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ANALYSIS OF CONTACT PRESSURE FOR INNER AND OUTER RACE OF BALL BEARING 6004

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ABSTRACT

In the contact analysis of ball bearing Hertzian contact theory is used. Using this theory maximum contact pressure is found for different load. And similarly for different material. This analysis is done for inner race and outer race of ball bearing. And results are compared for inner race and outer race. Same analysis is done on finite element analysis. Both FEA results and analytic results are compared. And both result match.

KEYWORDS- Hertzian contact pressure, FEA analysis deep groove ball bearing, inner race, and ball.

I. INTRODUCTION

Ball bearings are widely used in industry, machines, and aerospace and in many applications. Like nuclear reactor. It is risk to for a application if there is any failure. So bearing should operate without failure. If bearing fails so there is power loss ultimately there is loss.

The Lundberg-Palmgren theory considers the inverse of a 9th power relation between Hertz stress and fatigue life for ball bearings. The effect of race conformity on ball set life independent of race life is not incorporated into the Lundberg-Palmgren theory. It is concluded that, the actual bearing fatigue life is usually equal to or greater than that calculated using the ANSI/ABMA and ISO standards that incorporate the Lundberg- Palmgren theory, [1].Two simple algebraic relationships were established to calculate life factors to determine the effect of inner and outer race conformity combinations on bearing life for deep groove and angular contact ball bearings. Deep groove ball bearing's structure is simple and is widely applied. Its main failure mode is contact fatigue sapling of rolling elements The contact finite element analysis can show bearings' information under contact, such as contact stress, strain, penetration and sliding distance, and so on, which play a significant role in optimum design of complicated rolling bearings. Contact is a complex nonlinear phenomenon [3]. Engineering machinery frequently relies on the integrity of components with interacting surfaces such as gears, bearings, or cams. Loads are often supported on a small surface area of the component. Contact pressures and stresses therefore tend to be high. The engineer needs to design the component to withstand these high contact stresses. Excessive contact stress or deformation can lead to component failure by Overload - components yield or fracture from excessive contact loading. [6]. any time there is a radius in contact with another radius contact stresses will occur. In the case of two spheres contacting each other, the entire force will be imparted into a theoretical point. Due to elastic properties of the materials this point will deform to a contact area. The deformation that occurs will produce high tensile and compressive stresses in the materials. Even if a singular loading does not produce a failure, it can lead to future fatigue or surface damage Engineering machinery frequently relies on the integrity of components with interacting surfaces such as gears, bearings, or cams.
Loads are often supported on a small surface area of the component. Contact pressures and stresses therefore tend to be high. The engineer needs to design the component to withstand these high contact stresses. Excessive contact Stress or deformation can lead to component failure by Overload - components yield or fracture from excessive Contact loading. [2].

II. CONTACT PRESSURE ANALYSIS FOR INNER RACE

Nomenclature

ν1, ν2 : Poisson's ratio for ball and race
E1, E2 : young's modulus for ball and race in (Mpa)
P : Maximum acting load in (N)
Pmax : Maximum contact pressure in (Mpa)
a : semi-major axis of contact ellipse in (mm)
b : semi-minor axis of contact ellipse in (mm)

Table 1. Ball bearing material used in analysis.

Parameter	symbol	value	unit
young's modulus for ball	E_1	210	Gpa
young's modulus for race	E_2	210	Gpa
Poisson ratio for ball	ν_1	.29	
Poisson ratio for race	ν_2	.29	

III. METHDOLOGY

Maximum pressure (Pmax) at the centre of ellipsoidal contact area is calculated by Hertzian Elliptical contact theory using different loads (W) whose results given in Table 2.

Table 2.Results: Load and Pmax

Load (N)	Pmax (Mpa)
800	1720
1000	2139
1200	2274

- Analytical results are compared with finite element analysis of ball bearing. The 3–dimensional modelling has been done through pro-e. The commercial software ANSYS workbench used as a FEA tool in this analysis work.

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IV. FEA ANALYSIS

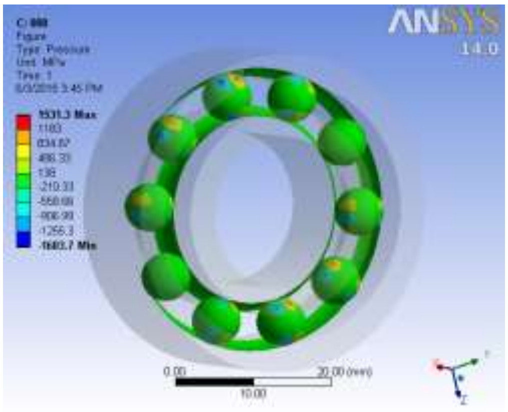

Fig.1. Result : Pressure AT 800 N

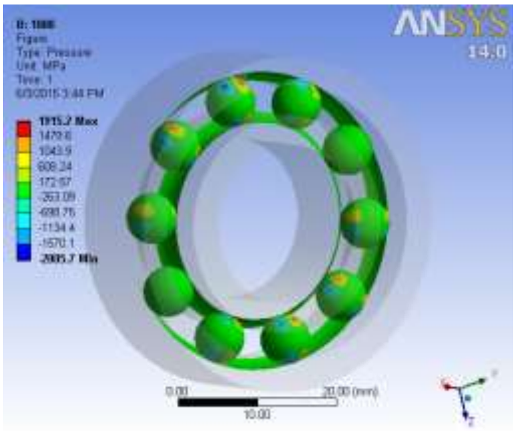

Fig.2. Result : Pressure AT 1000 N

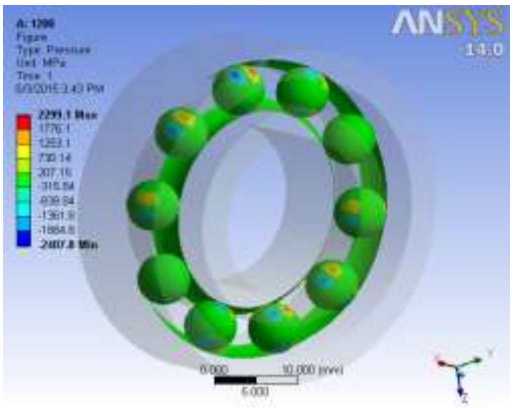

Fig.3. Result : Pressure AT 1200N

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ANALYSIS ON ALUMINIUM ALLOY (Cao.Al_2o_3)

Material Property: (E = 100 Mpa ν = 0.25)

***Table 3.*RESULT: Load to Pmax**

Load in (N)	Pmax in (Mpa)
800	1190
1000	1310
1200	1392

I. Contact pressure analysis for outer race

Table 4.Result: Load to Pmax (For steel)

Load in (N)	Pmax in (Mpa)
800	1650
1000	2071
1200	2201

Table 5. Result: Load to Pmax (For Aluminium alloy)

Load in (N)	Pmax in (Mpa)
800	1150
1000	1268
1200	1348

II. Results

Contact pressure for inner race and outer race is determined and compared with FEA.

Table 6.Comparison of result for steel

Load in (N)	Pmax in (Mpa) for inner race	Pmax in (Mpa) for outer race
800	1720	1650
1000	2139	2071
1200	2274	2201

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Table 7.Similarly for aluminium alloy

Load in (N)	Pmax in (Mpa) for inner race	Pmax in (Mpa) for outer race
800	1190	1150
1000	1310	1268
1200	1392	1348

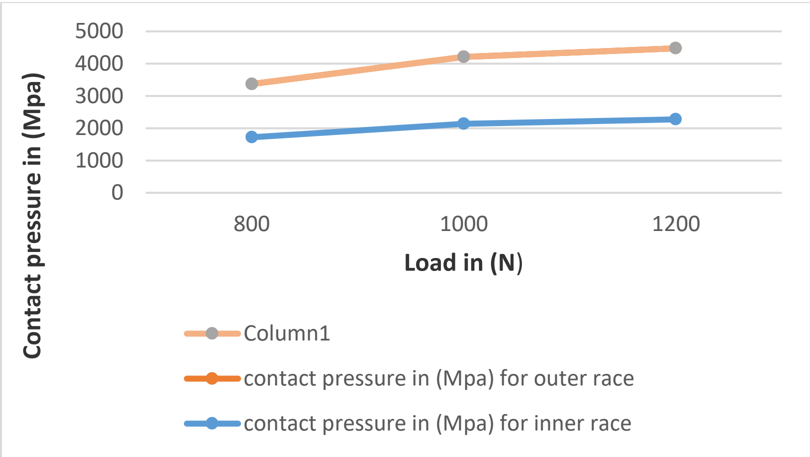

Fig.4. Graph for Steel between inner and outer race

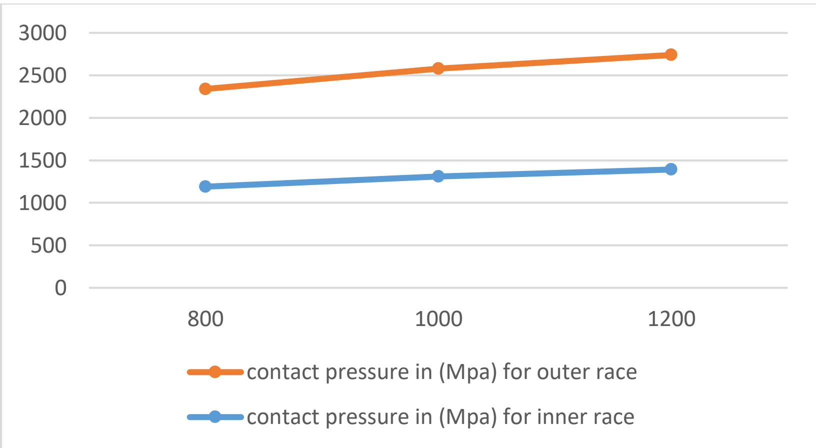

Fig.5. Graph for Aluminium alloy between inner and outer race

V. CONCLUSION

Contact pressure for both inner race and outer race is determined. Contact pressure is directly proportional to contact area and inversely proportional to young modulus and Poisson ratio. By proper material combination we can lower maximum pressure.

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