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An Investigation and Analysis on Failure for Bearings of Casting Shakeout Used In Foundry Industries

Prof. S. N. Satone, Prof A. A. Gangshettiwar
Student, Mechanical Engineering Department, D.B.N.C.O.E.T Yavatmal, Maharashtra, India
sudhirsatone@gmail.com
HOD, Mechanical Engineering Department, D.B.N.C.O.E.T Yavatmal, Maharashtra, India
Ashish.gangshettiwar@gmail.com

Abstract:-This project deals with investigation and analysis on failure of bearing of casting shakeout, required in foundry industries to separate solidified casting and sand from mould box. After the study of existing shakeout and the details provided by industry, it is revealed that, frequent breakdown of shakeout occurs due to failure of roller spherical bearings used on center shaft. The failure of bearings is mainly due to excellence tends to damage within a short period, due to cavities created on the bearing raceway. This result in roller and inner races surface of spherical bearing get damage affects the vibrations of casting shakeout deck and will require more time for separation of casting and sand from mould box. The analysis of existing system uses four bearings as modified setup of existing system to distribute the load acting on shakeout aims at reducing this frequent breakdown, increases life of bearings and increases the productivity of plant. The software Pro-E wildfire 4 will be used for modeling and also finds out stresses and deformation in both existing as well as modified using ANSYS software.

Keywords- Excellence, Roller and Inner Races Surface of Roller Bearing, Spherical Roller Bearing Life.

I.INTRODUCTION

If we look at today's industries, it is seen that these industries are playing very important role in development and production of many products required for particular application and make them available to customers.

A foundry is a factory that produces metal casting. Metals are cast into shapes by melting them into a liquid, pouring the metal in a mold, and removing the mould material or casting after the metal has solidified as it cools. One of the shakeout process is used to separate sand and casting from mould box after solidification when mould box placed over the vibrating deck of shakeout.After the discussion carried out at Jayaswal NECO Ltd, Butibori, related to performance of shakeout, it is found that bearings used in shakeout are spherical roller bearing having specification 22322 get fails within one to two months even it having higher dynamic load capacity.

The vibration of shakeout is possible due to mass of counter weight imbalance which results in excessive load on bearings mounted on shaft driven by 30 HP motor with 960 rpm speed. The Bearings and shakeout are shown in figure 1.1. In the present work failure analysis of spherical roller bearing of casting shakeout having load capacity of 2 Tone is done. The investigation is carried out on the failure of spherical roller bearing that included a visual examination, analytically bearing life calculation and finite element analysis.

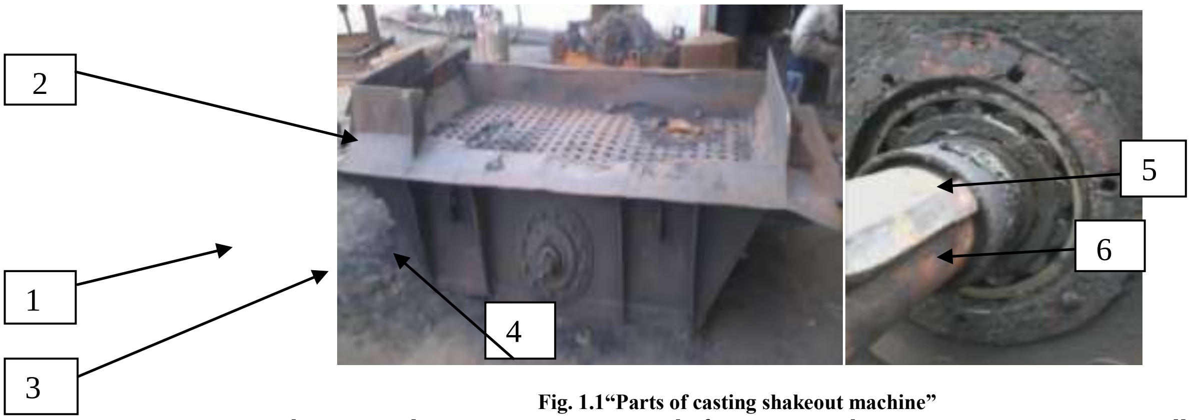


Fig. 1.1"Parts of casting shakeout machine"

Where, 1-Body, 2-Screen, 3-Center shaft, 4-Bearing housing, 5-Outer races, 6-Roller

II.REVIEW OF LITERATURE

Now-a-days, a large class of rolling element bearings exists. The industrial equipments are subjected to different type of loading and atmospheric conditions results in failure of bearings. There are a few publications on the failure of bearings of components used at industries, which are reviewed and studied. In brief they are given below.

B. A. Kardile [1], This study work is proposed to carry out vibration analysis of heavy duty centrifugal Blowers & bearing failure analysis. The life of bearing can be improved by carrying corrective actions on blower & modifying its accessories like Plumber block to prevent bearing failure. Data analysis is done on the basis of spectral plot, amplitude against frequencies with the help of prufteck vibroexpert meter. In comparison of vibration spectral with experimental actions are carried out under the vibration severity standard, the chart results of rectification will be compared with spectral plot & corrective action. The results will be compared with initial condition & condition monitoring schedule is prepared for avoiding premature failure of equipment. Standard schedule for maintaining basic condition of variables of equipment like as CBM /TBM will be planned to avoid premature failure of the bearing.

Jyoti K. Sinha [2], describes several vibration based methods are used in practice to identify the fault in the antifriction bearings (ball bearings and roller bearings), however experience suggests that these methods are just indicative to the bearing health and not sufficient to identify the root cause if the failure is premature and frequent. Many rotating machines have rotors that are supported through anti-friction ball or roller bearings. The most common vibration based techniques for detection of faults in anti-friction bearings are crest factor and kurtosis measurements. The envelope or more precisely the amplitude demodulation at the carrier frequency (usually the rotating speed of a machine) is often used to locate the exact nature of fault by identifying the bearing characteristic natural frequencies.

R.K. Upadhyay, L.A. Kumaraswamidhas and Md.Sikandar Azam [3]**,** Rolling Contact Fatigue (RCF) occurs due to the result of cyclic stresses developed during operation and mechanism that involve in fretting failure of rolling element bearing. As bearing raceways of non-rotating rolling element bearings exposed to vibration or sliding oscillation false Brinelling occurs. Bearing surface due to false Brinelling tends to damage within a short period, due to cavities created on the bearing raceway. Recommendation towards enhancement of bearing life is also suggested.

P. G. Kulkarni and A. D. Sahasrabudhe [4], presents a methodology for fault diagnosis of rolling element bearings based on discrete wavelet transform (DWT) and wavelet packet transform (WPT). In order to obtain the useful information from raw data, db02 and db08 wavelets were adopted to decompose the vibration signal acquired from the bearing. Further De-noising technique based on wavelet analysis was applied. This paper categorized defects in rolling element bearings as localized and distributed defects. Pitting, spalling etc. are the examples of localized defects while waviness, misaligned races, surface roughness are the examples of distributed defects.

D. Azad and K. Ramji [3], **t**he detection of faults in the industrial systems. Early detection of faults in these systems allows the user to initiate repairs and it can prevent costly maintenance. Fan problems result from impeller unbalance, misalignment of shafts, cracks, resonance, looseness, bearing problems etc in this paper, fault detection techniques which are based on vibration signals that are acquired from accelerometers, are proposed. Bearing fault detection is conducted by signal processing methods, based on the vibration signature of the rolling elements of bearings. In addition, infrared Theromgraphy technique is proposed as an integrated condition monitoring system with the existing monitoring system to increase the performance of fault detection and to know the degradation of bearings and also theoretical and numerical analysis of the heat conduction process of the bearing to its housing.

N.S. Jammu and P.K. Kankr [4], described the presence of faults in bearings results in severe vibrations of rotating machinery. Timely detection of these faults and estimation of the time to failure are the areas of concern for researchers because abrupt failure of bearings may cause malfunctioning of the entire system and this result in downtime for the system and economic loss to the customer. A bearing failure also has the potential to damage machinery causing soaring machinery repair and/or replacement costs.

Accurate bearing prognosis requires signals from several sensors which are costly and difficult to install in already mounted industrial machines. Also number of methodologies discussed above needs further study, in order to verify their application to industrial problems with varied experimental conditions.

The review of literatures published in above mentioned research papers are found very useful to calculate life of roller spherical bearing and identify the type of failure of bearings due to impact load of mould box and casting acts on shakeout used in Foundry. Some other papers, reports, technical articles, text book, design data book and catalog are also reviewed; Tittles and Authors details are mentioned in literature cited.

III. PROBLEM FORMULATION

Failure of the machinery devices is one of the major problems in foundry industry. Especially insufficient awareness and use of technology, and new design features can cause problems such as shakeout and breakdown. In the present work the investigation is carried out to identify the type of failure in the spherical roller bearing of casting shakeout subjected to static and dynamic loads.

IV. AIM & OBJECTIVE

- To identify type of failure in spherical roller bearing of casting shakeout under consideration.
- Literature review and data collection based on failure of spherical roller bearings used in industrial applications.
- Detail study of working of existing shakeout.
- Detail study of load acting on spherical roller bearing.
- Investigation and analytical calculation of spherical roller bearing failure by visual examination
- Modeling and simulation of existing setup of shakeout.
- Find out the strength of spherical roller bearings for existing setup by stress analysis in ANSYS software.
- Find out the strength of spherical roller bearings for modified setup by stress analysis in ANSYS software.
- Comparison of existing setup and newly modified proposed setup.

V.WORK DONE

In foundry industry once the molten metal has been poured in cavity of mould box to produce a casting, the solidification starts within 3 minutes. The whole assembly containing mould and casting is processed to shake out after the span of 1-2 minutes. In shakeout process, the casting and mould are kept on vibrating deck with jerk. Due to vibrations of deck, sand is separated from casting. After the separation, sand is processed to sand plant through hopper which is fixed below the casting mould vibrating screen to the conveyor. The bearings used in shakeout causes failure.

Construction and working of Casting Shakeout:

Casting shakeout mainly consists of the following parts (**shown in figure 5.1) Fig. 5.2:Details of shakeout parts and Bearings**

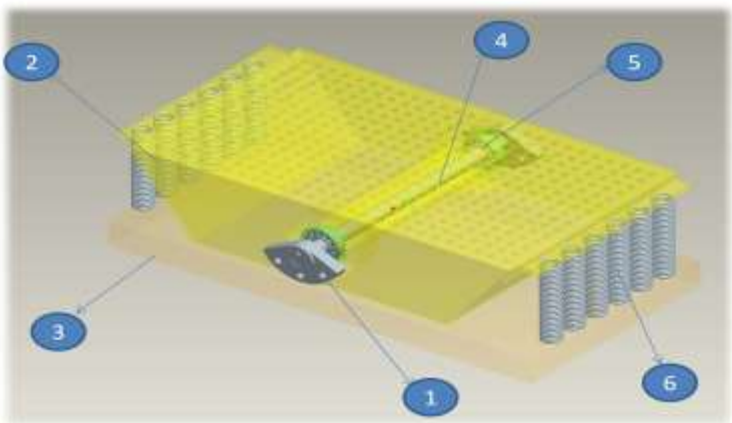


Fig. 5.1: Construction of Casting Shakeout

Where 1- Counter mass of 63 kg driven by 30 Hp, 960 rpm,
2- Vibrating deck having vibrating span of 10 to 15 mm, 3- Bottom Base,
4- Shaft having 110 mm dia., 5- Bearing of type 22322 (Roller spherical bearing), 6- Spring.

The actual photographs of parts of shakeout used in industry at moulding line are shown in figure 5.2

a) Inverted Shakeout Body


b) Springs c) Counter mass


d) Roller e) Spherical roller bearings

Specifications of shakeout

Table 5.1: Specifications of shakeout

Particulars	**Single shaft of 2 spherical roller bearings**	
Overall dimensions	Overall Length	2730mm
	Overall Width	1620mm
	Overall Height	620mm
Load Capacity	Body weight	1000 Kg
	Mould box and sand Weight	600 Kg
	Casting weight	200 Kg
	Shaft weight	200 Kg
	Gross weight	2000 Kg = 19.62 KN
	Counter mass weight (Two no.)	63 Kg = 618.03 N
Motor	RPM	960 rpm
	Power	30 KW
Spherical Roller Bearings (22322) (Two no.)	Inner Races Diameter	110mm
	Outer Races Diameter	240mm
	Width	80mm

Construction of Modified setup:
Modified setup is suggested as per bearing life calculation, which distribute load among bearings and life of bearing increases. This setup is consist of body, two shafts with four bearings and four counterweights, springs similar to previous setup and two driving motors of same specifications as in existing setup. The same operation is performed with this setup to separate the casting from sand.

Modeling of Modified Setup of Shakeout:
It is modeling of existing setup only change is done with the bearing and shaft instead of two bearing and one shaft, it uses four bearings and two shaft to have better load distribution. Also direction of rotation of shaft is reversed to that of other affect the shakeout only vibrates in vertical plane.

1) Modeling of Frame and Bearing assembly:

Fig. 5.3.1: Model of Frame and bearing assembly

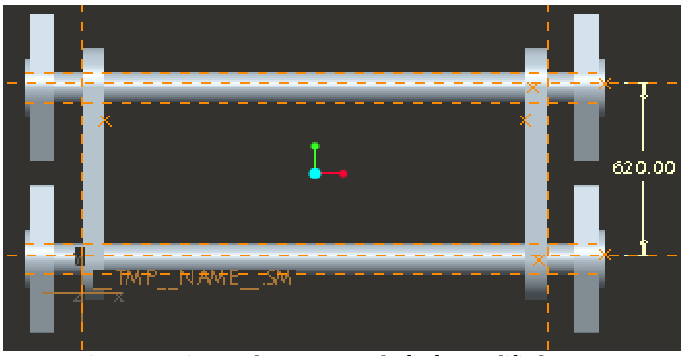


Fig. 5.3.2: Distance between two shafts for modified setup.

2) Modeling of assembly of shakeout body with frame, bearings, counterweights and shafts:

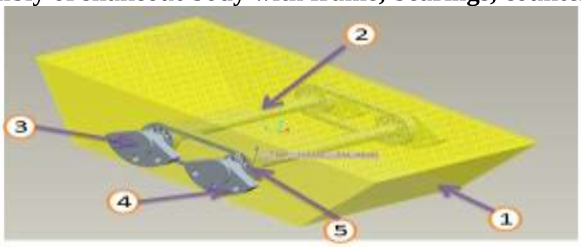


Fig. 5.3.3: Model of shakeout body, frame, bearings, Counterweights and shafts assembly.

Where, 1- Body of shakeout, 2- Shafts with two numbers driven by two 960 rpm motors, 3- Cap to counter weight assembled on shafts, 4- Counter weight with four numbers having same weight 63 Kg, 5- Spherical roller bearings of type 22322 with four numbers

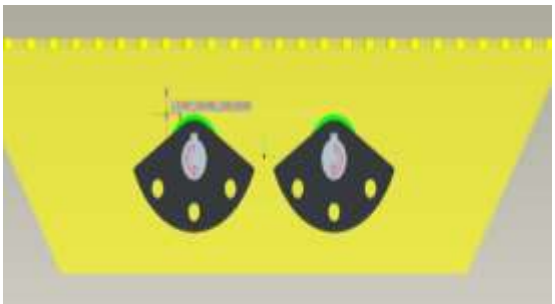


Fig. 5.3.4: Direction of rotation of shaft during shakeout.

RESULT AND DISCUSSION

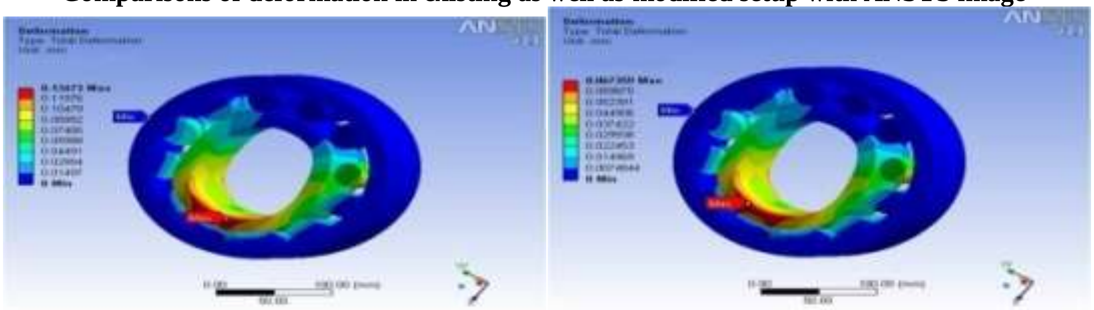
This project work addresses live problem of failure of shakeout bearing at Jayswal NECO Industries ltd. As per visual inspection and load consideration the type of shakeout bearing failure is brinelling. This failure can be rectified with increase in bearing life using modified setup.

In this work analytically calculate bearing life of existing setup, it found same with actual working condition. The model of actual shakeout and bearing created with design software Pro-E wildfire 4 and confirmed stresses and deformation produced in existing setup with analysis software ANSYS 11. Also considering distribution of load suggesting setup is to modify.The new setup is modeled and analysis is carried out with same software it is found that deformation and stresses are less in modified setup. Also the life of bearing in modified setup is calculated analytically and it is found ten times more than that in existing setup. It saves cost of annual production loss, reduces breakdown time.

Table 4.1: Comparisons of bearing life and annual production loss of Existing and modified setup.

Particulars / Setups	Analytical Bearing life calculation in Hrs	Average annual breakdown in Hrs	Annual production loss in Metric tone	Cost due to annual production loss in Rs.	Cost of bearings consumed annually in Rs.
Existing shakeout setup with two bearings	903.153	60	90 MT	54 Lakhs	7.8 Lakhs
Suggested modified shakeout setup with four bearings	9083.24	10	15 MT	12 Lakhs	2.6 Lakhs

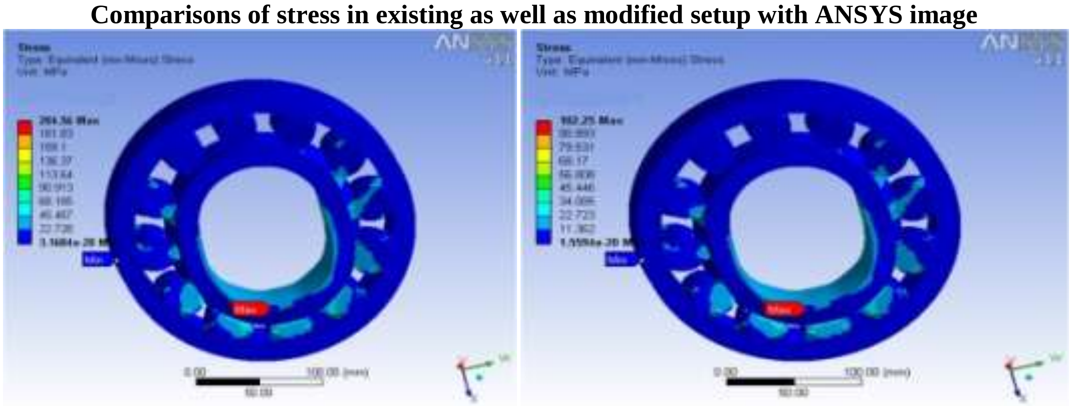
Comparisons of deformation in existing as well as modified setup with ANSYS image



Bearing of Existing setup Bearing of modified setup

Fig. 6.1: Deformation values in existing and modified setup

Comparisons of stress in existing as well as modified setup with ANSYS image



Bearing of Existing setup Bearing of modified setup

Fig.6.2: Stress values in existing and modified setup

SUMMARY AND CONCLUSIONS

In this project work, investigation on bearing failure of shakeout used in foundry industry is performed. The modifications are suggested in existing set up, which improve the bearing life ten times than that of in existing setup. It results reduced in breakdown time, improvement in manpower utilization and better cost advantage. Further, finite element analysis of bearing using ANSYS is also done to confirm stresses & deformation of bearing in existing and modified setup. The stress and deformation is less in modified setup. Further implementation of modifications suggested in existing setup is feasible and can be implemented under actual service conditions.

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