

Investigation of Safe Load of Aluminium Alloy Bearing Material Experimentally and Comparing it with that of Ansys

Durairaj S

Department of Mechanical Engineering, Mailam Engineering College, Mailam, Tamilnadu, India

ABSTRACT : A bearing is a machine element used to constrain relative motion and reduces friction between moving parts with necessary lubrication provided. Bi-metal aluminium bearing manufacturers say their products offer long-term durability, dry-start protection, resistance to debris, corrosion resistance and dimensional accuracy for stock and light duty, as well as performance and racing, applications. The main objective of the work is to determine the safe load and seizure load of the Aluminium alloy Bearing material using Thrust type seizure testing machine and to determine the stress for the safe load of the same material using ANSYS, under same operating condition and then, finally to compare the experimental result with ANSYS result.

KEYWORDS - Bearings, Machine components, Computer simulation, Materials testing, CAD/CAM

I. INTRODUCTION

Almost all latest model passenger car and light truck engines in domestic and Asian vehicles are now equipped with bi-metal aluminium alloy rod and main bearings as original equipment. As the bearings are alloys, manufacturers say the bearings are able to maintain their properties throughout their entire depth, resulting in consistent, reliable performance.

Aluminium, on the other hand, has a higher temperature rating than copper/lead. The melting point of a typical aluminium bearing alloy is over 1,100° F. This provides added protection against localized overheating due to detonation, overloading, misalignment and similar conditions.



Figure 1. Bearing Material



Figure 2. Seizure testing machine

Our work was experimented in a bearing manufacturing company in Coimbatore where it is expertise in producing high quality bearing for auto mobile companies. Our work is based on experimenting on 3 bearing samples and compare the results of experimentation with that of analysis software and exactness of result between the two. We found out that the result found out was almost closer to that of experimentation and the analysis software was a reliable solution under our testing conditions.

A. Properties Required for Bearing material

The following are the properties required for a bearing material.

- Compressive strength Fatigue strength Conformability
- Embeddability
- Bonding

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- Corrosion resistance
- Thermal conductivity
- Seizure resistance – surface action

II. EXPERIMENTAL PROCEDURE

Seizure resistance is the most important property of Engine bearing material. Normally seizure occurs during oil film squeeze under extreme load condition during operation. So, determination of seizure load will help in determining the rated load carrying capacity of the bearing material.

The experimental procedure is as follows:

- Seizure Resistance can be determined under increasing loads over a period of time at a constant speed
- Standard Rectangular Specimen are made out of Aluminium bearing material to be Tested.
- Specimen is kept stationary and is submerged in heated circulating oil

III. TABULATION AND CALCULATIONS

Tabulation and calculations of 3 bearing samples are obtained and bearing 1 alone is tabulated for example.

A. Calculation of Bearing Sample 1

Ring Area (πDT) = 172.732 mm²

Slot Area (4WL) = 38.624 mm²

Effective Area = Ring – Slot = 172.732 - 38.624 (in mm²)
= 1.341 cm²

Seizure load = 208.79 kg/cm²

Safe load = 20 Mega Pascal

B. Tabulation of Bearing Sample 1

LOAD (kg)	TIME(min)	FRICTION FORCE(N)	
0	0-5	0	0
20	5-10	14	14
40	10-15	27	24
60	15-20	32	39

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80	20-25	44	38
100	25-30	50	25
120	30-35	53	45
140	35-40	45	27
160	40-45	32	34
180	45-50	36	45
200	50-55	34	29
220	55-60	30	67
240	60-65	80	155
260	65-70	170	178
280	70-75	185	225

Table 1. Finding seizure load for bearing material sample 1

C. Calculation of Bearing Sample 2

$$\text{Ring Area (I} \pi \text{DT)} = 120.166 \text{ mm}^2$$

$$\text{Slot Area (4WL)} = 30.6 \text{ mm}^2$$

$$\begin{aligned} \text{Effective Area} &= \text{Ring} - \text{Slot} = 120.166 - 30.6 \text{ (in mm}^2\text{)} \\ &= .9056 \text{ cm}^2 \end{aligned}$$

$$\text{Seizure load} = 446.62 \text{ kg/cm}^2$$

$$\text{Safe load} = 42 \text{ Mega Pascal}$$

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D. Tabulation of Bearing Sample 2

LOAD (kg)	TIME	FRICTION FORCE	
0	0-5	0	0
20	5-10	10	10
40	10-15	17	16
60	15-20	24	28
80	20-25	34	27
100	25-30	31	26
120	30-35	29	25
140	35-40	26	24
160	40-45	27	25
180	45-50	28	24
200	50-55	28	25
220	55-60	29	29
240	60-65	31	29
260	65-70	32	30
280	70-75	32	31
300	75-80	33	32
320	80-85	35	33
340	85-90	36	37
360	90-95	38	39
380	95- 100	32	40
400	100- 105	41	75

Table 2. Finding seizure load for bearing material sample 2

E. Calculation of Bearing Sample 3

Ring Area (πDT) = 172.732 mm²

Slot Area (4WL) = 38.624 mm²

Effective Area= Ring – Slot = 172.732-38.624 (in mm²)
= 1.341 cm²

Seizure load= 283.37 kg/cm²

Safe load = 26 Mega Pascal

F. Tabulation of Bearing Sample 3

LOAD(kg)	TIME(min)	FRICTION FORCE(N)	
0	0-5	0	0
20	5-10	11	8
40	10-15	22	23
60	15-20	23	40
80	20-25	43	44
100	25-30	48	59
120	30-35	55	56
140	35-40	60	67
160	40-45	73	78
180	45-50	85	50
200	50-55	59	48
220	55-60	58	40
240	60-65	55	52
260	65-70	53	52
280	70-75	61	60
300	75-80	61	50

320	80-85	52	54
340	85-90	55	50
360	90-95	54	80
380	95-100	82	125

IV. COMPUTER SIMULATIONS

In this project work, ANSYS 8.0 software has been used to find the maximum stress occurs in the bearing material. A non linear contact analysis is carried out to separate the work piece and shaft to find the stress distribution in the contact element. One of the major engineering materials namely aluminium alloy bearing material was taken for analysis. Material properties of aluminium alloy bearing are: Viscosity of the oil (0.3534 N*s/m^2) and Specific Gravity of the oil (0.90).

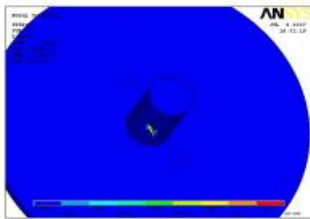


Figure 3. Stress intensity for aluminium alloy bearing material sample 1

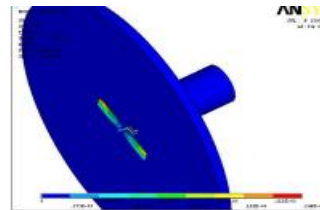


Figure 7. Displacement sum for aluminium alloy bearing material sample 1

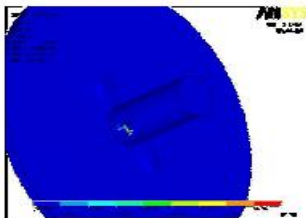


Figure 4. Von mises stress for aluminium alloy bearing material sample 1

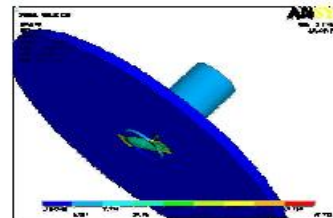


Figure 8. Stress intensity for aluminium alloy bearing material sample 2

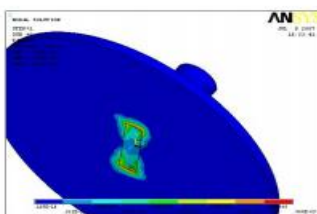


Figure 5. Strain intensity for aluminium alloy bearing material sample 1

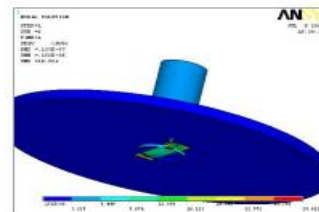


Figure 9. Von mises stress for aluminium alloy bearing material sample 2

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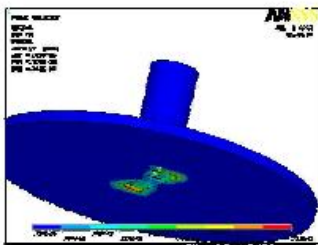


Figure 6. Von mises strain for aluminium alloy bearing material sample 1

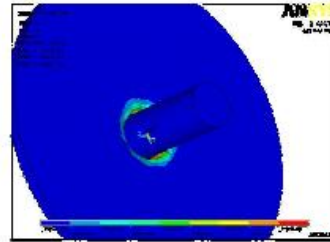


Figure 10. Strain intensity for aluminium alloy bearing material sample 2

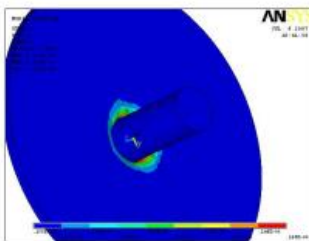


Figure 11. Von mises strain for aluminium alloy bearing material sample 2

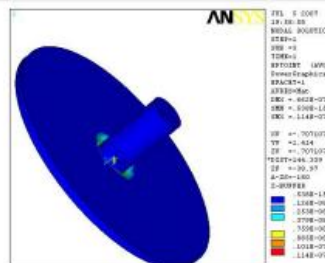


Figure 15. Strain intensity for aluminium alloy bearing material sample 3

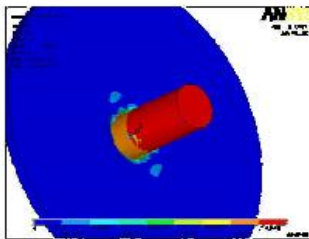


Figure 12. Displacement sum for aluminium alloy bearing material sample 2

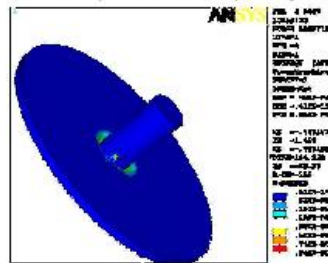


Figure 16. Von mises strain for aluminium alloy bearing material sample 3

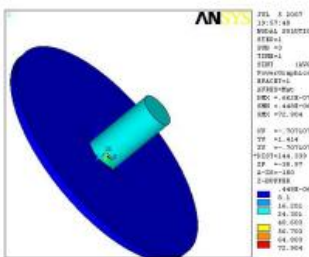


Figure 13. Stress intensity for aluminium alloy bearing material sample 3

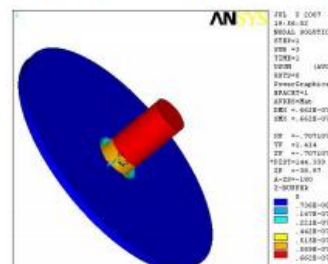


Figure 17. Displacement sum for aluminium alloy bearing material sample 3

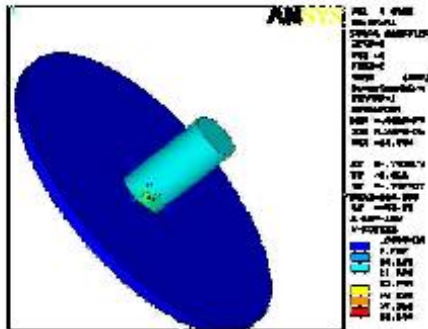


Figure 14. Von mises stress for aluminium alloy bearing material sample 3

V. RESULTS AND DISCUSSION

The safe load and seizure load of the aluminum alloy engine bearing material were determined using thrust type seizure testing machine. The stress for the safe load of the same material under same operating condition was simulated using ANSYS. The results obtained using ANSYS were in close agreement with the experimental results.

A.Experimental Results

Sample No	Safe load (Kg)	Stress (Mpa)
Sample 1	260	20
Sample 2	380	43
Sample 3	360	27

Table 4. Testing Machine Result

B. ANSYS Result

Sample No	Safe load (Kg)	Von Mises Stress (Mpa)
1	260	26
2	380	65
3	360	32

Table 5. Simulated ANSYS result

C. Summary of results

Von mises stress for aluminium alloy bearing material sample 1, 2 and 3 are 26.752 Mega Pascal, 29.021 Mega Pascal, and 65.080 Mega Pascal. Stress intensity for aluminium alloy bearing material sample 1, 2 and 3 are 29.83 Mega Pascal, 32.392 Mega Pascal, and 72.904 Mega Pascal. Strain intensity for aluminium alloy bearing material sample 1, 2 and 3 are 0.560E-09, 0.222E-8 and 0.114E-7. Von mises strain for aluminium alloy bearing material sample 1, 2 and 3 are 0.381E-9, 0.165E-8 and 0.842E-8. Displacement sum for aluminium alloy bearing material sample 1, 2 and 3 are 0.246E-8, 0.133E-7 and 0.662E-7.

The above experiments were simulated using the finite element package ANSYS. Stress for the safe load of aluminium alloy bearing material is determined under the same operating condition.

From this analysis, the stress values obtained from simulation were compared with experimental values.

The results indicate that the stresses found out using ANSYS are nearest to that of experimental values. Therefore ANSYS can be used to find out the stress induced in the aluminium alloy bearing material by the application of thrust load.

This work can also be extended, to test the Copper alloy bearing material and to determine the safe load of the bearing material under dynamic operating conditions.

VI. CONCLUSION

Experiments were conducted in thrust type seizure testing machine to determine seizure load for aluminium alloy bearing material. With help of the determined seizure load, the safe load (rated load carrying capacity) of aluminium alloy bearing material is found.

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