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Analysis of Single Row Deep Groove Ball Bearing

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***Abstract:* With the increased usage and the increased sophistication mechanical design came to necessity to predict their endurance capability. In this project an effort has been put to analyze the ball bearing using finite element analysis the stress level or displacement behavior of ball bearing. The main target is to find the most influencing parameters for radial stiffness of the bearing under an axial load. All the result based on one specific single row deep groove ball bearing with the outer diameter 170 mm and inner diameter 80 mm and ball diameter 28.575 mm. They are used to support load and allow relative motion inherent in the mechanism to take place. By this analysis we can analyze the life span of bearing, rejection rate and productivity of bearing. We can do static and dynamic analysis**

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***.Keywords:* ball bearing, finite element analysis, life span, rejection rate, productivity, static and dynamic analysis**

1. INTRODUCTION

The main objective of bearing is to provide relative positioning and rotational freedom while transmitting a load between two parts. From the mechanical designer's point of view the study of antifriction bearings differs in several respects when compared with the study of other topics because the bearings they specify have already been designed. The specialist in antifriction bearing design is confronted with the problem of designing a group of elements that composes a rolling bearing, these elements must be designed to fit into a space whose dimensions are specified, they must be designed to receive a load having certain characteristics, and finally these elements must be designed to have a satisfactory life when operated under the specified conditions. Bearing specialist must therefore consider such matters as fatigue loading, friction, heat, corrosion resistance, kinematic problems, material properties, lubrication, machiningtolerance, assembly, use, and cost. From a consideration of all these factors,bearing specialists arrive at a compromise that in their judgement, is a good solution to the problem as started.

1.2 OBJECTIVES

Selection of Bearing, the analysis of selected bearing has been done, validation of that analysis by experimental method, the modification of design by changing the parameter of bearing, again the analysis will be done with modified parameter, both results will be compared, the conclusion is that we can increase lifespan of bearing.

From the related thesis and research papers the literature review is done.The evolution of performance is done in which the lifespan of bearing is calculated. The geometric model of bearing is made. Static Analysis and Dynamic Analysis of this bearing is done.

Here, ANSYS Software is used for finite element analysis of single row deep groove ball bearing. ANSYS calculates stress distribution across the bearing element. The aim of this research is to identify the deformation and life span of the bearing.

2. LITERATURE REVIEW

Static behavior and life of ball bearing, theoretical basis for the determination of deformation, stiffness and change the contact angle and life of ball bearings with angular contact has shown in the research paper.

In this study the static analysis of an angular contact ball bearing using Finite Element Method is investigated. The main goal is to find the most important influencing parameters for radial stiffness of the bearing under an axial load.

The influence of bearing clearance on the contact force of raceway was researched. This was realized by building the static model considering clearance of the bearing firstly; then the internal loads distribution of the bearing was obtained by solving this static problems.The coating applied to critical surfaces of the rollers of bearing can increase the fatigue life can provide resistance to the adhesive wear responsible for false brinelling and fretting and can reduce torque losses.the radial and axial vibrations of rigid shaft supported ball bearings are studied. In the analytical formulation the contacts between the balls and the races are considered as nonlinear springs, whose stiffness are obtained by using the Hertzian elastic contact deformation theory.

The analysis reported herein considers the life of the ball set as well as the respective lives of the races and to reassess the effect of ball-race conformity on ball bearing life. Two simple algebraic relationships that incorporated ball set life were established to calculate life factors (*LFc*) incorporating ball set life to determine the effect inner- and outer-race conformity combinations have on bearing *L*10 life for deep-groove and angular-contact ball bearings, respectively.

Halving the cycle time of a machining process can be very challenging and demands a thorough analysis in order to find potential areas for optimization. The requirement set by the customer to have carbonitrided the inner ring of the analyzed ball bearing put the focus on two main processes, the first obviously being the carbonitriding treatment and the second the groove grinding process which features in case of carbonitrided rings double the time than for through hardened ones.

3. Design of Single Row Deep Groove Ball Bearing

Inner diameter = 80 mm
Outer diameter = 170 mm

Thickness = 39 mm

Ball size = 28.575 mm

No of Balls = 8

Inner groove radius = 14.644 mm

Outer groove radius = 14.787 mm

X = 0.56
Y = 1
F_r= 3000 N
F_a= 4440 N
b_m= 1.3
f_c= 56
i = 1
D_w= 28.575 mm

C_r = Basic dynamic radial load rating, in newtons

F_r = Bearing radial load, in newtons

F_a= Bearing axial load, in newtons

L_{10} = Basic rating life, in million revolutions

L_H = Basic rating life, in hours

P_r = Dynamic equivalent load, in newtons

X = Dynamic radial load factor

Y = Dynamic axial load factor

b_m= rating factor for contemporary, normally used material and manufacturing quality, the value of which varies with bearing type and design
e = limiting value of F_a/F_r for the applicability of different values of factor X and Y
f_c= factor which depends on the geometry of the bearing components, the accuracy to which the the various components are made
i = Number of rows of balls in a bearing
α = nominal contact angle of bearing, in degrees

3.1Physical data
Density- 0.283 lbs/in^3
Specific Gravity - 7.83
Modulus of Elasticity Tension - 21×10^4 N/mm^2

3.2 Evolution of Performance

$P_r = XF_r + YF_a$
$= (0.56)*(3000) + (1)*(4440)$
$= 1680 + 4440$
$= 6120$ N

$C_r = 3.647*bm*fc*(i\cos\alpha)^{0.7}*(z)^{(2/3)}*(D_w)^{1.4}$
$= 3.647(1.3)*(56)*(0.98)*(4.02)*(110.33)$
$= 115401.88$ N
$L_{10} = (C_r/P_r)^K$
$= (115401.88/6120)^3$
$= (18.85)^3$
$= 6704.76$
$L_H = L*10^6/(60*N)$
$= 6704.76*10^6/(60*3500)$
$= 31927.44$

4. RESULTS AND DISCUSSION

4.1 Static Analysis

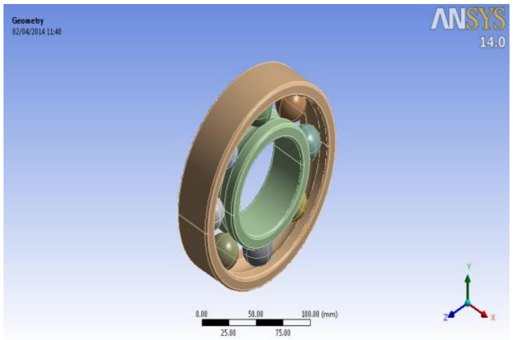

Fig 4.1 Geometry of the model

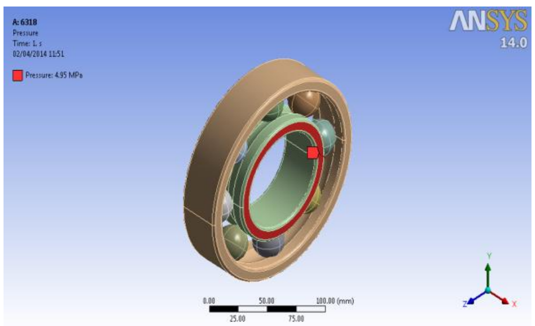

Fig 4.2 Pressure load

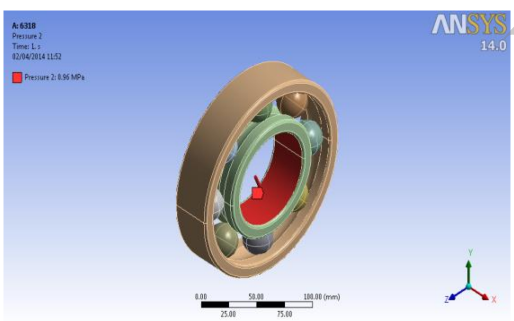

Fig 4.3 Radial load

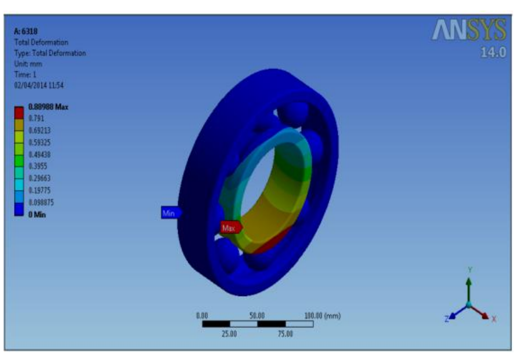

Fig 4.4 Total deformation

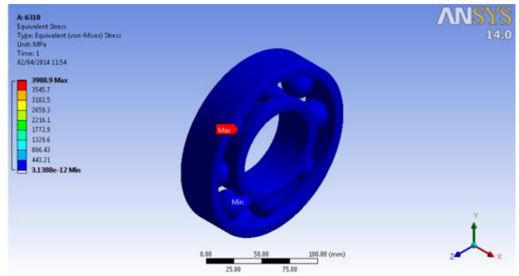

Fig 4.5 Equivalent (von-Mises) stress

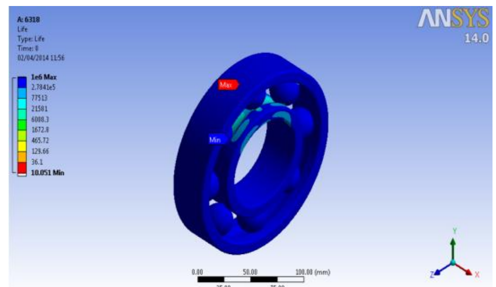

Fig 4.6 Fatigue life of bearing

4.2 Dynamic Analysis

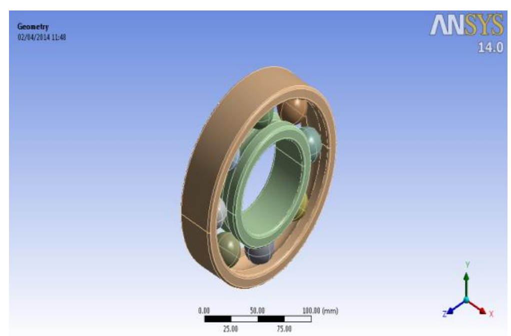

Fig 4.7 Geometry of the model

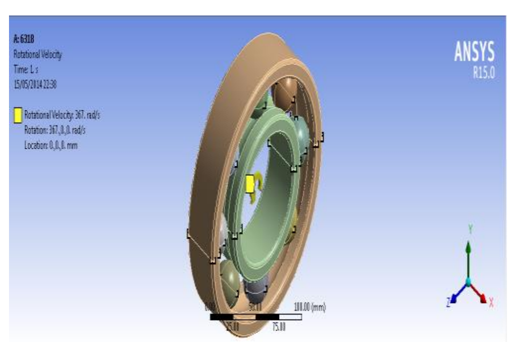

Fig 4.8 Model after applying rotational velocity

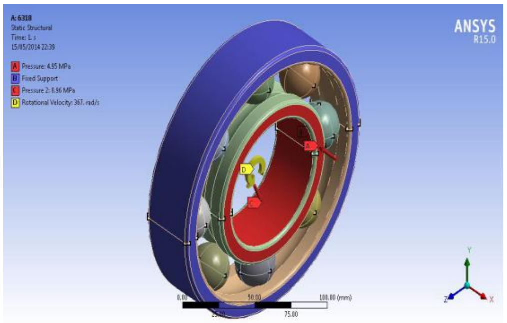

Fig 4.9 Radial Load, Axial Load, Rotational Velocity and fixed support

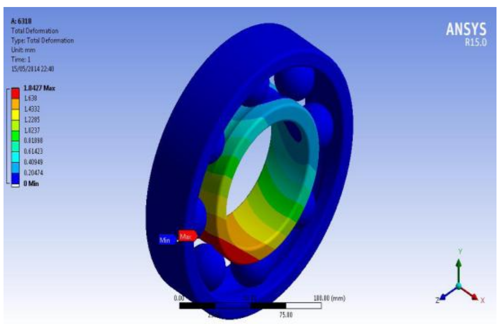

Fig 4.10Total Deformation

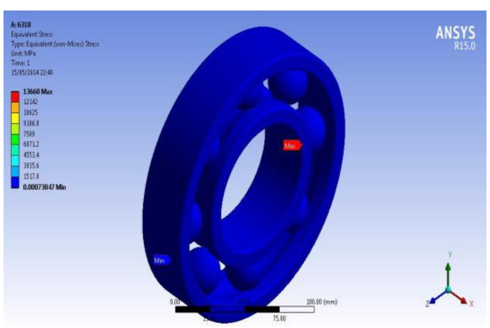

Fig 4.11 Equivalent (von-Mises) stress

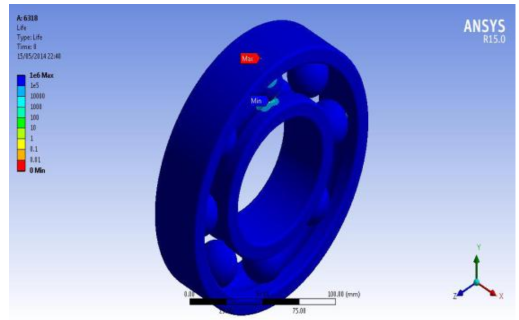

Fig 4.12 Fatigue life of Bearing

5. CONCLUSION

In the previous chapter static analysis and dynamic analysis is shown. From that we can conclude that the deformation of this bearing in static condition is 0.88 mm and the maximum stress generated in static condition is 3988 Mpa. While the deformation of this bearing in dynamic condition is around 1.9 mm and maximum stress generated is 13660 Mpa. The life of bearing we get is in the multiple of 10^6. So we can conclude that our bearing is safe against the radial and axial load which is applied at static and dynamic condition.

6. FUTURE SCOPES

In future we can replace this single row deep groove ball bearing 6316 with another single row deep groove ball bearing whose load carrying capacity is more than this bearing. There are certain parameters due to change of that this load carrying capacity is increased and deformation may be reduced. Also we can increase the lifespan of the bearing.

7. REFERENCES

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