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# Shape Optimization of Roller Follower Mechanism for Improving Mechanical Efficiency

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**Abstract—***Cam follower mechanism is an important part of automobile engine that operates the inlet and outlet valve. The follower is in contact with the cam lobe. In this paper, the design of a roller follower has been modified to reduce the contact area of the follower so as to reduce the friction and wear loss of the follower. This in turn helps to improve the mechanical efficiency. The modified shapes are modeled in Solid Works and they have been investigated for modal analysis and static structural analysis using ANSYS 14.5. Different materials are investigated for the modified design in ANSYS which include Stainless Steel, Structural Steel and Chromium Steel, and the results are compared to select the optimal design for the follower.*

## 1. INTRODUCTION

A cam follower mechanism is an integral part which operates the inlet and exhaust valves of an Internal Combustion Engine. A cam is a rotating part that converts rotary motion into translating motion of a follower. The cam follower mechanism finds application in machines of printing press, shoe industry, textile machinery, gear cutting machines and screw machines. The contact surface between the cam and follower causes friction loss which reduces the mechanical efficiency of the engine. There are different methods to reduce the friction losses such as lubrication shape, optimization etc.

Few types of follower used are knife edge follower, flat follower, roller follower and mushroom follower. In this work, we consider a roller cam follower as it is widely used in the automobile engines and reduces the line contact between the cam and follower.

Mahesh et al. (1) discussed about design optimization of cam follower mechanism of an IC Engine. The current cam follower mechanism in the four strokes IC Engine employs a flat follower. In this work an attempt is made to change the flat follower to a curved face follower to reduce the line contact of the flat face follower because the line contact between the cam and follower results in high friction losses which results in low mechanical efficiency. The authors have made the design of the cam follower in the PROE software and the analysis part is done in the ANSYS Software. Nitesh and Rajendra (2) discussed about the existing cam follower mechanism using flat faced follower in the 4 stroke IC engine and replaced it with the curved follower reducing the point contact. Digvijay and Maruti (3) discussed about the cam used in the IC engines in variety of forms which have a line contact and result in the high friction losses. They used optimization technique to reduce the line contact and reduced the friction losses using chromium steel for the cam follower and varying parameters like length of contact and the radius of the roller follower. Divya and Prabhat (4) discussed about the life prediction of cam and follower with static and dynamic analysis using FEA. Life prediction of the cam follower is done with the Artificial Neural Network (ANN) on the basis of static and dynamic analysis. Akkamahdevi and Raut (5) conducted finite element analysis of roller cam by optimization of surface contact area. Frequency range of modified roller follower shows a good match with frequency range and proves that the change in the design is safe. In another work, Raut and Akkamahdevi (6) replace the roller of the rocker arm of hero Honda passion bike to reduce the vibrations in the engine.

## 2. PROBLEM STATEMENT

The existing cam and follower mechanisms used in internal combustion engines have roller cam followers with full line contact. To improve the mechanical efficiency and reduce the vibration, it is desirable to reduce the line contact between cam and follower. In this work, an attempt is made to reduce the line contact by designing different shapes of cam followers and then analyzing the results. **Fig-1** shows the line contact between the existing cam and follower.

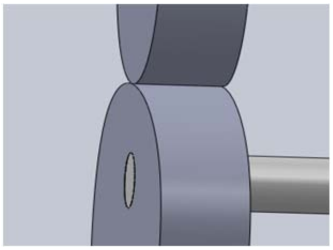

**Fig. 1.1: Line contact between existing follower**

## 3. OBJECTIVE:

The main objective of this project is:

- To study about the different types of cam follower mechanisms used in the automobiles.
- To modifying the design of the cam follower to reduce the line contact of the cam follower, thus reducing the friction between the cam and follower.
- To compare the natural frequency of vibration of the existing and the modified designs.

## 4. METHODOLOGY

The design of roller cam follower is modified to reduce the line contact between the cam and follower. In this work two types of modified designs are compared with the existing design of roller cam follower. Software used for designing is Solid Works. Standard dimensions are used for designing the roller cam follower. After completing the design of the cam follower, the models are imported into IGES format for analysis. ANSYS 14.5 software is used for the analysis. While analyzing the part, three types of material are used: Structural steel, Stainless steel and Chromium steel. Modal analysis and static structural analysis are then performed. Finally, the results of the existing and the modified follower are compared.

## 5. DESIGNS OF THE CAM FOLLOWER

Three designs are evaluated: one is the existing design of the roller cam follower and other two types are the modified types of roller cam follower.

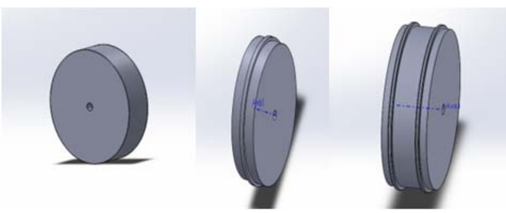

**Fig. 1.2 – Design of existing and modified follower**

The main difference in the existing and the modified cam follower are in the mating point which is contacting with the cam follower. Designs of the roller follower are shown in Fig. 1.2.

## 6. MESHING

Meshing size of 1 mm is used for the cam-follower. Mapped type meshing is used to divide the specimen in equal parts and create nodes and elements. The number of the nodes and elements depends on the design of the part. Number of Nodes is 31509 and those of Elements is 69947.

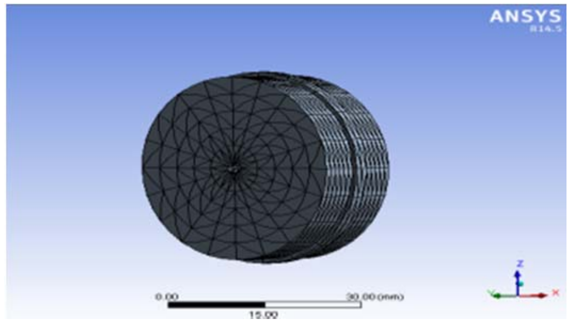


**Fig. 1.3: Meshing of the existing cam follower**

## 7. BOUNDARY CONDITIONS

In the ANSYS software, boundary conditions are fed to perform the analysis as per requirement of the problem. In the modal analysis, the centre part of the follower is fixed and in the structural analysis, a load of 675N is applied on the contact area of the follower with the central part fixed.

## 8. RESULTS AND DISCUSSION

Modal Analysis is used to determine the vibration characteristics for natural vibration and the mode shapes with the help of ANSYS 14.5 for the three types of steel.

### 8.1 Modal analysis result for structural steel:

Frequency range for the existing roller cam follower design is 4394.5 Hz to 71285 Hz.

Frequency range for the modification 1 of roller cam follower design is 4358 Hz to 70686 Hz.

Frequency range for the modification 2 of the design is 3002.2 Hz to 68322 Hz.

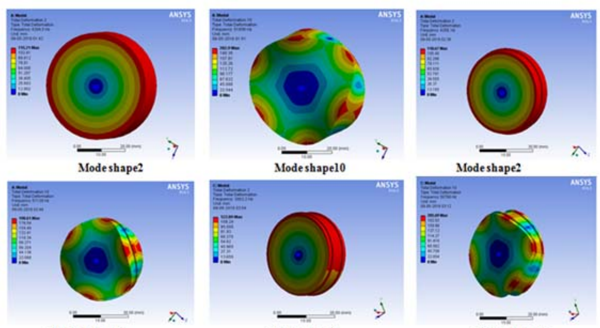


**Fig. 1.4:-Mode shapes of different design of cam follower for Structural steel**

### 8.2 Modal analysis result for Stainless steel:

Frequency range for the existing roller cam follower design is 4328.1 Hz to 70524 Hz.

Frequency range for the modification 1 of roller cam follower design is 4292 Hz to 69927 Hz.

Frequency range for the modification 2 of the design is 4309.4 Hz to 69947 Hz.

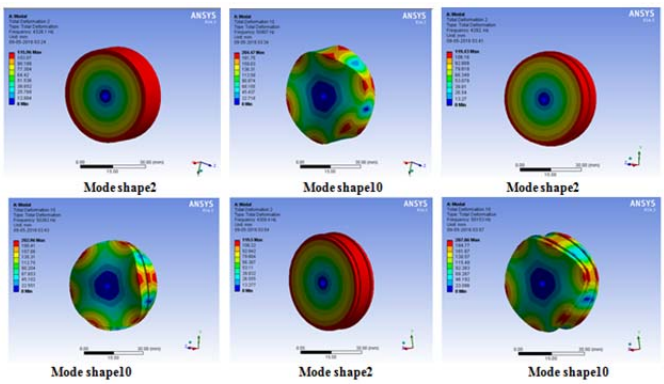


**Fig. 1.5:-Mode shapes of different design of cam follower for Stainless steel**

### 8.3 Modal analysis result for Chromium steel:

Frequency range for the existing roller cam follower design is 4375.5 Hz to 70013 Hz.

Frequency range for the modified 1 roller cam follower design is 4339.1 Hz to 69414 Hz.

Frequency range for the modified 2 roller cam follower design is 4338.4 Hz to 69396 Hz.

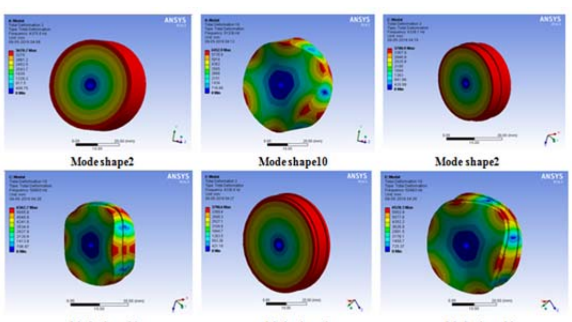


**Fig. 1.6: Mode shapes of different design of cam follower for chromium steel**

### 8.4 Static Structural Analysis

Static structural analysis is performed in the ANSYS to find the deformation for different boundary conditions for the three different materials. Shape of the contact area is changed according to the design of the roller follower. The value of the deformation is matched with the existing design to ensure that the design is safe.

### 8.5 Prominent changes between the existing and modified design of the follower

Line contact area is the main difference of the existing and the modified design follower.

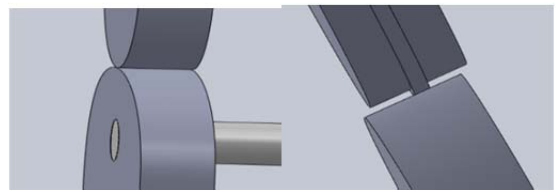

**Fig. 1.7: Line contact of the existing and modified follower**

## 9. CONCLUSIONS

In this work, modification is done in existing roller cam follower design. Two such modifications are suggested. Main motive to change the design of the cam follower is to reduce the line contact between the cam and the follower. It is 12.70 mm in the existing design, and after modification it is 2 mm. Contact area has been kept the same in the both modified designs. Evaluating three different types of materials, it is found that the results obtained for chromium steel are better than other materials because in chromium steel the percentage of the chromium is more than the 10.5%, so the part is safe from the crossion. Two types of the modified design are evaluated but the values of the modification 1 of design are less than the existing roller follower and the frequency of the modification 2 of the design is very less. With Modification 1 of design, line contact is reduced and the value is close to the existing cam follower design frequency. In static structure, the deformation value is close to the existing value of the cam follower which means that the design is safe.

## REFERENCES

[1] Mahesh R. Mali, Prabhakar D. Maskar, Design Optimization of Cam & Follower Mechanism of an Internal Combustion Engine for Improving the Engine Efficiency,2012 Modern Mechanical Engineering, 2012, 2, 114-119.

[2] Nitesh.S.Hirulkar, Rajendra.S.Tajane, Replacing Line Contact with Point Contact in IC Engine to Reduce Frictional Losses.International Association of Scientific Innovation and Research (IASIR) ISSN (Print): 2279-0020 ISSN (Online): 2279-0039.

[3] Digvijay L. Shinde, Maruti A. Mohite, Design optimization of cam and roller follower for improving efficiency of an I.C enginee*-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 3 Ver. III (May- Jun. 2014), PP 84-88 IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE).*

[4] Diya Pandey, Prabhat Kumar Sinha, Life prediction of cam and follower through Ansys and Artificial Neural Network(ANN) International Journal of Modern Engineering Research (IJMER)

[5] Akkamahdevi G. Chanagond, L. B. Raut Finite Element Analysis of Roller Cam By Optimization of Surface Contact Area, International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974

[6] L.B.Raut, AkkamahdeviG.Chanagond, Experimental Analysis of Cam Roller of Internal combustion Engine by Change in Area of Contact. International journal of Mechanical Engineering and Technology (IJMET) ISSN0976-6340 (print), ISSN 0976-6359(online) volume 6, February 2015,pg no99-105.