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STUDIES CONCERNING NEW BALL-BEARINGS HAVING 35 mm THE INNER DIAMETER OF THE INTERNAL RING (part I)

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ABSTRACT
The paper presents some aspects regarding the new construction of ball-bearings with 35 mm the dimension of the inner diameter, providing from the standard construction of the 6305 ball-bearing. Different constructions were obtained using an algorithm, having another internal geometry, other dimensions of the rings and other number of balls, in the way to obtain higher static or dynamic performances/ capacities.
Keywords: 6305 ball-bearing, internal construction, deformations

1. INTRODUCTION
There are papers [1, 2, 3] in which there are presented the possibilities to modify the internal geometry of ball-bearings in the way to obtain high performances (for example - loading capacities) or to increase the inner diameter, for three established dimensions (external diameter D, internal diameter d and the width B).

2. THE BALL-BEARING INTERNAL GEOMETRY
The basic geometric parameters which determine the internal building of a ball-bearing are presented in figure 1, where: D – external diameter; D_1 – external ring collar diameter; d – internal diameter; d_1 – internal ring collar diameter; B – width; E – external ring rolling-way diameter; F – internal ring rolling-way diameter; P_w – primitive disposal diameter of the rolling bodies; D_w – rolling bodies diameter.

The set dimensions of a ball-bearing are d, D and B. Among those there is a space where there are two rings and a number of balls. The thickness of the rings is limited by the technological possibilities. The ideal situation is to have thin rings and many and bigger balls. In this way, the loading capacities (static and dynamic) are bigger than those from the catalogue.

The rolling bodies number comes corresponding to these, number influenced both by P_w and by D_1, D_w, d_1, conditions of the possibilities of device building. The ball diameter D_w and the z number influence directly and most the basic loads (static and dynamic), because they lead to the curve radius modifications in the contact zone [1, 4]. Because of this fact, the ball diameter D_w and the z ball number influence there selves, it is difficult to

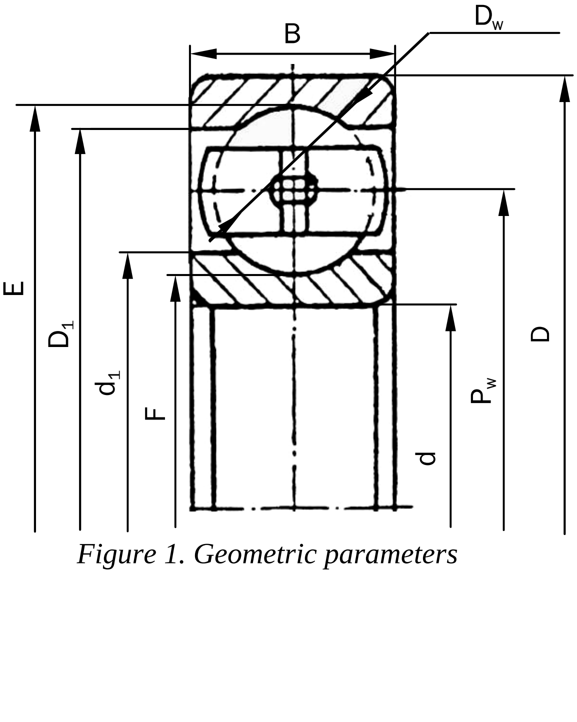

Figure 1. Geometric parameters

establish analytically the ball optimum diameter, but only by means of repeated tests, taking the minimum value, $D_{w\ min}$, or the maximum one, $D_{w\ max}$ with a 0.01 mm precision. Afterwards it is necessary to adopt a normalized value. The ball dimension is superior limited by the resultant dimensions of the rings (external ring thickness) to have ensured a corresponding rigidity, directly related to the technological possibilities of the producer, too. The ball diameter is also correlated with the bearing section width, B, considering the necessary thickness of the cage, the possibility of mounting some security lids.

3. BALL-BEARINGS CONSTRUCTION

Starting from the 6305 ball-bearing catalogue dimensions, using the algorithm presented in literature[1, 2, 4], there where built some other versions named 6305 M1, 6305 M2, 6305 M3 and 6305 M4, having other dimensions of the balls or other number of them. In all of those cases, there are obtained high performances, high loading capacities, static or dynamic.
In the table 1 are presented the obtained versions of ball-bearings and their characteristics.

Table 1. 6305 Ball-bearings' variants

Ball-bearing	D	B	z	D_W	d	h	C_r
6305 URB	62	17	8	10.31817	25	3.44	20.7
6305 M1			8	11		2.8	23.3
6305 M2			8	11.112		2.544	23.7
6305 M3			8	11		2.8	23.3
6305 M4			9	10.3187		1.64	22.4

As it can be seen, the thickness of the rings, h, has a variation between 1.64 mm and 3.44 mm. Technologically, the minimum thickness of the rings can be accepted at 2.5 mm, provided that normal deformations are obtained after the heat treatment.

4. EXPERIMENTAL RESEARCHES

In the cases of the ball-bearings with thin rings, there is very important to determine the deformation correspondent to different radial loading, using a traction-compression testing machine and the ball-bearings mounted.
The 6305 URB, 6305 M2 and 6305 M4 variants were selected for the experimental tests for deformations' determination. For each of these variants, two pieces of ball-bearings were tested both at charging (increasing loading) and at discharging (decreasing loading). The maximum loading force was about 4 kN. The deformations measured are presented in tables 2, 3 and 4 and seen in the figures 2, 3 and 4 which show the graphic representations of these deformations.

Table 2. Deformations for the 6305 URB ball-bearings

6305 URB			Load F [kN]			
			1	2	3	4
Deformation $f \times 10^{-1}$ [mm]	1st Bearing	Charging	3.2	5.8	7.6	10
		Discharging	4	6.1	8	10
	2nd Bearing	Charging	5.8	8	10.2	12.4
		Discharging	6	9	11	12.4

Table 3. Deformations for the 6305 M2 ball-bearings

6305 M2			Load F [kN]			
			1	2	3	4
Deformation $f \times 10^{-1}$ [mm]	1st Bearing	Charging	6.5	13	16	21.2
		Discharging	7.8	14	17	21.2
	2nd Bearing	Charging	4	9	12	16.5
		Discharging	4.8	9.8	13.6	16.5

Table 4. Deformations for the 6305 M4 ball-bearings

6305 M4			Load F [kN]			
			1	2	3	4
Deformation $f \times 10^{-1}$ [mm]	1^{st} Bearing	Charging	1.8	1	20.6	27.2
		Discharging	6	13.5	21.8	27.22
	2^{nd} Bearing	Charging	2.5	7	16.8	24
		Discharging	3.7	8.8	19	24

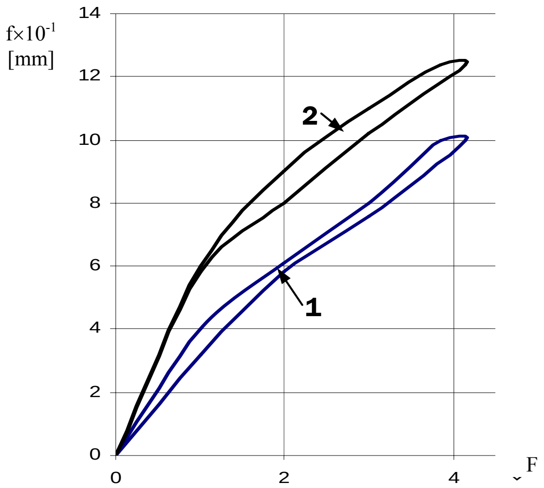

Figure 2. Deformations for the 6305 URB.

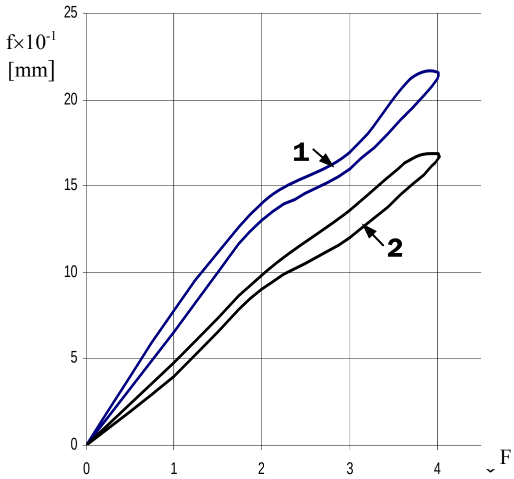

Figure 3. Deformations for the 6305 M2

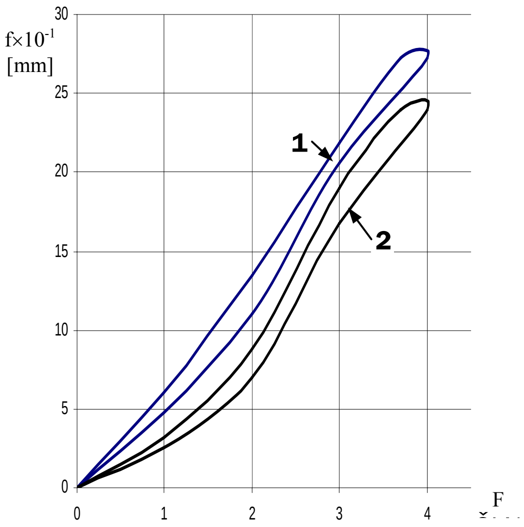

Figure 4. Deformations for the 6305 M4

5. CONCLUSIONS

There are some important conclusions from the experimental researches realized:

- It is a difference among the deformations obtained in all cases at F=4 kN, cause of the elastic deformation of the whole system;
- Deformations are biggest at the ball-bearings which have thinner rings (F=3 kN, $f_{I\_URB}=10.2\times10^{-1}$ mm, $f_{I\_M4}=20.6\times10^{-1}$ mm);
- There are differences between the deformations obtained at the same typo-dimension of the studied bearings (F=3 kN, $f_{I\_M4}=20.6\times10^{-1}$ mm, $f_{II\_M4}=16.8\times10^{-1}$ mm) because of the execution unconformity, the radius of the rolling ways and because of the functional clearance (specific to each ball-bearing);

- There are more emphasized differences, for greater loading values, between the deformations obtained at charging and those obtained at discharging process (F = 3kN, $f_{II\_URB\_charging}$= 10.2×10^{-1} mm, $f_{II\_URB\_discharging}$= 11×10^{-1} mm, $f_{I\_M2\_charging}$= 16×10^{-1} mm, $f_{I\_M2\_discharging}$= 17×10^{-1} mm, $f_{I\_M4\_charging}$= 20.6×10^{-1} mm, $f_{I\_M4\_discharging}$= 21.8×10^{-1} mm) because of the inner frictions, the stabilization of the loading regime between charging and discharging.

6. COPYRIGHT

7. REFERENCES

[1] Săvescu, D., Lateş, M.: Concerning the modelling of the geometry for the 6309 ball bearing (Part I and II). Proceedings of the 2nd International Conference RaDMI 2002, Vol. 2, p. 655-679, Vrnjaka Banja, Yugoslavia.

[2] Săvescu, D.: Theoretical researches concerning ball bearings having 35 mm the inner diameter (Part I and II). The 3rd International Conference RaDMI 2003, p. 1973-1980, Herceg Novi, Serbia and Montenegro.

[3] Săvescu, D. Some aspects regarding the internal construction of ball-bearings and their rigidity. The IXth International Conference on Theory of Machines and Mechanisms, 2004, Liberec, Czeck Republic, p. 689-694.

[4] Săvescu. D. About new constructive variants of ball-bearings used in mechanical constructions. The IXth International Conference on Theory of Machines and Mechanisms, 2004, Liberec, Czeck Republic, p. 695-698.