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CAPACITY OF BALL BEARINGS ANGULAR CONTACT FULL CERAMIC MATRIX COMPOSITE BALL BEARINGS

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***Abstrac**t The ball bearings are universal used . He assume the radial force but and the axial force and compose force (radial and axial). The calculus of the angle of contact and respectively the zone of contact is very importante.*
Full ceramic-matrix composite angular bearings made enterly of ceramic composite /material and are superior to common stell angular contact bearings in many way.
***Keywords**: contact ,angular, ball, bearings, ceramic, composite*

1.INTRODUCTION

The normal tensions whoappears in the interaction between the balls and the rolling way in the case of radial load of the bearing are distributed into an ellipsoidal area.
In fig.1 is presented the ellipsoidal contact area between the ball and the rolling way of inter inner.The major axis is symmetry in the width of rolling way.
In the case of combined load (radial-axial) or pure axial, the ball moves to the board of the rolling way, at a constant angle α , the contact ellipse may be imperfect , respectively the contact tension is maxim to the board of rolling way.

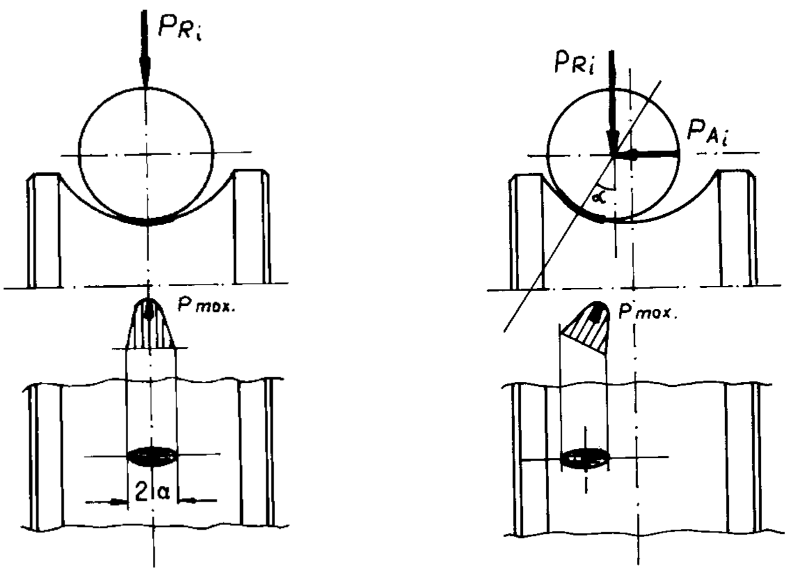

Figure.1 **Figure.2**

The tension in the imperfect contact ellipse are major that in the case of the tension in the contact ellipse at radial load of bearing.
For avoid the appearance of same excessive tensions in the board zone of rolling way is major necessary to calculation the angle of contact α than the major axis of ellipse is perfectly.

2.THE ADMISIBLE ANGLE OF CONTACT CALCULATION

In the case of the problems is:- what major is the α angle than the pressure ellipse are perfect (the major axe rest in the rolling way).
In fig.1 is presented the situation that the radial bearing are loaded with radial load P
In fig.2 the load is P_1+P_2 for the most loaded ball.
For the eccentric contact ellipse do not pass the boarder of the rolling way to be satisfied by the inequality (fig.3)

$$\alpha + \alpha_e \langle \alpha_s \quad (1)$$

$$\cos \alpha_s = \frac{r_b - h}{r_b}$$

$$\sin \alpha_e = \frac{a}{d_b}$$

Respectively the inequality (1) are verify with

$$\alpha + \arcsin \alpha_e \leq ar\cos \alpha_s$$

If not, the contact ellipse pass the board of rolling way and implicit the tension in marginal zone are over-fulfilled.

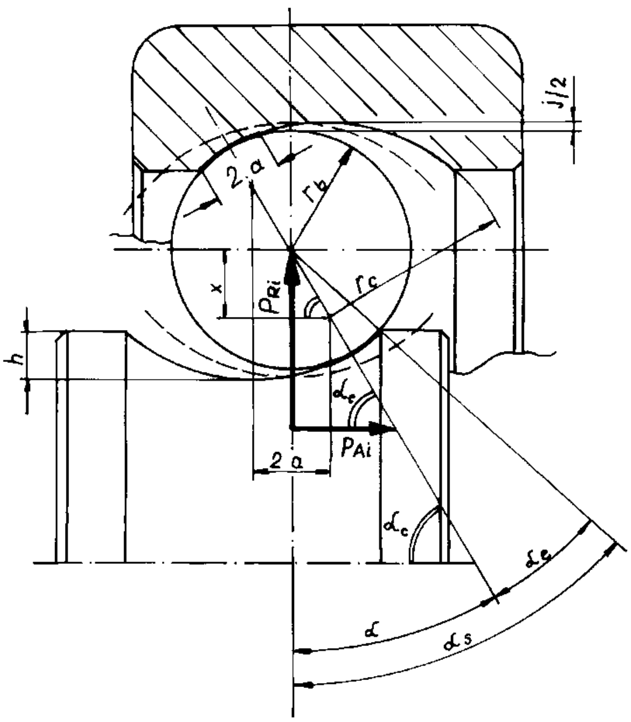

Figure.3

Notation fig.3

i = number of ball

P_R = total radial load

P_A = axial load/ball

r_b = d_b/2-ray ball

r_c = ray of rolling way

a = major axis of contact ellipse

j = diametrical working

h = depth of rolling way just at inner shoulder

α_c = angle between the center of contact ellipse on exterior way

α = angle between the center of contact ellipse with symmetry axis of bearing

α_s = angle between the symmetry axis of inner and the board of rolling way

α_e = angle determined by the center of contact ellipse with the board of rolling way

3. THE CALCULATION OF LIMIT AXIAL LOAD

The relation Hertz-Beliaevpermit the calculation of the axis of the ellipse of contact, elastic deformation and the maximum unitary effort

$$a = 23.6\,10^{-3} a^* \sqrt{\frac{P_i}{\sum \rho}} \text{ [mm]} \tag{2}$$

$$P_i = \sqrt{P_{R_i}^2 + P_{A_i}^2} \text{ [N]}$$

and

$$\sum \rho = (\rho_1 + \rho_2)_I + (\rho_1 + \rho_2)_{II} \textit{ [1/mm]}$$

- ρ_1 and ρ_2 are the curvatures of the ball in the planes I and II , respective the minim invers value of curvatures rays
- a^* parameter of function F(ρ) –the parameter a^* is done by diagram (fig.5)

$$tg\,\alpha_e = \frac{P_{R_i}}{P_{A_i}} = \frac{x}{a} \tag{2}$$

$$x^2 + a^2 = (r_c - r_a)^2$$

$$P_{A_i} = P_{R_i} \frac{a}{x} = \frac{P_R}{i} \frac{a}{x}$$

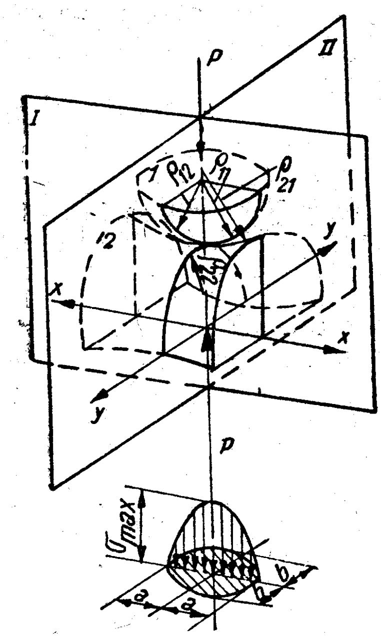

Figure.4

For the most loaded ball we have:

$$P_A = \frac{P_{A_i}}{i} \; and \; P_R = \frac{5P_{R_i}}{i}$$

-and from (2) result

$$x = \sqrt{(r_c - r_b)^2 - a^2}$$

$$P_{A_{lm}} = P_{A_i} i = \frac{5P_R a}{\sqrt{(r_c - r_a)^2 - a^2}}$$

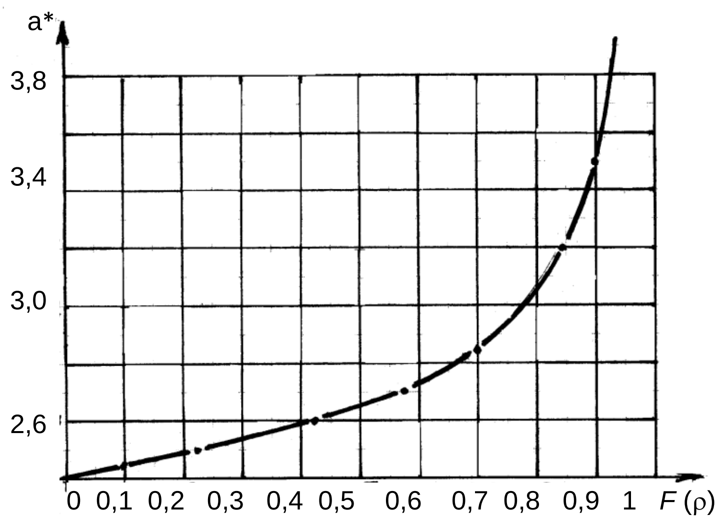

Figure.5

In the case of ball bearings (one road), the limit axial load depend by measure of dynamic equivalent radial load P_R, the measure of major axis of contact ellipse (a) , geometry
Of ball and rolling way, materials, etc.

4. ANGULAR CONTACT FULL CERAMIC MATRIX COMPOSITES (CMCS) BEARINGS

Full Ceramic Angular Contact Ball Bearings are made entirely of ceramic material and are superior to common Steel Angular Contact Bearings in many ways. Ceramic is the perfect material for any application seeking to achieve higher RPM's, reduce overall weight or for extremely harsh environments where high temperatures and corrosive substances are present. Applications such as cryopumps, medical devices, semiconductors, machine tools, turbine flow meters, food processing equipment, robotics and optics. Ceramic materials commonly used for angular contact bearings are Silicon Nitride (Si_3N_4), Zirconia Oxide (ZrO_2), Alumina Oxide (Al_2O_3) or Silicon Carbide (SiC.)

Because ceramic is a glass like surface it has an extremely low coefficient of friction and is ideal for applications seeking to reduce friction. Ceramic balls require less lubricant and have a greater hardness than steel balls which will contribute to increased bearing life. Thermal properties are better than steel balls resulting in less heat generation at high speeds. Full Ceramic bearings can have a retainer or full complement of balls, retainer materials used are PEEk and PTFE.

Full Ceramic Angular Contact Bearings can continue to operate under extremely high temperatures and are capable of operating up to 1800 Deg. F. Ceramic is much lighter than steel and many bearings are 1/3 the weight of a comparable steel bearing. Full ceramic bearings are highly corrosion resistant and will stand up to most common acids, they will not corrode in exposure to water or salt water. And finally full ceramic bearings are non-conductive.

Full Ceramic Angular Contact Bearings are designed such that there is an angle between the races and the balls when the bearing is in operation. An axial load passes in a straight line through the bearing, whereas a radial load takes an oblique path that tends to want to separate the races axially. So the angle of contact on the inner race is the same as that on the outer race. Full Ceramic Angular Contact Bearings are typically assembled with a thrust load or preload. The preload creates a contact angle between the inner race, the ball and the outer race. The preload can be done while manufacturing the bearing or it can be done when the bearing is inserted into an application.

The contact angle is measured relative to a line running perpendicular to the bearing axis. Full Ceramic Angular Contact Bearings are capable of withstanding heavy thrust loads and moderate radial loads. The larger the contact angle (typically in the range 10 to 45 degrees), the higher the axial load supported, but the lower the radial load. In high speed applications, such as turbines, jet engines, dentistry equipment, the centrifugal forces generated by the balls will change the contact angle at the inner and outer race.

Ceramix-matrix composites (CMCS) comprise a ceramic matrix reinforced by a refrectory fiber, such as silicon carbide (SIC) fiber. CMCS offer low density, high hardness and superior thermal and chemical resistance,

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