DESIGN OF BEARING USING HYBRID ALUMINIUM METAL MATRIX COMPOSITE

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Abstract—*In this project work an effort has been taken to study bearing failures. It has been noticed that frequent failures occurs due to improper material selection, corrosion, fatigue, poor design etc. Work was carried out to change Clearance ratio and redesign of inner and outer bearing ring dimensions. This result in increase of life and work efficiency. Also suitable material was chosen and a new design of material was made. The material chosen was hybrid Aluminium metal matrix composite reinforced with Aluminium oxide (Al2O3) and silicon carbide (SiC). The metal matrix was Aluminium 6061. This results in considerable reduction of weight and wear. Also due to Aluminium matrix high amount of corrosive resistance property is achieved. This new design enables less weight high mechanical property and tribological properties. Modelling has been done in CATIA v5.Simulation results were carried out in ANSYS 12.0.*

1. INTRODUCTION

Moving parts in machinery involve relative sliding or rolling motion. Examples of relative motion are linear sliding motion, such as in machine tools, and rotation motion, such as in motor vehicle wheels. Most bearings are used to support rotating shafts in machines.

2. LITERATURE REVIEW

The necessity for engineering materials with the technological importance for the areas of aerospace and land vehicles has led to a rapid development of composite materials. Composites have an edge over monolithic materials because of their unique properties such as high specific strength and stiffness, increased wear resistance, corrosion resistance, strength-to-weight, strength-to-cost, enhanced temperature performance together with better thermal and fatigue and creep resistance. Metal matrix composites are one of the main innovations in the development of advanced materials. Among

the different matrix materials available, aluminium and its alloys are widely utilized in the fabrication of MMCs and have reached the industrial production stage. Aluminium based composite reinforced by hard ceramic particles have become more and more attractive in the research of structural composites. The addition of ceramic particles like SiC, Al2O3, B4C to an aluminium based matrix does not considerably change the density of significant rise in strength and modulus of composite.

3. EXSISTING MATERIAL

Stain Less Steel AISI 44OC (1.1% C, 17% Cr, 0.75% Mn ,1% Si,0.75% Mo)

PROPERTIES

Properties	value
Density (1000 kg/m3)	7.75-8.1
Elastic Modulus (GPa)	190-210
Melting Point (°C)	1371-1454
Tensile Strength (MPa)	515-827
Yield Strength (MPa)	207-552
Percent Elongation (%)	12-40
Hardness (Brinell 3000kg)	137-595
Poisson's Ratio	0.27-0.3
Thermal Conductivity (W/m-K)	11.2-36.7

4. REPLACE MATERIAL

Aluminum metal matrix composite reinforced with Al2O3 & SIC (90% Al, 3% Al2O3, 7% SIC)

PROPERTIES

- Low density.
- High strength.
- Low thermal expansion.
- High hardness.
- High elastic module.
- High stiffness.

A. *Properties of Silicon Carbide*

Properties	value
Density gm/cc (lb/ft^3)	3.1
Flexural Strength (Mpa)	550
Elastic Modulus (Gpa)	410
Poisson's Ratio	0.14
Compressive Strength (Mpa)	3900
Hardness (Kg/mm^2) Fracture Toughness K_{IC} (MPam$^{1/2}$)	2800 4.6
Maximum Use Temperature (no load)(°C (°F))	1650
Thermal Conductivity(W/m°K)	120
Specific Heat (J/Kg°K)	750

B. Aluminium Oxide properties

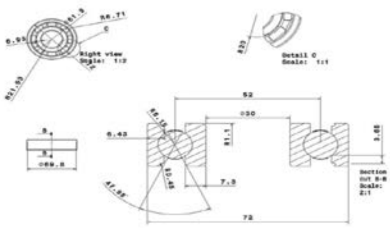
Properties	value
Density gm/cc (lb/ft^3)	3.89
Flexural Strength (Mpa)	379
Elastic Modulus (Gpa)	375
Poisson's Ratio	0.22
Compressive Strength (Mpa)	2600
Hardness (Kg/mm^2) Fracture Toughness K_{IC} (MPam$^{1/2}$)	1440 4
Maximum Use Temperature (no load)(°C (°F))	1750
Thermal Conductivity(W/m°K)	85
Specific Heat (J/Kg°K)	880

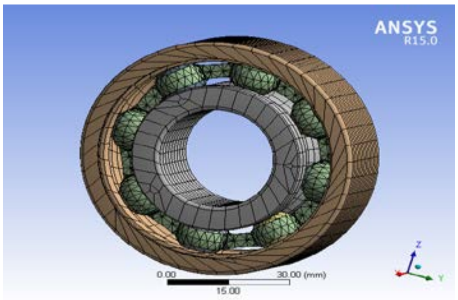
5. DESIGN CALCULATION

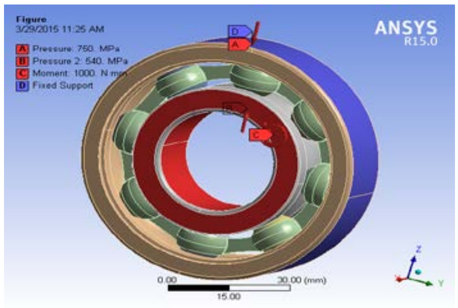
Inner ring diameter : 30mm
Outer ring diameter : 72mm
Ball diameter : 12.30mm
Inner ring thickness : 7.3mm
Outer ring thickness : 6.43mm
1/Rin=1/R roller +1/Rinner raceway
=1/0.00615 +1/0.019
=0.004646m
1/Rout=1/Rroller-1/Router raceway
=1/0.00615+1/0.0033
=0.00755m
Wmax=4Wbearing / n
=4×8000/14
=2285.714 N
Eeq = E/1-v²
= 819.2Gpa

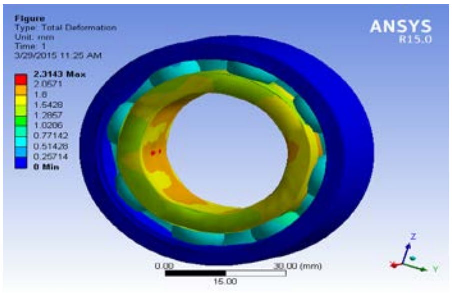
Maximum force inner ring; W= Wmax/Eeq ×Rxin×L =0.000185 Maximum force outer ring; W=Wmax/Eeq×Rout×L =0.000369 Maximum pressure inner ring; Pmax in=Eeq(w/2л)½ =0.445Gpa Maximum pressure outer ring; Pmax outer=Eeq(w/2л)½ =0.253Gpa

6. DESIGN OF BEARING

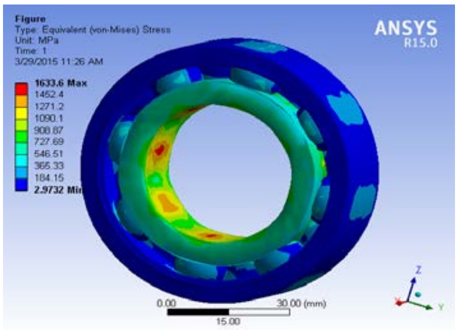




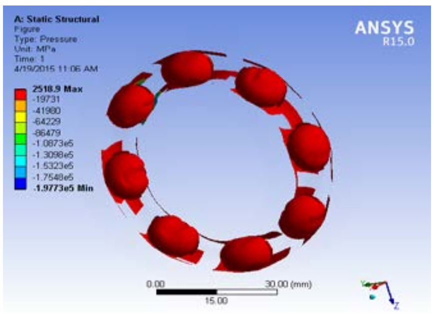




7. ANALYSIS OF STRAIN



8. APPLIED PRESSURE IN BEARING



9. ANALYSIS OF RESULTS

The analysis of metal matrix composites which gives the maximum values of stress, strain, total deformation and contact region and compared to existing material which gives high strength to weight ratio.

TABLE COMPARISON OF ANALYSIS RESULTS

Types of analysis	Minimum value	Maximum value
Stress (Mpa)	2.9732	1633.6
Strain (Mpa)	0.0009334	0.25264
Total deformation (Mpa)	0	2.3143
Contact region (Mpa)	0.19773	2518.9

10. CONCLUSION

Compared to the existing material with metal matrix composites which reduces the 30% percent of material weight and reduces the wear rate. While using a metal matrix composite which gives good shear strength and bending strength and increase the material life.

It gives good stability and good stiffness and less deformation of bearings. Metal matrix composites bearings are less wear and good corrosive resistance.

Using of solid lubrication it reduces the friction and also avoid the noise operation.

It resists high temperatures. The analysis result gives maximum values of stress, contact, strain, deformation which has more

It has good impact strength and more hardness. accurate value compared to existing material. It increases the life and service life of material.

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