COMPARATIVE ANALYSIS OF EXPERIMENTAL AND SIMULATING RESEARCH WITH CAE SYSTEM MSC.VISUALNASTRAN 4D OF THE SLIDING BEARINGS

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Abstract. In deeper entering of CAD/CAE systems in engineering practice, processes connected with development and researching of different products are carrying in the virtual space. In that reason arise the question how far the results received from the investigation of different 3D models with CAE systems correspond to the real. In the paper is made comparison of the results from the experimental investigations of the journal - bearings with the sliding bearings at the different friction coefficients. The same investigation is done with the CAE system MSC.visualNASTRAN 4D. The received results show that the researches are comparative.

Keywords: journal - bearings, sliding bearings, kinematic analysis, CAD-CAE

1. Introduction

The journal – bearings are design for supporting in the curtain positions revolving or making variating movement elements, to take their loading and to transmit to the stand. Simultaneously with that providing correspondence relative movement.

Bearing meetings present under different forms in the all mechanisms. In the biggest meaning for the behaviour of the bearings is arising in the process of their work friction. The adequacy reading of the friction in the bearings at the different interferences is from the critical meaning for the accuracy of receiving results [1, 3].

Sliding bearings are one of the most popular journal – bearings in the precise technique.

The mean reasons for the breaking the normal work of sliding bearings are [2, 3]:

- Wearing of the working faces, which lead to increasing of the gap in the bearing and accordingly breaking of the accuracy;
- Overheating of the bearing, received in the result of the increased temperature.

CAD/CAE systems enter in the engineer practice processes connected with development and researching of different products are carrying in the virtual space. The exchange of the real stands with 3D models with the help of CAE system is converting into very important actual question at the distance training and globulin of the world. MSC.visualNASTRAN 4D is CAE system of the kinematic analysis of the mechanisms by means of their 3D models [4, 5].

The goal of the present paper is to compare the results received at the investigation of t sliding bearings received with using of CAE system MSC.visualNASTRAN 4D and data from the experimental research conduct in the laboratory conditions. The used method is fading oscillations. The influence of friction coefficients in the bearing over kinematic analyze received from the system.

2. Theoretical setting of the research

Determining of the moment of friction in the bearing is done from the following formula:

$$M_{TP} = G \cdot l \cdot \frac{\alpha_0 - \alpha_n}{2n} \text{ or } M_{TP} = G \cdot l \cdot \frac{\alpha_0 - \alpha_n}{4N} \quad (1)$$

where

M_{TP} – moment of friction, [N m];
G - weight of the pendulum, [N];
l – length of the pendulum, [m];
h – difference in the height of the pendulum in the begin and in the end position, [m];
$\alpha_0 \div \alpha_n$ – angle of the diversion of the pendulum, [rad];
n – number of half-period;
N – number of the periods of the oscillating of the pendulum, $N = n/2$.

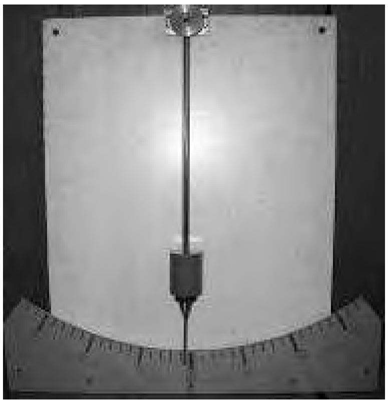
The tie between moment of friction and value of the friction coefficient of friction is:

$$M_{TP} = F \cdot f \cdot r \quad (2)$$

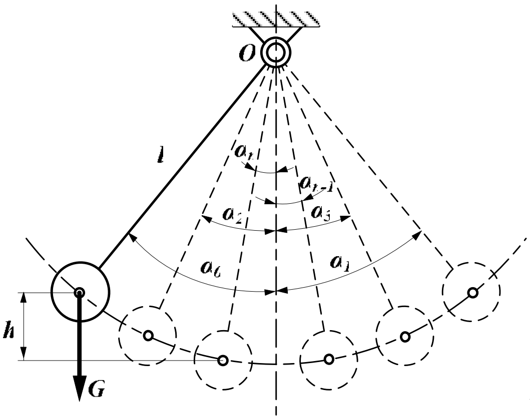
where

F – loading force, [N];
f - friction coefficients;
r – radius of the bearing, [m].

For the experimental determining of the moment of friction in the different bearings on oscillation damping method is used the experimental setting shown at the picture figure 1. At the figure 1a is given the photo of the stand. At the figure 1b is given the calculation scheme.



a)



b)

Figure 1. Experimental setting
a) Photo of the stand; b) Calculation scheme

Experimentally are defined moments of friction and friction coefficients in the two fractioning couple: steel / steel and steel / laminated fabric. Friction coefficients at the sliding in those friction couples according received experimental data published in other paper of the authors are: for steel / steel $f = 0.39$; for steel / laminated fabric $f = 0.25$.

The rest parameters of the experimental setting are:

- radius of the investigated bearing $r = 0.0085$ m;
- weight of the pendulum $G = 10$ N;
- length of the pendulum $l = 0.38$ m.

For the three initial angles for the each couple the experimental results are: α_0 = 10° = 0.175 rad; 20° = 0.349 rad; 30° = 0.524 rad.

Those data and results from the experiment are used like base for the comparison in conducting of the investigation with CAE system *MSC.visualNASTRAN 4D*.

3. Investigation with the help of CAE system *MSC.visualNASTRAN 4D*

For the purpose of the development in the medium of CAD system *Solid Works* [4] is created 3D model of the experimental setting, shown at the figure 2. That model is imported in the CAE system *MSC.visualNASTRAN 4D.* It is a CAE system for kinematic analysis of mechanism by means of 3D models. The system allowed to defined parameters of the movements for the separate elements of the researched mechanism and appearing at those movements' deformations, for that is used method of finite elements. The common view of the 3D model of the experimental setting in the medium of *MSC.visualNASTRAN 4D* is given at the figure 3.

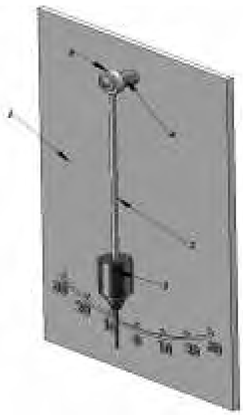


Figure 2. 3D model of the experimental setting
1– base; 2 – pendulum; 3 – weight; 4 – lease;
5 – bearing bush

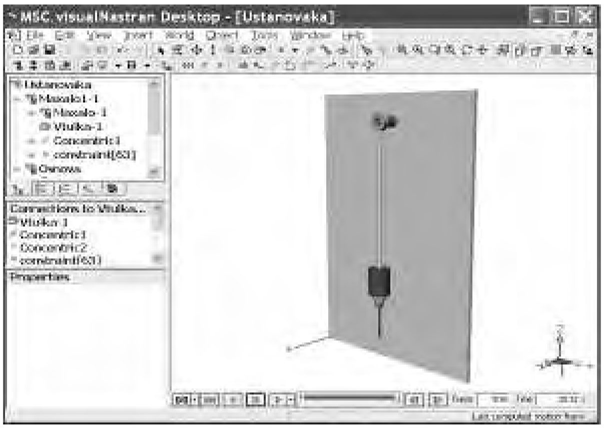


Figure 3. Investigation model imported in CAE system

At the investigation are set the following limits:

- Bearing bush (5, figure 2), pendulum (2, figure 2) and weight (3, figure 3) are union in a slide fit "Pendulum 1" are treat like one body in the system;
- Lease (4, figure 2) and base (1, figure 2) are union in a slide fit " Base", which is fixed toward the beginning of the co-ordinate system;
- Materials of the concrete details with corresponding physic – chemical characteristics.
- Between "Pendulum 1" and "Base" is initiate connection allowing turning of the pendulum toward the base;

- Conditions of the friction in the bearing are start giving through the characteristics of the contact, figure 4.

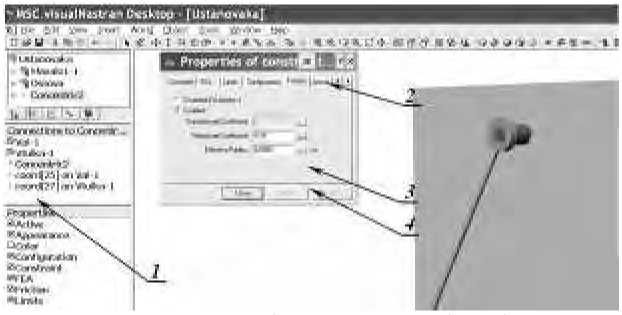


Figure 4. Start giving of the condition of the friction in the investigation model
1 – connection between lease and the bush; 2 – window for start giving of the parameters of the connection; 3 – coefficients of the friction in the bearing; 4 – radius of the bearing *r*

4. Results from the investigation

Results from the analyze with *MSC.visualNASTRAN 4D* at the friction couple steel / steel and α_0 = 30° are shown at the figure 5. At the fig.6 are shown results received at the analyze with *MSC.visualNASTRAN 4D* graphs for the oscillating of the pendulum (α_i) like a function of the time for the different trials of the experiment. The rest results are conducted experiment are used for building of the graphs, shown at the figure 6. For the corresponding values of α0 are used average values from the consecutive trials.

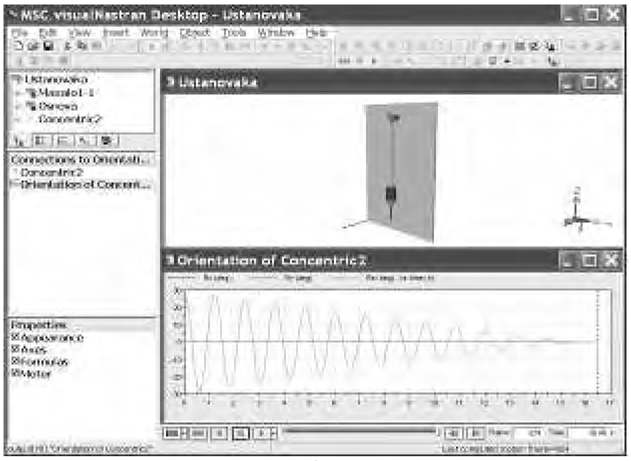


Figure 5. Results received from the investigation with *MSC.visualNASTRAN* 4D at friction couple steel / steel and α_0 = 30°

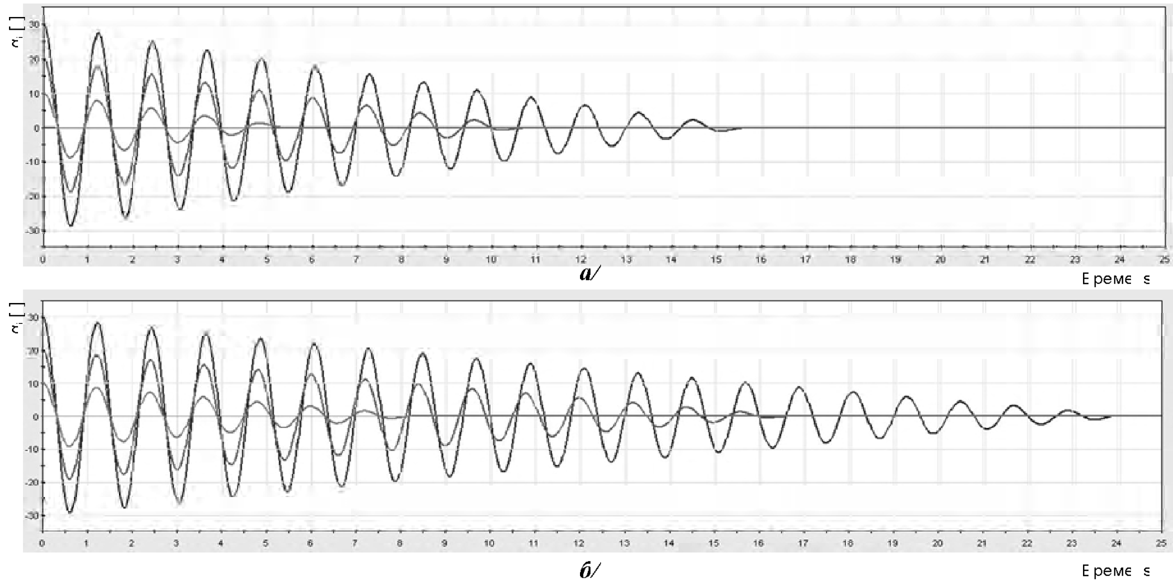


Figure 6. Results received from the investigation with *MSC.visualNASTRAN* 4D at different trials of the experiment
a) Friction couple steel / steel; b) Friction couple steel laminated fabric

Comparison of the results from the conducted experiments and investigation with *MSC.visualNASTRAN 4D* are shown at the figure 7.

5. Conclusions

1. Results from the investigation of the sliding bearings at work with *MSC.visualNASTRAN* 4D are commensurate c with results from the real conducted experiments.

2. Received results from the investigation with *MSC.visualNASTRAN* 4D and experimental results are with difference under 1.5°.

3. CAE system *MSC.visualNASTRAN* 4D can be used for conducting of the virtual investigations and distance training.

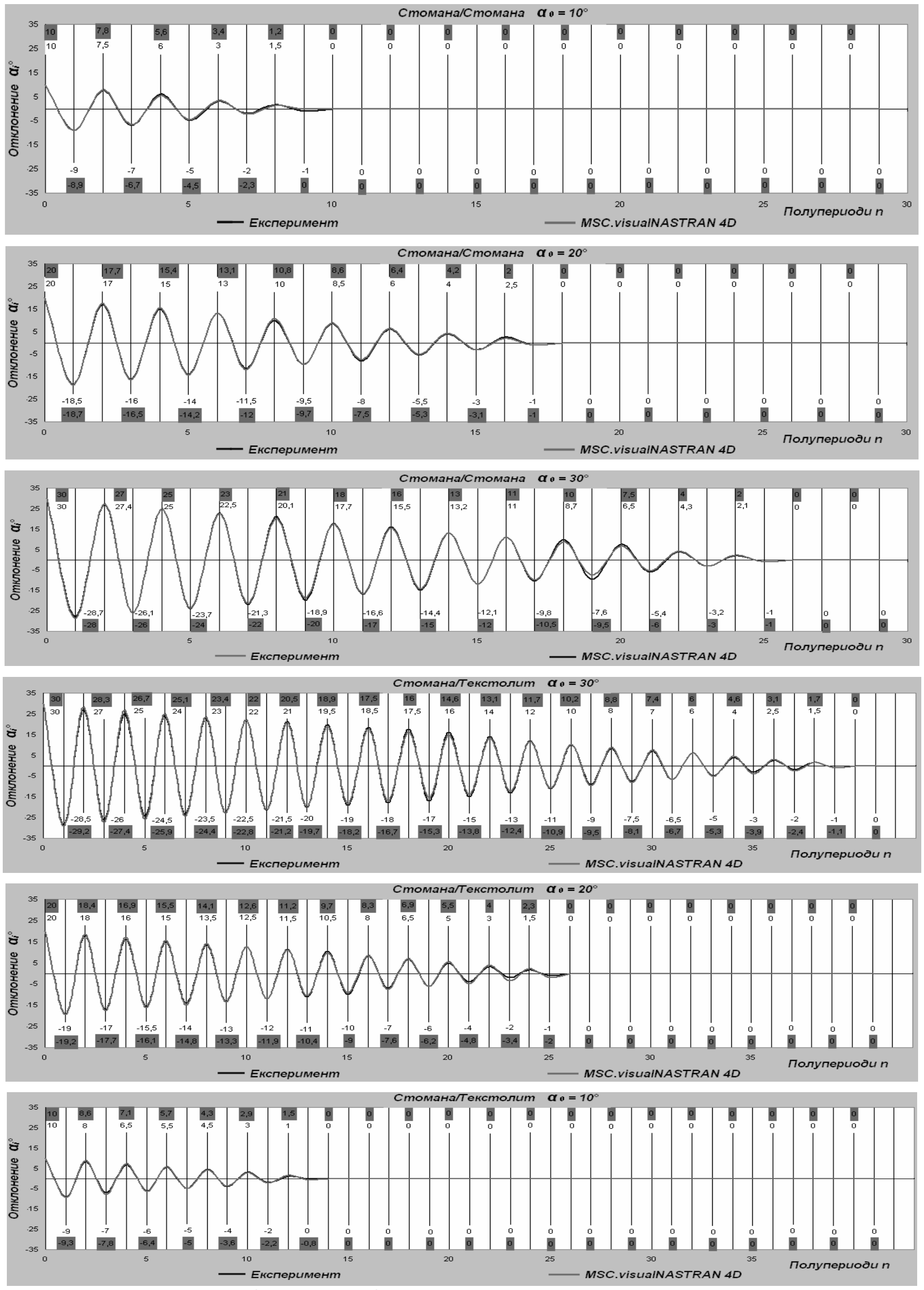


Figure 7. Comparison of the results from the conducted experiments and investigation with *MSC.visualNASTRAN* 4D and experimental results

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