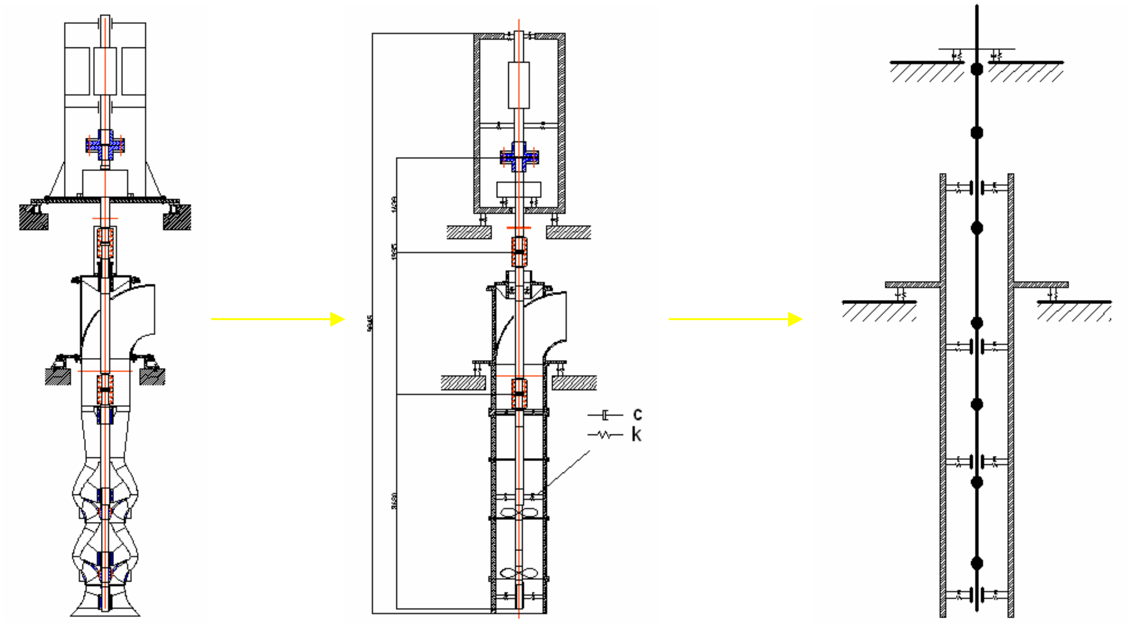

Fig. 2. Structural models of pump 80D

The figure presents evolution stages, from a complex system to a more simplified one. The most vibroactive element of the presented machines is a complex drive system with a support structure.

The most important problems connected with dynamics of shafts include:

-tests on stability and determination of the critical rotations.

-problem of dynamic strength of shafts under the influence of centrifugal forces

-defining the level of dynamic loading of bearings and the support structure

-vibrations of blades and rotor disks

-dynamic balancing of rotors

-vibration diagnosis.

Complexity of the system causes that in this type of machines vibrations are also produced by:

-rotor unbalancing

-non-concentricity of shafts

-anisotropy of stiffness

-forces of hydrodynamic nature (Gryboś, 1998).

An indispensable stage prior to formulation of motion equations is identification of the system dynamic parameters. This work deals with identification of rubber-water bearings parameters, making up supports of the drive system. A view of a drive system together with bearings set on them, have been presented in figure 3, and the bearing spatial cross-section has been shown in figure4.

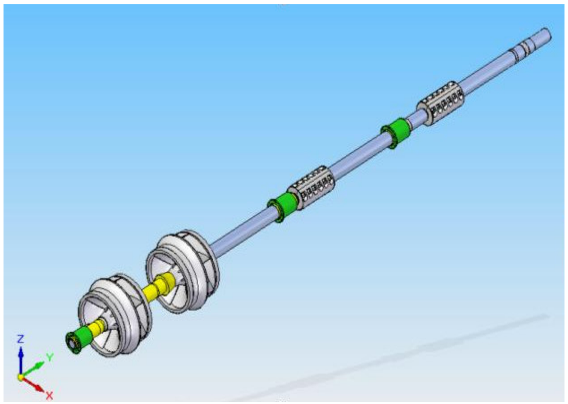

Fig. 3. The pump drive system

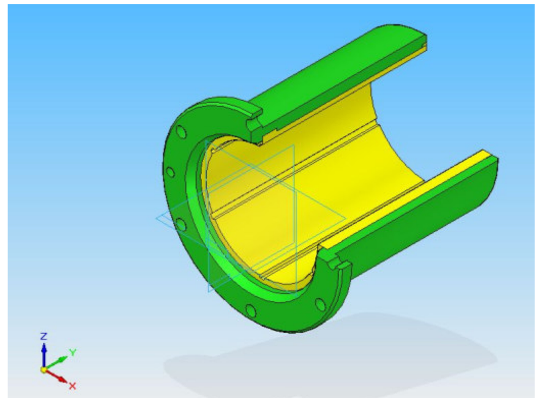

Fig. 4. Cross-section of hydrodynamic bearing

3. Experimental tests

Determination of the bearing dynamic parameters can be performed by an analytic or an experimental method. Because of the hydrodynamic bearing characteristics (liquid, rubber, metal, assumed clearings) the easiest access to results was to examine the bearings experimentally.

For this purpose a special test stand has been presented in figure 5.

Fig. 5. Stand for determination of bearings parameters

Simplicity of the presented test stand –system with one freedom degree, eliminates occurrence of measurement errors connected with the rotor motion. Schemes of the stand have been presented in figures 6.

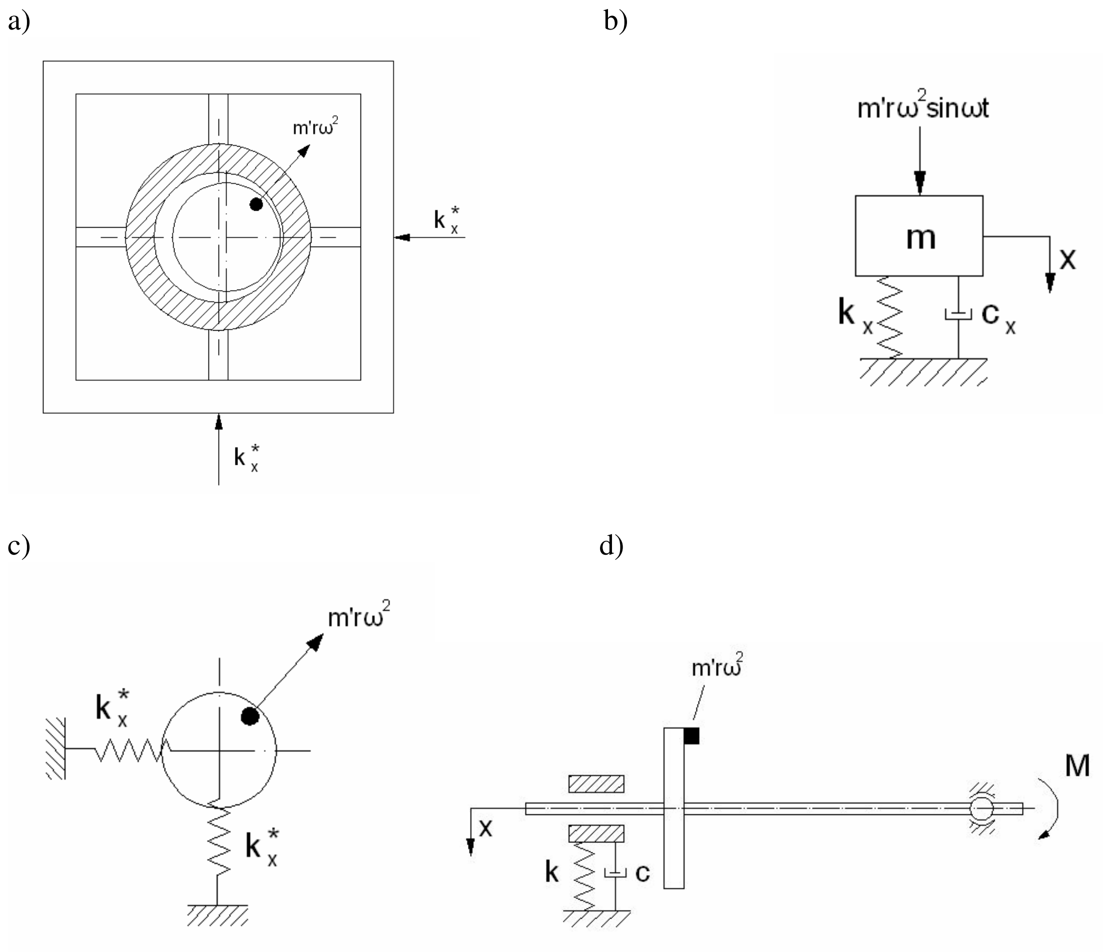

Fig. 6. Scheme of a test stand : a-bearing fixed in an isotropic casing, b,c- discrete model of the bearing, d-the rotor support scheme

Tests were carried out for different values the bearing-shaft system clearings and different values of the pressure of water supplying the bearing. In order to determine the bearing parameters functions of dynamic susceptibility functions were determined (figure 7).

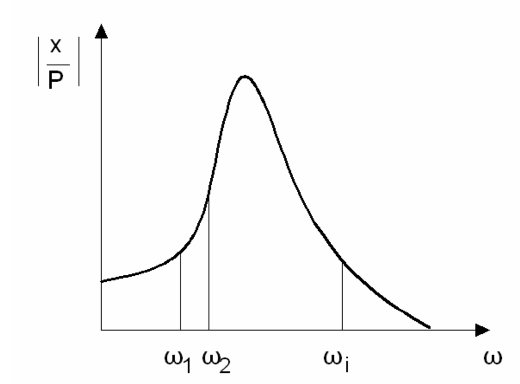

Fig. 7. Dynamic susceptibility chart

The formula describing amplitude-frequency characteristics (module of spectral transmutation) of a system with one freedom degree, has the following form:

$$\left|\frac{x}{P}\right| = \frac{1}{\sqrt{\left(k - m\omega^2\right)^2 + (\omega c)^2}} \tag{1}$$

where:

m-shaft mass

k-bearing springiness coefficient

c-bearing damping coefficient

ω-shaft wheel periodicity

P- force of unbalancing

x-coordinate of the shaft vertical shift in the bearing

Tests were carried out for different values of rotational speed with variable pressure parameters of the water supplying (0,2 MPa, 0,3 MPa, 0,4 MPa) and clearings in the system pan –shaft (0,2 mm, 0,4 mm, 0,6 mm).

Selected results have been presented in the figures beneath.

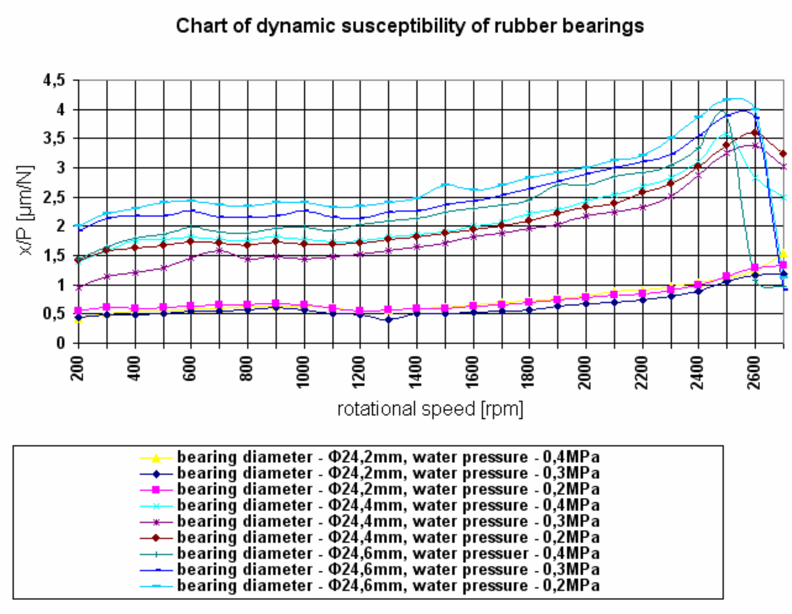

Fig. 8. Chart of dynamic susceptibility of rubber bearings

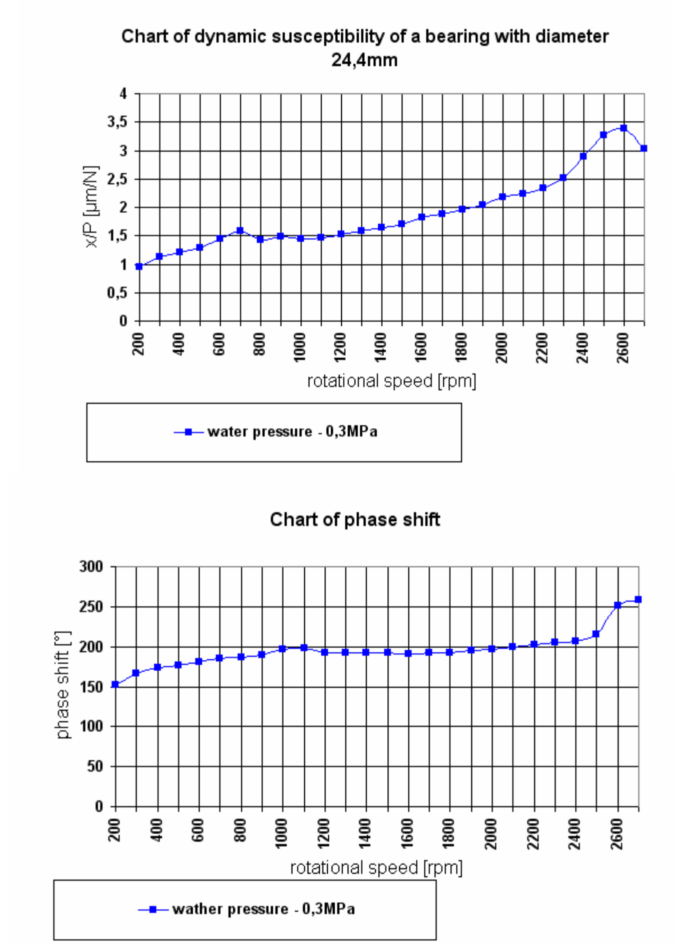

Fig. 9. Charts of dynamic susceptibility and an angle of phase shift for the bearing with diameter 24,4mm.

Because the tests prove that the influence of water pressure on the dynamic susceptibility characteristics is insignificant, it was resolved to examine the rubber stiffness on Instron device (fig1) in a static and a dynamic way. Tests results have been presented in figures 11 and 12.

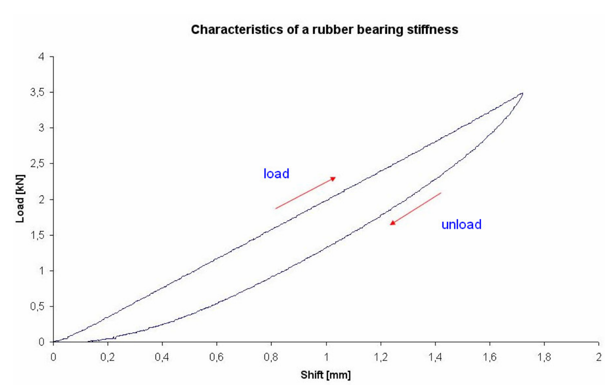

Fig. 10. Testing stiffness in static and dynamic ways on INSTRON device

Fig. 10. Stiffness characteristics of a rubber bearing determined in a static way

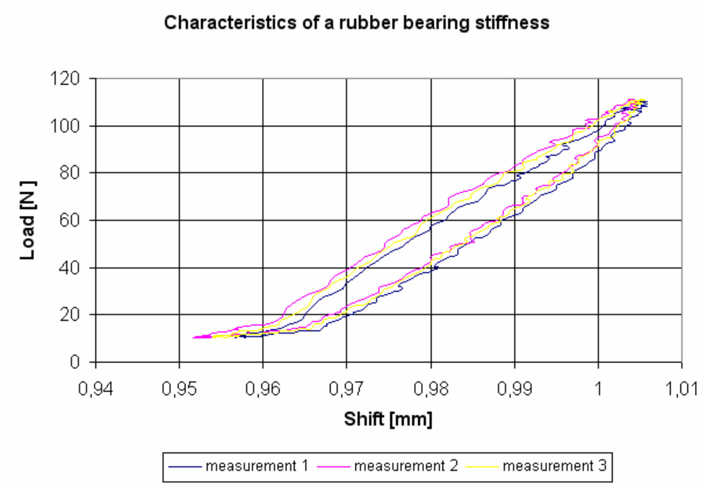

Fig. 11. Characteristics of rubber bearing stiffness determined in a dynamic way for frequency of constraint force f=5Hz.

Calculation results have been presented in table 1.

Tab.1. Stiffness measurement results

the parameter determination method	**stiffness k [N/m]**	**damping c [Ns/m]**
- from the static susceptibility characteristics	1905627,7	1312,6
- statically	2069620,2	
-dynamically	2177874,6	

4. Conclusions

1. In the carried out tests a simplified linear model was assumed and it was accepted that a narrow range of forcing frequencies meet the linearity criteria.
2. In further tests the system susceptibility to must be examined, assuming nonlinearity
3. Influence of water supplied to the bearing is not significant
4. At a certain rotational speed and with appropriate clearing between the shaft and the bearing there occurs dramatic decrease of the shaft vibrations. This scope of the bearing work should be examined thoroughly.
5. It is intended to continue testing bearings totally dipped in water.
6. A slight difference for stiffness calculated dynamically and statically has been noticed.

References

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