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Analysis of journal bearing regarding number and position of lobes

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Abstract
This project entirely done by considering the basic design of a journal bearing from BHEL, Hyderabad. Major considerations in journal bearing are regarding stresses developed and vibrations produced. By utilizing the basic design, designs for no-lobe, one-lobe, two-lobe, three-lobe, four-lobe, and six-lobe has been generated in order to make a static and dynamic analysis on the journal bearing regarding no. of lobes. A lobe is a portion obtained by removing a circular portion of a known radius on the internal surface of the bearing, which results in good lubrication of the bearing, due to increase flow of lubrication. As the removal portion was in microns thickness, which may not show effect on the structural strength of bearing, by performing static analysis on types of bearings we determine the stresses developed in the structure based on the no. of lobes, position of lobe. No. of lobes, position of lobe can also be considered as criteria for selecting a journal bearing. More number of lobes may increase the lubrication but it may also decrease its strength so we concentrate on this issue also. These lobes may also result in generation of vibrations, which will be concluded by dynamic analysis.
Software used are CREO 1.0 for modeling and ANSYS 15.0 for analysis work

Keywords: Analysis; Journal Bearing; Position of Lobes;

1. Introduction
The sliding contact bearings in which the sliding action is guided in a straight line and carrying radial loads may be called slipper or guide bearings. Such type of bearings is usually found in cross-head of steam engines.
The sliding contact bearings in which the sliding action is along the circumference of a circle or an arc of a circle and carrying radial loads are known as journal or sleeve bearings. When the angle of contact of the bearing with the journal is 360 then the bearing is called a full journal bearing. This type of bearing is commonly used in industrial machinery to accommodate bearing loads in any radial direction.
When the angle of contact of the bearing with the journal is 120°, then the bearing is said to be partial journal bearing. This type of bearing has less friction than full journal bearing, but it can be used only where the load is always in one direction. The most common application of the partial journal bearings is found in rail road car axles. The full and partial journal bearings may be called as clearance bearings because the diameter of the journal is less than that of bearing.
When a partial journal bearing has no clearance i.e. the diameters of the journal and bearing are equal, then the bearing is called a fitted bearing.
The sliding contact bearings, according to the thickness of layer of the lubricant between the bearing and the journal, may also be classified as follows:

- **Thick film bearings:** The thick film bearings are those in which the working surfaces are completely separated from each other by the lubricant. Such types of bearings are also called as hydrodynamic lubricated bearings.
- **Thin film bearings:** The thin film bearings are those in which, although lubricant is present; the working surfaces partially contact each other at least part of the time. Such type of bearings is also called boundary lubricated bearings.
- **Zero film bearings:** The zero film bearings are those which operate without any lubricant present.

- **Hydrostatic or externally pressurized lubricated bearings:** The hydrostatic bearings are those which can support steady loads without any relative motion between the journal and the bearing. This is achieved by forcing externally pressurized lubricant between the members.

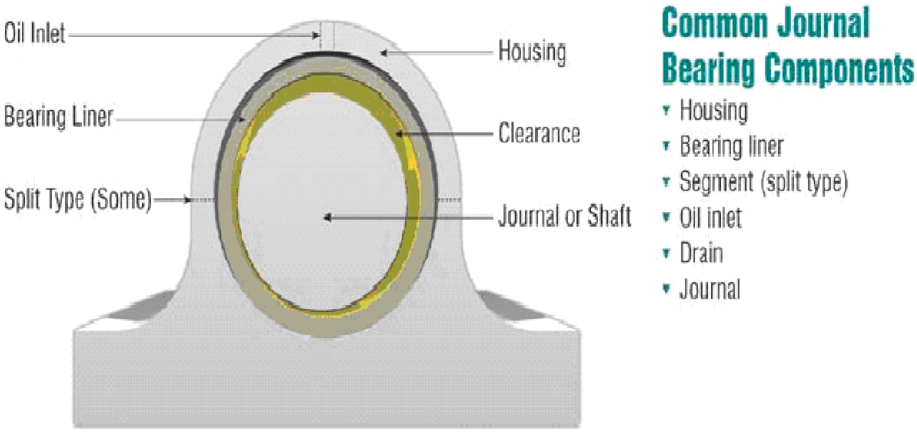

Fig 1: Journal bearings

Journal Bearings and Their Lubrication

Journal or plain bearings consist of a shaft or journal which rotates freely in a supporting metal sleeve or shell. There are no rolling elements in these bearings. Their design and construction may be relatively simple, but the theory and operation of these bearings can be complex. This article concentrates on oil- and grease-lubricated full fluid film journal bearings; but first a brief discussion of pins and bushings, dry and semi-lubricated journal bearings, and tilting-pad bearings.

Low-speed pins and bushings are a form of journal bearing in which the shaft or shell generally does not make a full rotation. The partial rotation at low speed, before typically reversing direction, does not allow for the formation of a full fluid film and thus metal-to-metal contact does occur within the bearing. Pins and bushings continually operate in the boundary lubrication regime. These types of bearings are typically lubricated with an extreme pressure (EP) grease to aid in supporting the load. Solid molybdenum disulphide (moly) is included in the grease to enhance the load-carrying capability of the lubricant. Many outdoor construction and mining equipment applications incorporate pins and bushings. Consequently, shock loading and water and dirt contamination are often major factors in their lubrication.

Dry journal bearings consist of a shaft rotating in a dry sleeve, usually a polymer, which may be blended with solids such as molybdenum, graphite, PTFE or nylon. These bearings are limited to low-load and low-surface speed applications. Semi lubricated journal bearings consist of a shaft rotating in a porous metal sleeve of sintered bronze or aluminium in which lubricating oil is contained within the pores of the porous metal. These bearings are restricted to low loads, low-to-medium velocity and temperatures up to 100 °C (210 °F).

2. Design

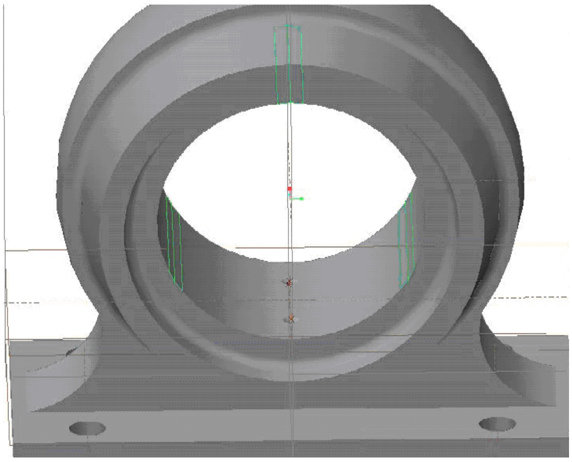

Fig 2.

3. Analysis

3.1 Static structural

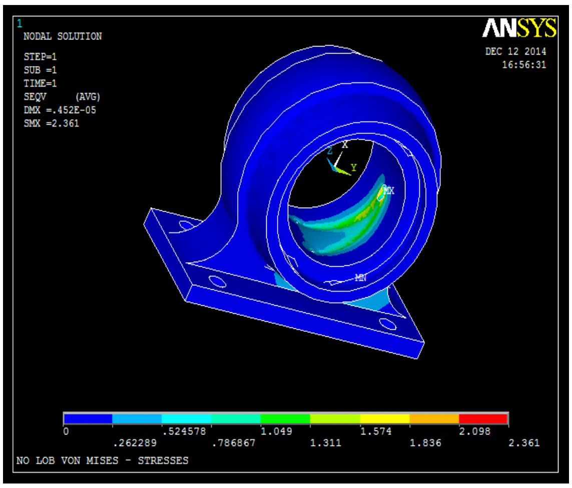

Fig 3: Von-mise stress in No Lob

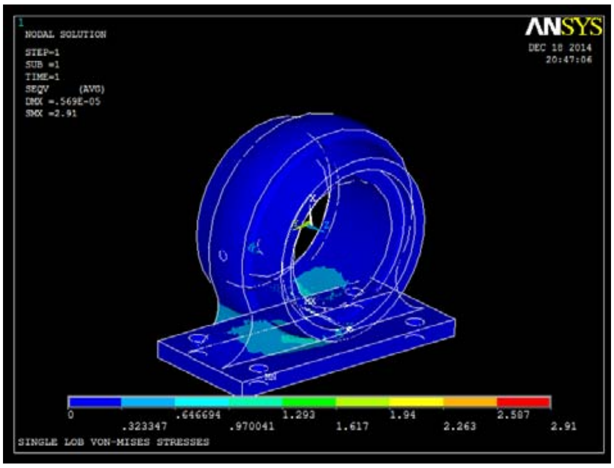

Fig 4: Von-mise stress in Single Lob

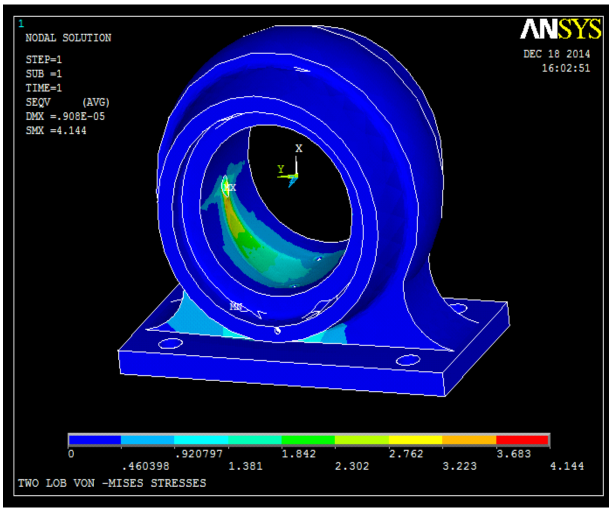

Fig 5: Von-mise stress in Two Lob

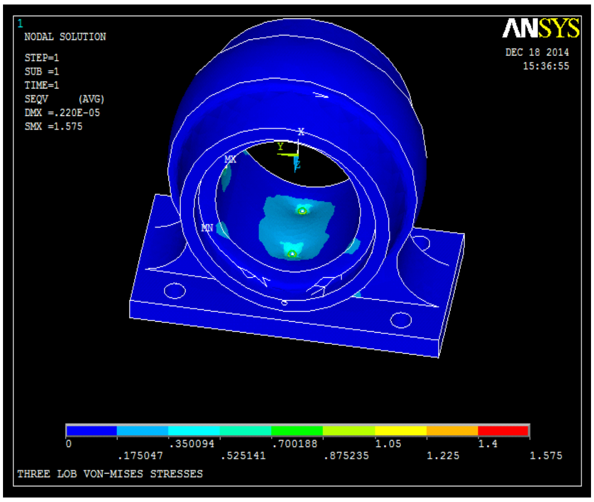

Fig 6: Von-mise stress in Three Lob

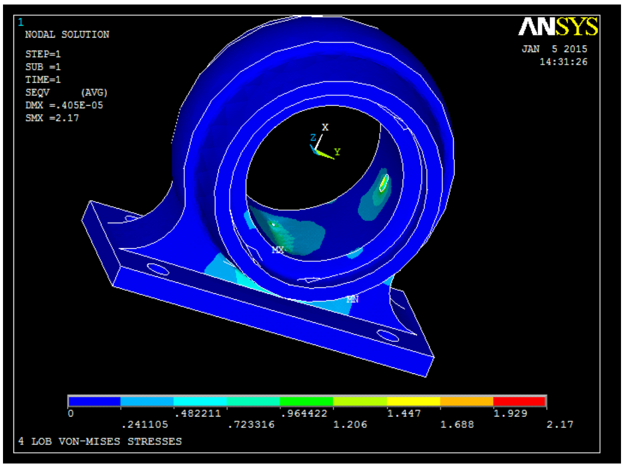

Fig 7: Von-mise stress in Four Lob

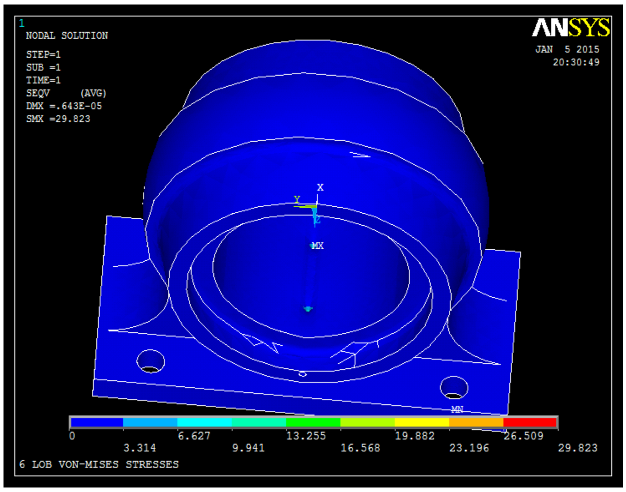

Fig 8: Von-mise stress in Six Lob

3.2 Dynamic analysis

Mode 5

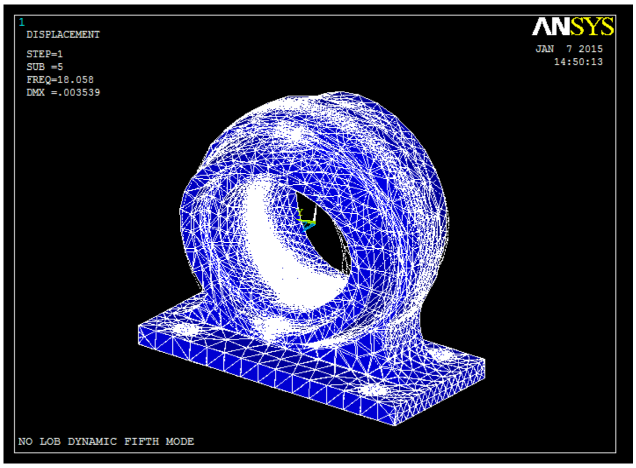

Fig 9: No Lob

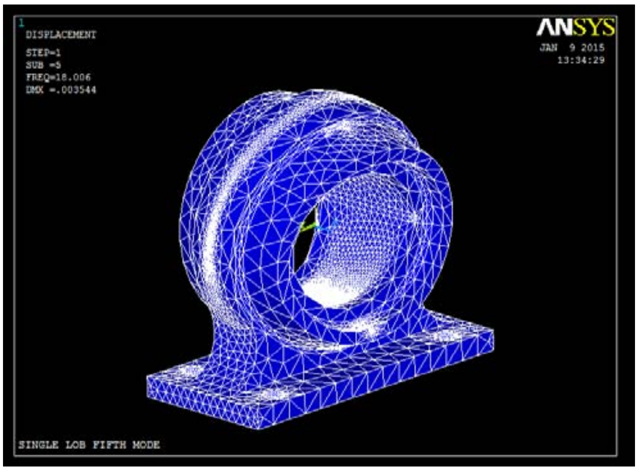

Fig 10: Single Lob

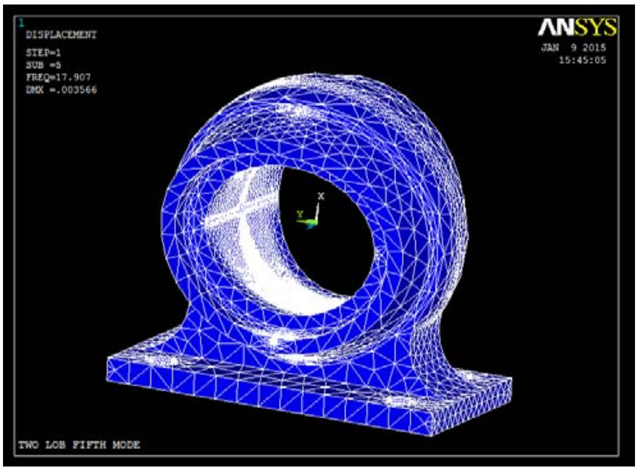

Fig 11: Two Lob

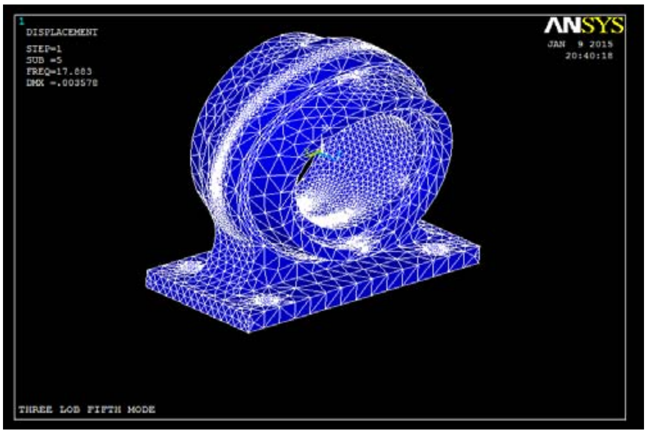

Fig 12: Three Lob

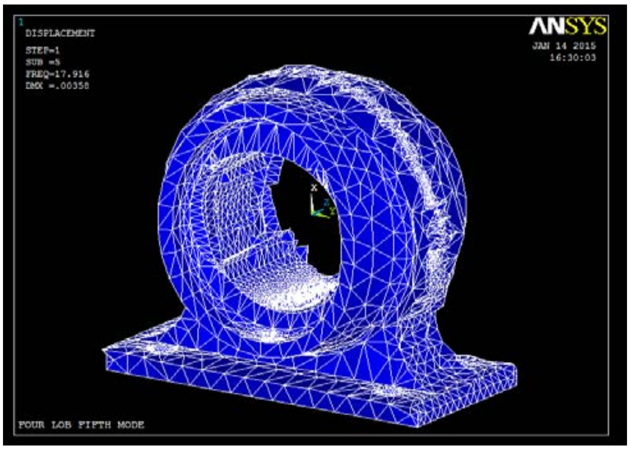

Fig 13: Four Lob

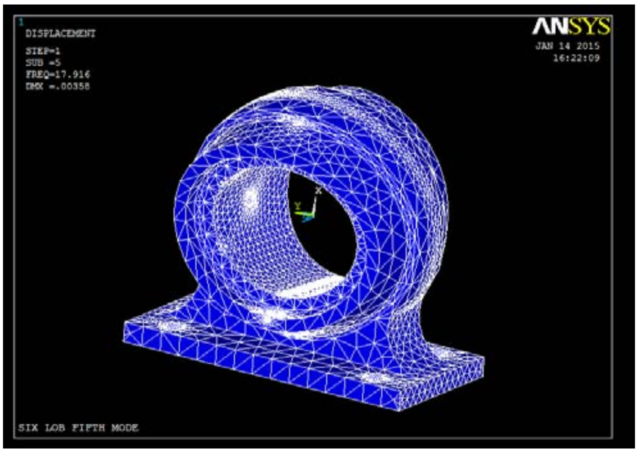

Fig 14: Six Lob

4. Results and Discussions

The obtained results of the study are as fallows, first static structural analysis results are tabulated and graphical comparisons are stated, later vibrational analysis for all the six bearings are tabulated in different modes and graphical comparisons for mode 1, mode 2 and mode 3 are given.

4.1 Static structural report

Table 1.

si.no	von-mise stress	total displacement		displacement in x		displacement in y		displacement in z	
		min	max	min	max	min	max	min	max
1	2.361	0	4.52E-06	-4.26E-06	1.99E-08	-1.50E-06	4.66E-07	-4.72E-07	6.02E-07
2	2.91	0	5.69E-06	-5.69E-07	2.78E-08	-2.30E-06	7.21E-07	-9.39E-07	9.48E-07
3	4.144	0	9.08E-06	-8.66E-06	5.15E-08	-3.24E-06	1.01E-06	-1.13E-06	1.18E-06
4	1.0575	0	2.20E-06	-2.16E-06	9.36E-07	-4.98E-07	4.10E-07	-3.15E-07	8.36E-07
5	2.17E+00	0	4.05E-07	-4.05E-06	1.42E-08	-7.09E-07	6.17E-07	-5.77E-07	6.14E-07
6	29.823	0	6.43E-06	-6.43E-06	1.20E-08	-7.57E-07	7.86E-07	-1.02E-06	1.05E-06

The above table is tabulated based up on the results from ansys report, according to this report the displacement of the bearing volume slowly increased from no lob design to two lob, in this three models lobs are coinciding with the lubricating inlet or outlet ports so we designed the fallowing two models i.e. three lob and four lob bearings with their lobs without coinciding with the Inlet and outlet ports but in six lob one of the lob coincide with the outlet port and also due to six lobs the structural strength of the bearing in dramatically decreased, now we are moving towards the vibrational analysis for further study.

4.2 Dynamic analysis

Table 2.

si.no	name	frequency				
		mode 1	mode 2	mode 3	mode 4	mode 5
1	no lobe	3.656	5.941	8.762	14.126	18.058
2	single lobe	3.662	5.912	8.766	13.994	18.006
3	two lobe	3.673	5.876	8.746	13.893	17.907
4	three lobe	3.667	5.887	8.731	13.922	17.883
5	4 lobe	3.655	5.881	8.718	13.923	17.916
6	6 lobe	3.672	5.897	8.743	13.925	17.916

5. Conclusion

After going through the reports generated from ansys we observed that increase in number of lobs decrease the strength and increases stress in the bearing and also increases their frequencies of vibration in different modes but we know that with increase in number of lobs the lubrication increases which in turn increases the life of the bearing, the placement of the lobs also plays a major role in the strength of the bearing and it's life, bearings with lobes placed without intersecting with the inlet and out let of the lubricant have better strength and less stress so we conclude that bearings with optimum number of lobs i.e. three or four placed without intersecting with inlet and outlet of lubricant are the best in strength and have better life span.

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