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EXPERIMENTAL RESEARCH ON SHOCK ABSORPTION IN THE LUBRICATING FILM AT THE NARROW HD RADIAL BEARING

Ioan Marius ALEXANDRESCU, Radu Iacob COTEȚIU, Simion HARAGÂȘ

Abstract: *The experimental research regarding shock absorption in the lubricating film on the operation of narrow HD radial bearings in the case of high load. The main objectives of the research are the determination of the acceleration of the bushing bearing and minimal lubricating film between spindle and bushing.*
Key words: *lubricating thickness, radial HD bearing, lubricating film, hydrodynamic regime.*

1. INTRODUCTION

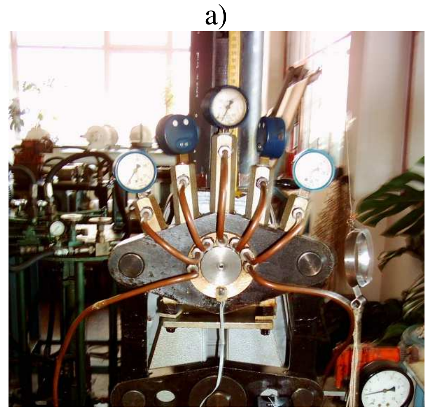
The laboratory stand was used for studies of HD bearing operation and pressure distribution under statistical and dynamic loading conditions of these bearings (Figure 1). The measurements were accomplished on the experimental stand shown in figure 1 using the radial bearing whose bushing bearing is shown in figure 2 and the measuring chain shown in Figure 5 [1], [4].

The experimental research on shock absorption in the lubricant film was accomplished using a narrow HD radial bearing with L/D=0,5 where L is the width of the bearing, D bearing bronze bushing diameter, D=59,93 mm, the spindle's diameter d=59,86 mm, made from 18MoCr10 [2].

Notations used:
G - static loading (N); F - dynamically loading (N); n - the rotational speed; p - pressure (Pa); h - fluid film thickness (m); H - weight release height (m).

The experimental determinations were carried out at a constant temperature of 40°C of the lubricating film, the supply pressure of p_{in} with values of 0.5 bar and 1.5 bar [2]. The type of lubricant was used LA 32, STR 5152, viscosity at 40°C of 31.3 cSt. Spindle rotational speeds are 370 rpm and 600 rpm. The static bearing loading system allow uploads $G_1 = 2250$ N and $G_2 = 4500$ N.

a)



b)

Fig. 1 The experimental stand (a) and experimental stand with acceleration sensor ADXL 190 WQC (b)

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The bearing point of the oil bearing is placed horizontally. The static regime is represented by the strike height H=0 cm. The dynamic regime is represented by the heights, H (5 cm, 20 cm and 40 cm), which correspond to dynamic loads F_1 = 1665 N, F_2 = 2356 N, F_3 = 3332.5 N.

Figure 2 shows the narrow bushing bearing in experimental research.

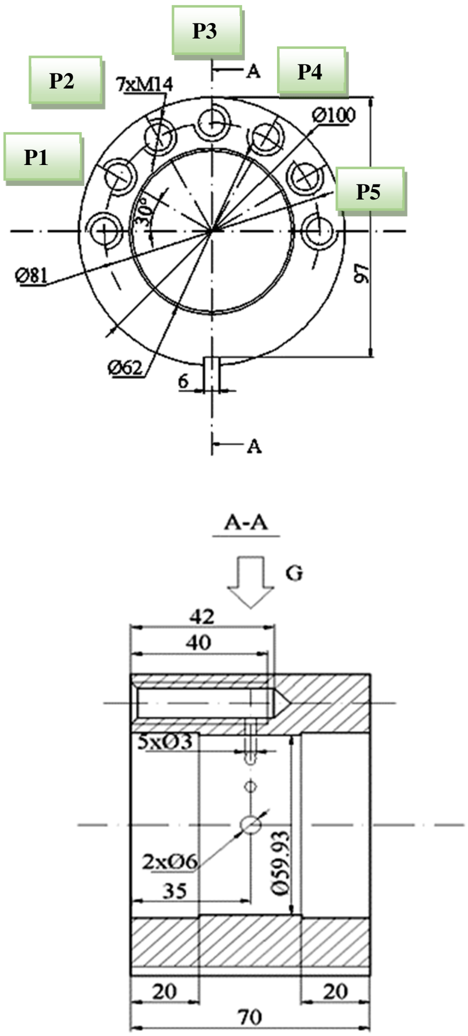


Fig. 2 The narrow bushing bearing; P1-P5 measurement positions on the periphery of the bearing

2. THE EXPERIMENTAL RESULT ON SHOCK ABSORPTION IN THE LUBRICANT FILM

The bushing bearing acceleration was determined using the acceleration sensor, ADXL 190 WQC, powered with 9 V voltage source. The output signal from the sensor, electrical voltage, is received by the fully integrated 12-bit multichannel data acquisition system ADuC 812 and is then processed using the MATLAB program 6.5.0.18091 3a [6].

The sensor calibration is carried out by the manufacturer, a voltage of 250 mV corresponding to an acceleration 9.8 m/s^2 [1].

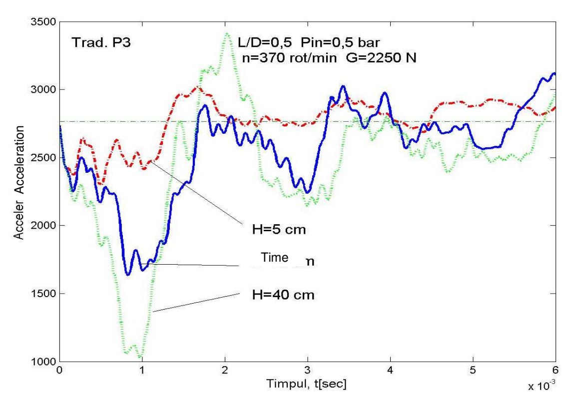
The acceleration of the bearing was measured successively for positions P1-P5 on the periphery of the bearing [4], [5].

Figure 3 presents bushing bearing acceleration at the time of shock, dynamic loads F_1, F_2, F_3, at n = 370 rpm, p_{in}=0.5 bar, transducer position P3, loads G_1 and G_2 and Figure 4 presents bushing bearing acceleration at the moment of shock, dynamic loads F_1, F_2, F_3, at n = 600 rpm, p_{in}=1.5 bar, transducer position P3, loads G_1 and G_2.

The minimum electrical resistance of the lubricating film, R_{11}, which estimates the minimum oil film thickness from the bearing was determined through realization a resistive circuit between the spindle and the bushing bearing, using a control resistance R_{12} = 49 KΩ (Figure 5).

The signals taken by the fully integrated 12-bit multichannel data acquisition system ADuC 812 and is then processed using the MATLAB program 6.5.0.18091 3a.

The minimum resistance of the lubricating film, determined experimentally, depending on the supply pressure, the dynamic load and the static load for different spindle speeds, is shown in Figure 6 for the case n = 370 rpm, p_{in} = 0.5 bar; Figure 7 for the case n = 600 rpm, p_{in} = 1.5 bar.



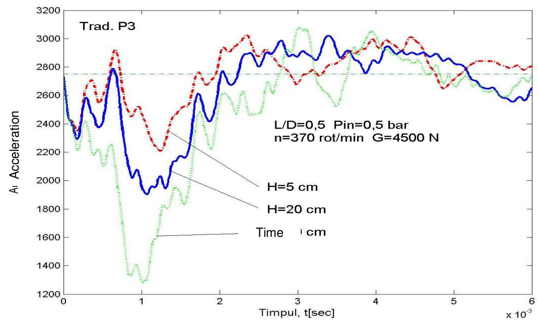


Fig. 3 Bushing bearing acceleration at the moment of shock, dynamic loads F_1, F_2, F_3, at n = 370 rpm, p_{in}=0.5 bar, transducer position P3, static loads G_1 and G_2

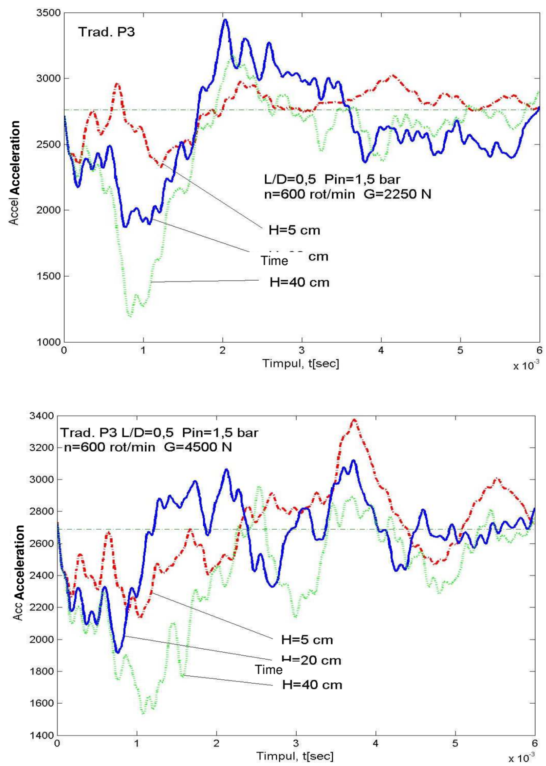


Fig. 4 Bushing bearing acceleration at the moment of shock, dynamic loads F_1, F_2, F_3, at n = 600 rpm, p_{in}=1.5 bar, transducer position P3, static loads G_1 and G_2

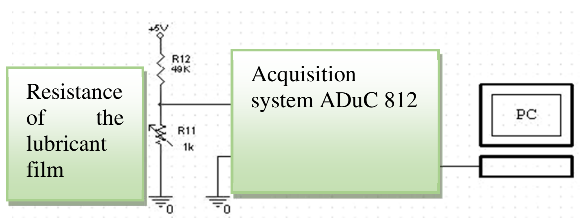
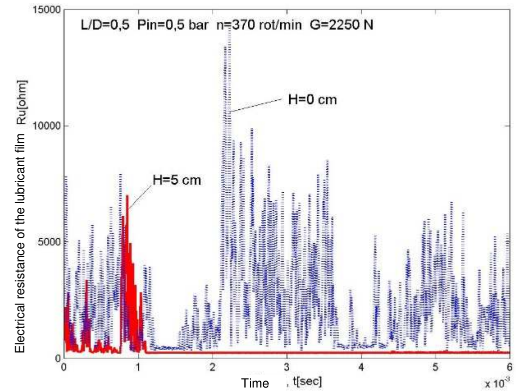
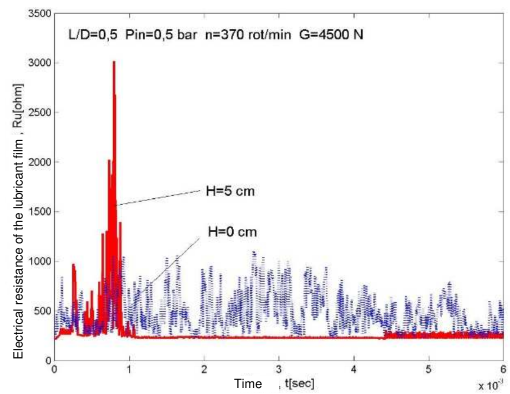
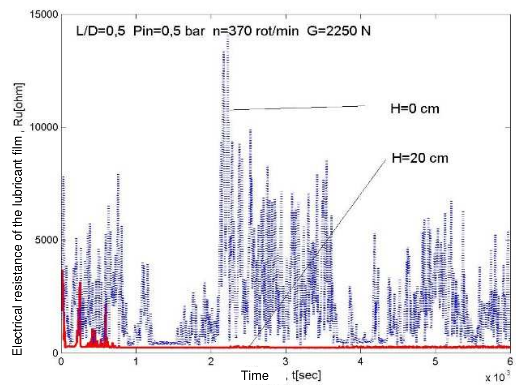
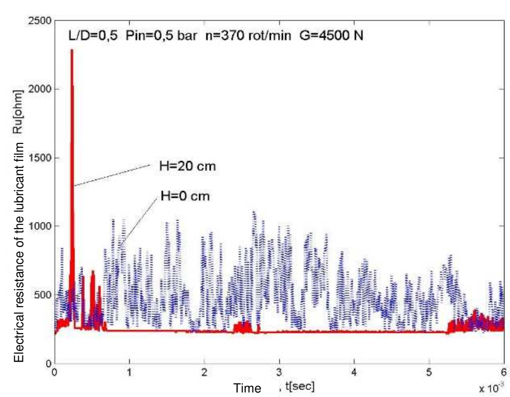


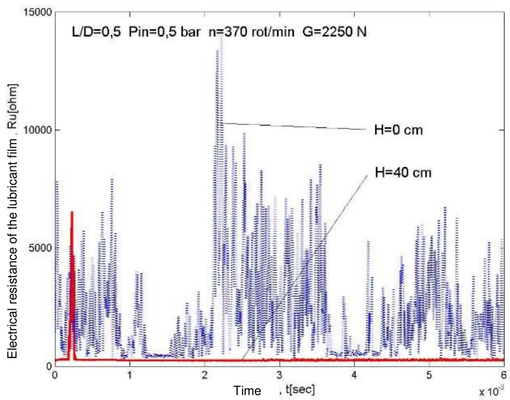
Fig. 5 Measuring the resistance of the lubricating film. R_{11} - the resistance of the lubricant film











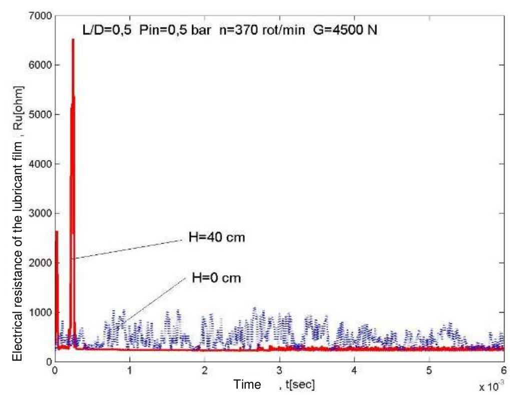
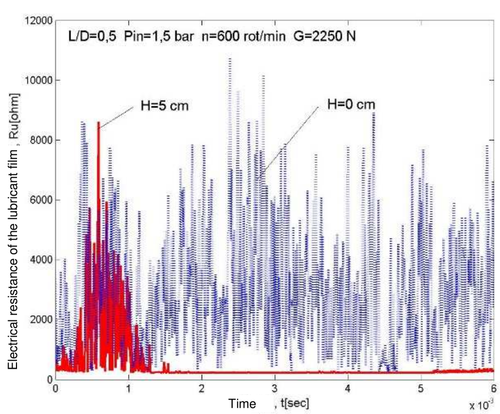
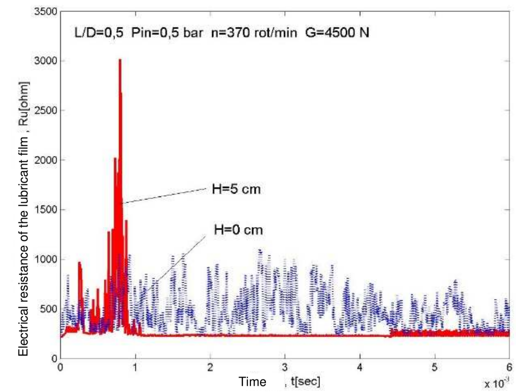
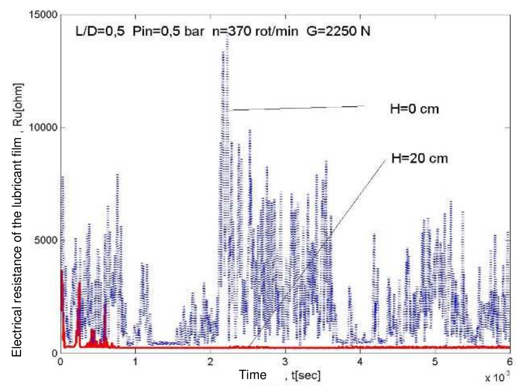
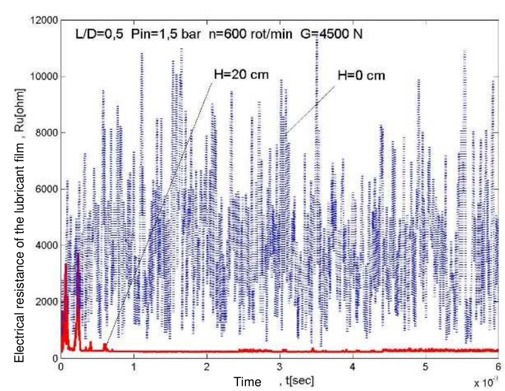


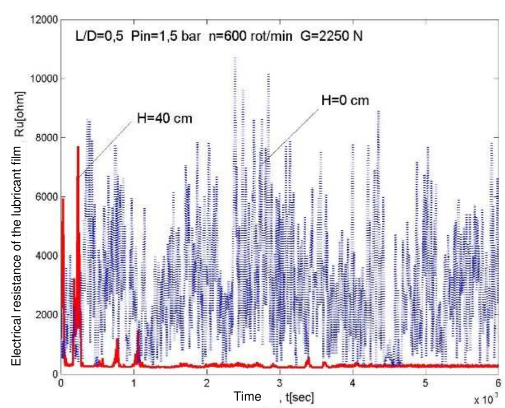
Fig. 6 Minimum electrical resistance of lubricant film for speed n = 370 rpm, p_{in} = 0.5 bar, in relation to static loads G_1, G_2 and dynamic loads F_1, F_2, F_3











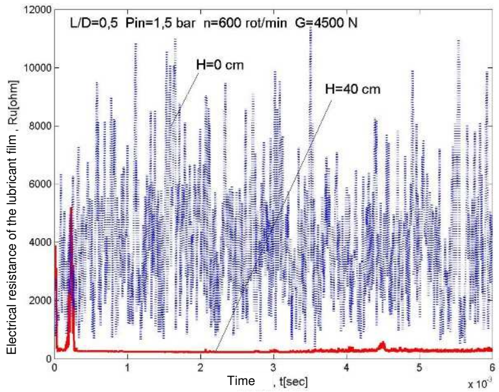


Fig. 7 Minimum electrical resistance of lubricant film for speed n = 600 rpm, p_{in} = 0.5 bar, in relation to static loads G_1, G_2 and dynamic loads F_1, F_2, F_3

3. CONCLUSIONS

The experiments include investigation of various operating conditions, but don't include lubricant properties, bearing geometries, or material compositions on shock absorption performance. No new theoretical models or computational simulations are used to predict and analyse shock absorption behaviour in narrow radial HD bearings.

The study involves conducting experiments to investigate how the lubricating film within a narrow radial HD bearing absorbs shocks or impacts during operation. The research may aim to characterize the shock absorption properties of the lubricant, understand the factors influencing shock absorption efficiency, or explore methods to improve shock absorption performance in such bearings.

The research is valuable for optimizing bearing design, enhancing machinery reliability, and preventing premature failure due to excessive shock loads.

The following aspects are noted:

• Keeping the static load constant, at increasing the rotational speed, the shock is higher, and the depreciation made by the lubricating film increases (the shock damping increases with the increase of the lubricating film thickness);

• With the increase of the static load, keeping the dynamic load constant, the shock, taken over by the bearing system - lubricating film - spindle, decreases (the thickness of the lubricating film decreases from the static operating regime, so that the shock damping capacity achieved by the lubricating film decreases);

• The shock initial damping in the three spindle speeds situations is achieved after approximately 5 ms, regardless of the dynamic load applied to the bearing;

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

• With the increase of the dynamic load, the electrical resistance of the film decreases (the retention time of the lubricating in the contact area decreasing with the increase of the load);

• With the increase of static load, decreases the electrical resistance of the lubricating film;

• With the increase of spindle speed, increase electrical resistance of the lubricating film under static conditions;

• With the application of the dynamic load for n = 370 rpm, is observed a decrease of the average value of the lubricanting film resistance in relation to the value of the static regime between 2.13 - 2.97 times for static load G_1 = 2250 N, respectively between 1.13 - 2.39 times, for static load G_2 = 4500 N; the strong decline of the thickness of the lubricating film is observed at the time of shock, with the observation that the retention in the contact area of the lubricating film is observed;

• By increasing the spindle speed to 600 rpm, we notice the increase of the thickness of the lubricating film; the lower the static charge, the greater the resistance of the lubricating film (1.19 times higher);

• With the application of the dynamic load for n = 600 rpm, a decrease of the average value of the lubricating film resistance is observed relative to the value of the static regime between 10.7 - 12.11 times, for the static load G_1 = 2250 N, respectively between 9.93 - 10.42 times, for static loading G_2 = 4500 N.

4. REFERENCES

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Cercetări experimentale privind absorbția șocurilor în filmul de lubrifiant la lagărul radial îngust HD

Rezumat: Această lucrare prezintă câteva cercetări experimentale despre absorbția șocurilor în filmul de lubrifiant la funcționarea lagărelor radiale înguste ce funcționează în regim HD în cazul sarcinilor mari. Ne concentrăm pe determinarea accelerației cuzinetului lagărului radial și a peliculei minime de lubrifiant care estimează grosimea minimă de lubrifiere între fus și cuzinet.

Ioan Marius ALEXANDRESCU Associate Professor Ph.D. Eng., Technical University of Cluj-Napoca, North University Center of Baia-Mare, Faculty of Engineering, Department of Engineering and Technology Management, 62A Victor Babes St., RO-430083, Baia-Mare, ROMANIA, E-mail: ioan.marius.alexandrescu@gmail.com, Tel. 0264-202975.
Radu Iacob COTETIU Professor Ph.D. Eng., Technical University of Cluj-Napoca, North University Center of Baia-Mare, Faculty of Engineering, Department of Engineering and Technology Management, 62A Victor Babes St., RO-430083, Baia-Mare, ROMANIA, E-mail: radu.cotetiu@gmail.com, Tel. 0264-202975.
Simion HARAGÂŞ Professor Ph.D., Department of Mechanical System Engineering, Technical University of Cluj-Napoca, Simion.Haragas@omt.utcluj.ro.