METHOD TO DETERMINE THE FRICTION COEFFICIENTS IN THE BALL SLIDING BEARINGS

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Abstract: *The paper presents a study on the static friction coefficient variation in ball sliding bearings, for different type of bearings configuration. The experiments were realized on a high precision tribometer, witch function on the inclined plane principle. The balls sliding bearings were tested with the help of special designed and produced plates, in which were made three different shape channels. To design these bearings it were used different bearings ball size. Also it is presented the work methodology and the experimental results obtained for four types of bearings. The comparative analyses for the studied bearings needs to draw some curves witch represent global friction coefficient variation in terms of used balls diameter. So it was remarked a great influence of channels types and ball diameters in the starting global friction coefficient.*

Keywords*: sliding bearing, friction coefficient, tribometer, experimental results.*

1. INTRODUCTION

The ball sliding bearings are used very often in many engineering domains, due to advantages comparing to common sliding bearings.

So, friction and adhesion wear are much reduced, the precision of positioning is high, the phenomenon of "stick-slip" is absent, there is the possibility of increasing the movement speeds, high rigidity and the possibility of making the sliding bearings by modules. Also, these sliding bearings are remarked by decreasing of friction force, therefore the decreasing of power needed for action, because of uniformity of movement at small speeds and because of high sensibility at precise movements.

An average estimation of friction forces who appear in ball sliding bearings it is made by introducing a global friction coefficient. In balls translation guides path, the power needed to actuate the mobile part is far higher than that to maintain the translation movement. The value of this force is equal with normal load amplified with a global friction coefficient $\mu_0 = \text{tg}\alpha_0$. The work paper proposes to determine the values of this global friction coefficient for different types of ball translation guides path in term of balls diameter and channel shape in witch the balls circulate.

2. APPARATUS AND DEVICES

To determine the global friction coefficient in ball sliding bearings, we use a high precision tribometer with prisms [1]. The tribometer worked on the principle of the inclined plan. The tribometer presents a simple designing solution and it has a precise, fast and handy using (fig. 1).

On the tribometer mobile plate it is laied a device made by two plates who present a relative translation movement by the rolling balls.

There were designed and made with high precision several special plates sets [1], being grouped two by two according to their profile. So, two plates are massive, having both faces perfect plane (fig. 2). On two plates it were made on one of the faces three identical, trapezoidal and longitudinal channels, having the angle of channels at 120º (fig. 3), and on two other plates being made only on one of the faces three identical, longitudinal and curved channels, having medium radius equal with 30 mm (fig. 4).

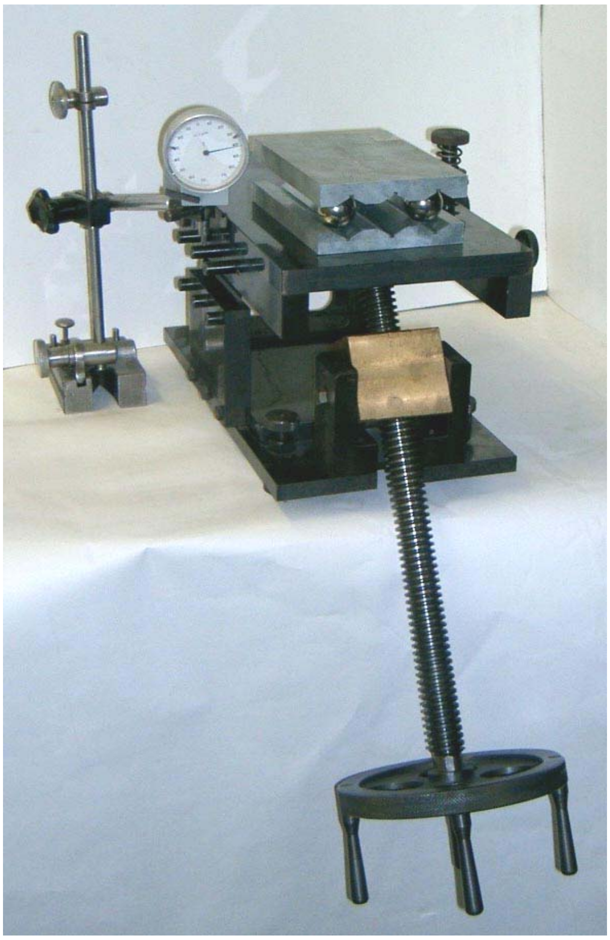

Fig. 1 Tribometer with prisms

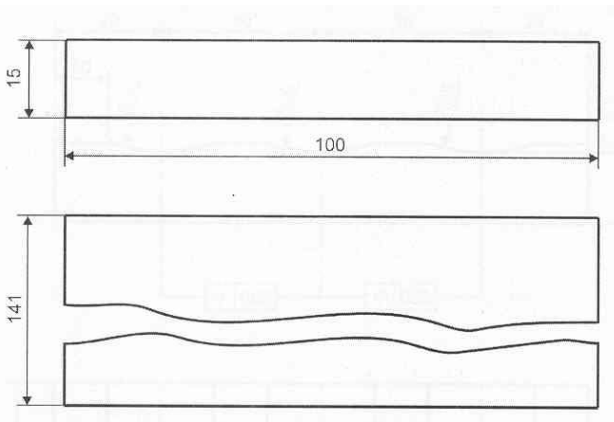

Fig. 2 Plate having both faces perfect plane

Between each of these two plates, different diameter ball bearings are successive disposed.

Every plate becomes alternative fixed plate or mobile plate in the device.

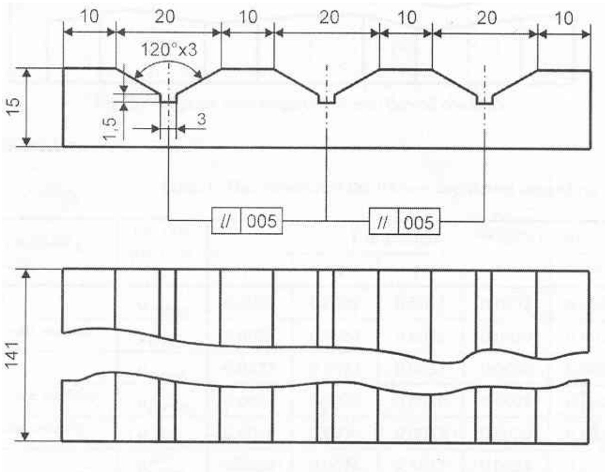

Fig. 3 The plate with trapezoidal and longitudinal channels

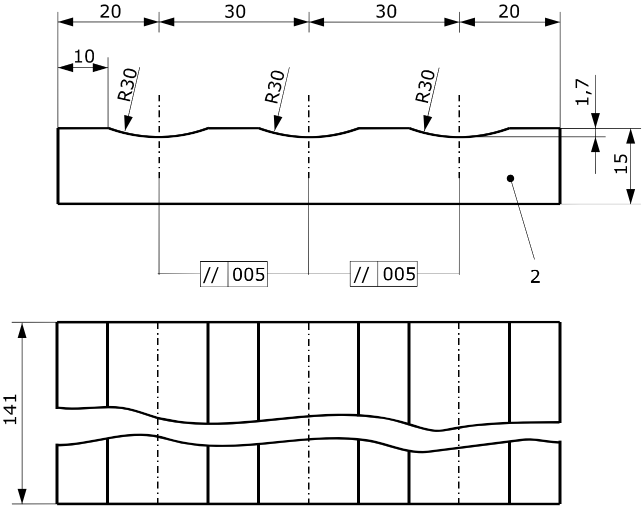

Fig. 4 The plate with longitudinal and curved channels

3. WORK METHODOLOGY

The practical work methodology for friction coefficient determination consists in:

- we verify the apparatus horizontality with a three screws horizontal level device, designated for this job;
- we verify the mobile plate horizontality, using a high precision level;
- we clean up and un-grease the contact zones between plates and balls;

- we clean up and grease the balls, in the situation when we want to have a lubricated bearing;
- we put the ball sliding bearing on the apparatus body;
- we incline the mobile plate using a driving screw, with slow moves and without shocks;
- we stop the driving screw in the moment when the superior plate of the device starts to move;
- we read the value of the L_s length between apparatus pins, with the aid of a comparative watch;
- we read the friction coefficient value from the apparatus table in term of length between pins.

We repeated the process for 9 times. All these measurements must conduct to similar or close friction coefficient values.

We made the average of the values, and so we obtained the global friction coefficient value.

This kind of method it is precise, fast and handy.

4. EXPERIMENTAL RESULTS

For the experimental determinations we used ball sliding bearings formed by the next sets of plates, specially designed:

1. The inferior and superior plates plane (fig. 5).

Fig. 5 The inferior and superior plates plane

2. The inferior plate with 30 mm radius identical trapezoidal channels / plane superior plate (fig. 6);

Fig. 6 The inferior plate with identical trapezoidal channels / plane superior plate

3. The inferior plate with 120º identical trapezoidal channels / plane superior plate (fig 7);

Fig. 7 The inferior plate with identical trapezoidal channels / plane superior plate

4. The inferior and superior plates with 120º identical trapezoidal channels (fig. 8);

Fig. 8 The inferior and superior plates with identical trapezoidal channels

Table 1 Global friction coefficient in term of ball diameter

The type of the sliding bearings	Friction coefficient	The diameter of the balls [mm]							
		8	10	12	16	18	20	22	26
1	$\mu_{average}$	0.0042	0.0025	0.0028	0.0032	0.0032	0.0027	0.0020	0.0016
2	$\mu_{average}$	0.0028	0.0024	0.0026	0.0035	0.0028	0.0024	0.0021	0.0019
3	$\mu_{average}$	0.0028	0.0027	0.0023	0.0030	0.0028	0.0022	0.0017	0.0014
4	$\mu_{average}$	0.0026	0.0023	0.0022	0.0031	0.0030	0.0024	0.0020	0.0025

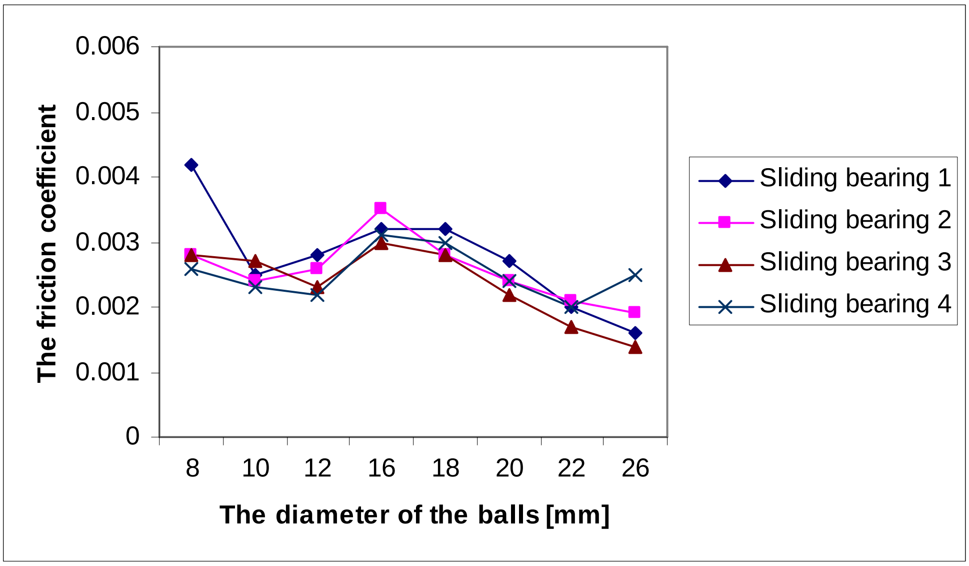

Fig. 9 Friction coefficient variation in term of balls diameters and pathway type

For every different type of ball bearing we used balls with diameters between 8 and 26 mm. For every ball dimension we made 9 measurements, and then we made an average, so we obtained a global friction coefficient value.

In the table 1 there are presented some experimental results realized for the friction coefficients regarding to the balls diameter for the 4 types of bearings. The average values were obtained for 9 determinations.

In the figure 9 it is presented the variation charts for the friction coefficient regarding to the balls diameter used to realize the ball bearings.

5. CONCLUSIONS

After the experimental determinations we observed that the global friction coefficient is affected by channels shapes and by the balls diameter too.

REFERENCES

1. Cozma, R., Bobancu, S., Cioc, V., *Aparate şi dispozitive pentru determinări tribologice,* Editura MATRIX ROM, Bucureşti, 2005.