Analysis of Shoch Damping in the Lubricant Film in a Hydrodynamic Radial Bearing

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Abstract: *In the present study, we investigate the shock behavior of a hydrodynamic radial bearing with L/D ratio 0.5 comparing the effect of spindle speed on the shock absorption in the lubricant film. We performed tests for different static loads, we kept the supply pressure constant, and the results presented refer to the maximum dynamic load F3.*

Keywords: *lubricant film, radial HD bearing, shock absorption, spindle speed*

1 INTRODUCTION

It is proposed to analyze lubricant film behavior for narrow radial bearing with elongation 0.5 subjected to shock for two studied speeds n_1, n_2 and two static loads G_1, G_2. The amplitude of the shock is monitored, visualized by determining the acceleration of the bushing bearing at the time of the shock, in accordance with the time required for vibration damping expressed in s^{-3}.

The characteristics of the radial bearing used in the experimental measurements are as follows: bearing elongation L/D = 0.5; bushing diameter (bronze bushing composed of 88% Sn, 8%Sb, 4%Cu) D_e =59.93 mm, spindle's diameter (composed of 18MoCr10) d_e =59.86 mm, spindle's asperity 58-62 HRC.

The dimensions of the narrow radial bearing housing are shown in Figure 1 [3].

Notations used:

F- dynamically loading (N); L- bearing width (m); D- bearing diameter (m); G- static loading (N); p- pressure (Pa); n – the rotational speed; H- dynamic load weight stroke (m).

2 EXPERIMENTAL RESULTS

The experimental results were carried out at a lubricant temperature considered constant (40°C), the supply pressure of p_{in} with values between 0.5 bar and 1.5 bar [2]. Spindle speeds are 370 rpm and 600 rpm.

In the experimental research, two values were considered for the static load of the bearing, G_1 = 2250 N, respectively G_2 = 4500 N. The bearing point of the oil bearing is placed horizontally at 90˚ relative to the place of application of the load.

The static regime is represented by the dynamic load weight stroke H = 0 cm, respectively maximum dynamic load for H = 40 cm, corresponding to the force F_3 = 3332.5 N.

Measurements were made for each position on the bearing circumference P1-P5, individually [1], [4]. The acceleration of the bearing was determined using the ADXL 190 WQC acceleration sensor.

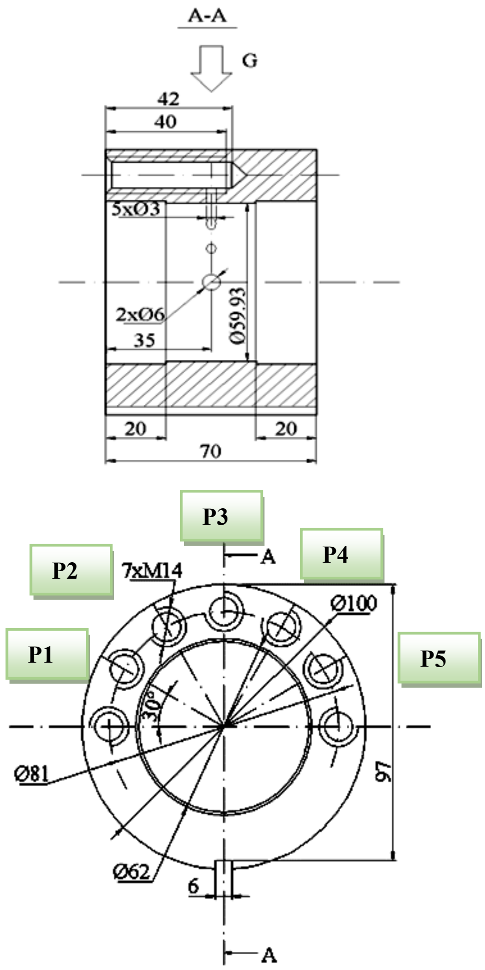


Fig.1. The dimensions of the narrow radial bearing

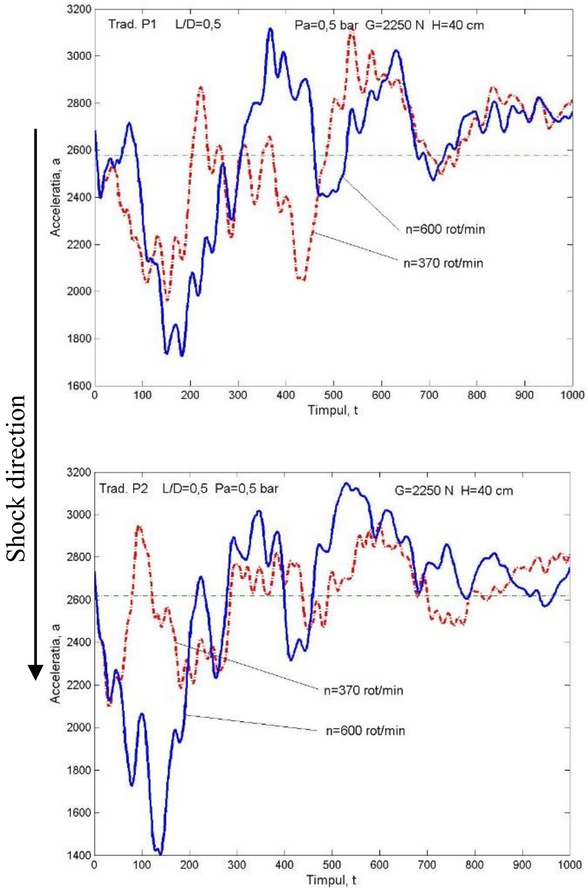
The output signal of ADXL 190 WQC being purchased by the ADuC 812 acquisition board, being processed through the MATLAB 6.5.0.18091 3a program [5], [6]. The acceleration sensor is supplied with DC power from a 9 V voltage source. The calibration of the output signal was done so that for 250 mV corresponding to acceleration 9.8 m/s^2, (calibration established by the manufacturer) [1]. On the bearing, the acceleration sensor is fixed rigidly, in the diametrically opposite direction to the position considered, by means of a polyester adhesive solution.

Figure 2 shows bushing bearing acceleration at the moment of shock, dynamic loads F_3 (H= 40 cm), at

n_1 = 370 rpm, n_2= 600 rpm, p_{in} = 0.5 bar, transducer position P1-5, static loads G_1, and Figure 3 shows bushing bearing acceleration at the moment of shock, dynamic loads F_3 (H= 40 cm), at n_1 = 370 rpm, n_2= 600 rpm, p_{in} = 0.5 bar, transducer position P1-5, static loads G_2.

Both the static and dynamic loads are located in the vertical plane in the direction of operation of the bearing, so that the maximum amplitude of the bearing acceleration will be located in the lower part of the graphs. We compared the influence of the radial bearing spindle speed on the bearing capacity of the lubricant film, for all 5 positions P1-P5, observing in each case the magnitude of the shock amplitude and the time in which this damping is achieved.

Also, the differences in this damp depending on the position on the periphery of the bearing are noted.



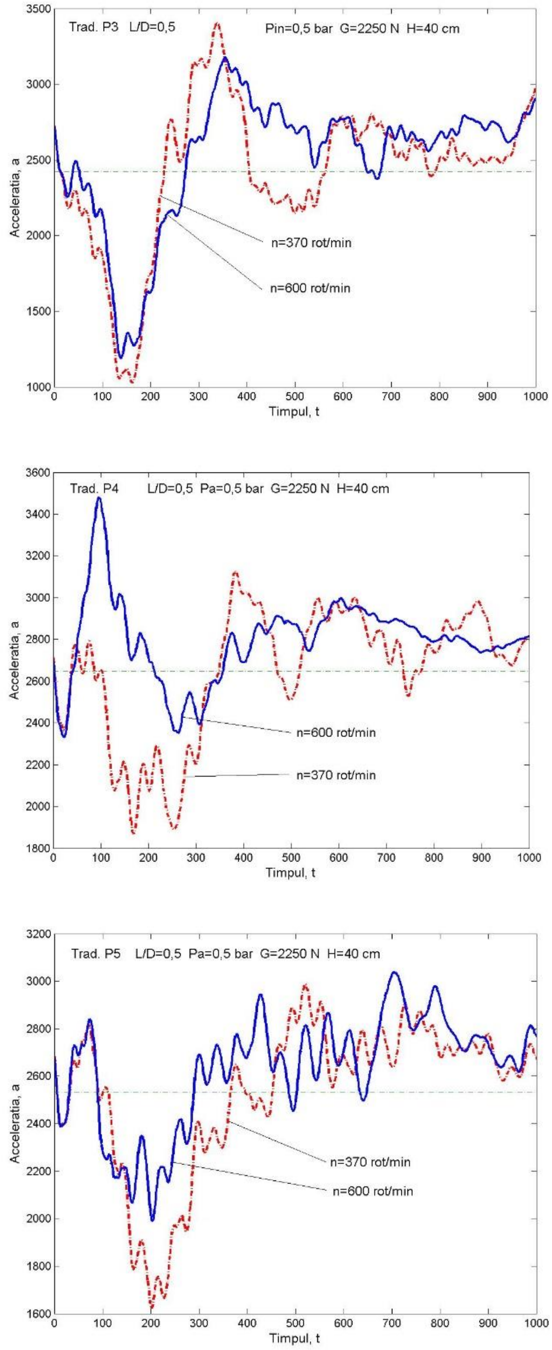
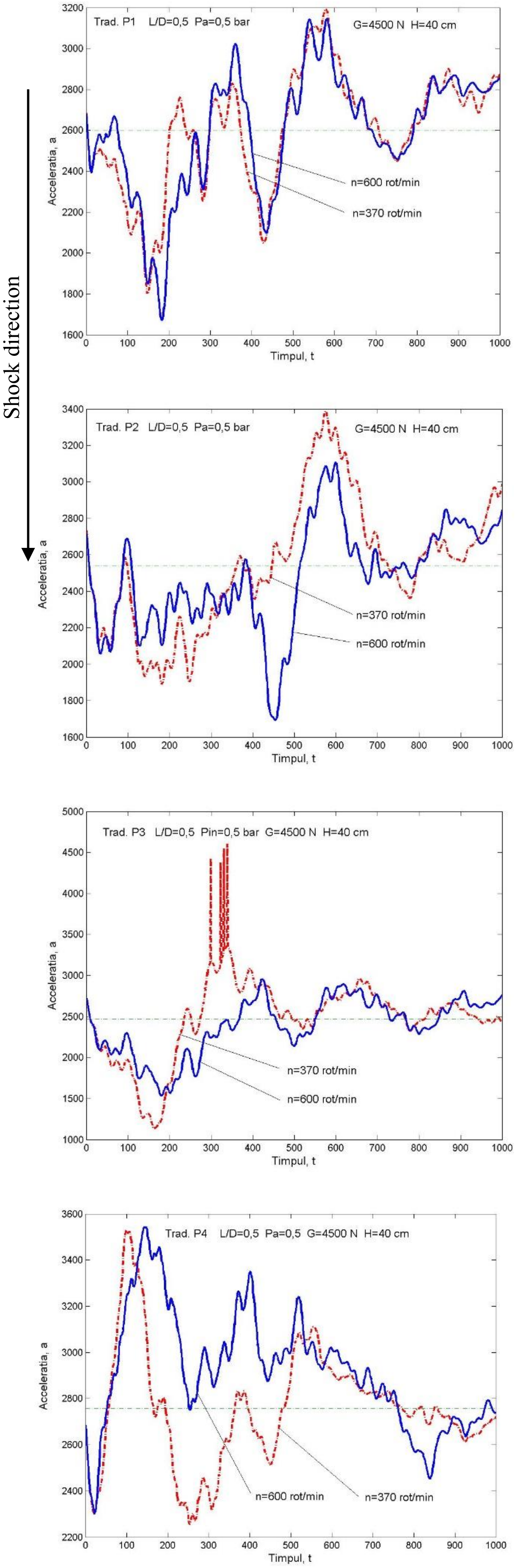


Fig. 2 Acceleration of the bearing at the moment of impact corresponding to the loading force F_3 (H= 40 cm), at n_1 = 370 rpm, n_2= 600 rpm, p_{in} = 0.5 bar, position P1-5, static loads G_1



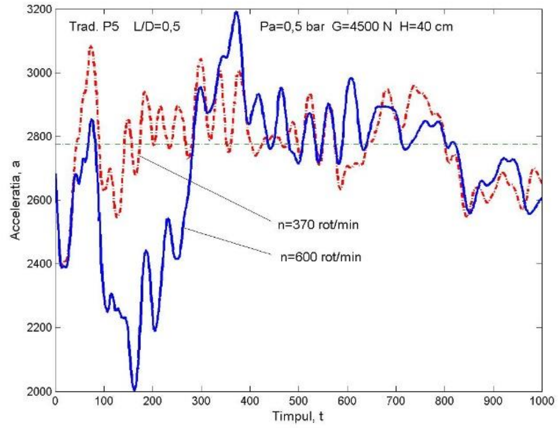


Fig. 3 Acceleration of the bearing at the moment of impact corresponding to the loading force F_3 (H= 40 cm), at n_1 = 370 rpm, n_2= 600 rpm, p_{in} = 0.5 bar, position P1-5, static loads G_2

3 CONCLUSIONS

The following can be concluded:

• with increasing spindle speed (from 370 rpm to 600 rpm), for the same static and dynamic load, the amplitude of the shock absorbed by the system is greater;

• the thicker the lubricant film, the greater the shock absorption, the acceleration amplitude decreasing rapidly;

• the initial shock damping in the two spindle speed situations (370 rpm and 600 rpm) is achieved after approximately 5 ms, regardless of the shock applied; the maximum amplitude of the bearing acceleration, in all the experimental research studied, was observed during the initial period of damping (0.5-1 ms);

• the shock amplitude is greater for the position P3 on the spindle circumference, for the speeds n_1=370 rpm and n_2=600 rpm;

• at dynamic load, F_3=3332.5 N, the maximum value of the bearing acceleration is between 56.8-68.6 m/s^2 for spindle speed n_1=370 rpm, between 45-58.8 m/s^2 for n_2=600 rpm;

• increasing the spindle speed leads to an increase in the minimum lubricant thickness, with favorable implications on the radial bearing capacity.

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