Optimization of a Radial Cam of an I.C. Engine by reducing area of contact with follower

Mr. AmolAchyutraoPande, Asst. Prof. Surendra C. Patil
PG Student, Assistant Professor
Department Of Mechanical Engineering
ShriShivaji Institute of Engineering & management studies
Parbhani,Maharashtra,India.

Abstract—**The existing cam & follower mechanisms used in Internal Combustion engines have a 35 mm line contact between them causing frictional losses. These frictional losses in present line contact are being considered on the higher side. These frictional losses affect the total efficiency of an Internal Combustion engine. So the line contact is reduced by optimization to 5mm contact only to check whether stresses are in limit or not to recommend for implementation.**

IndexTerms—**Diesel Engine Cam Drawing, ANSYS 12.0, Stress Analysis, Material Deformation.**

INTRODUCTION

Cam follower mechanism is a widely used mechanism in various machines, engines, etc. In this topic I have evaluate the effect made due to change in geometry of cam follower like reduce friction & increase in efficiency. Thus I have decided to change the shape of a cam. The cam of the cam follower mechanism is of flat type; which makes line contact with cam. This line contact of cam with roller will be changed to point contact by doing modification in the geometry of cam. The modified geometry of a cam should satisfy conditions: A) It should make point contact with roller of cam-follower mechanism.B) The values of stresses of an original geometry and modified geometry should be within limit. C) The value of frequencies of an original geometry and modified geometry should be within range. The purpose of this project is to reduce the friction between cam and the variety of different types of follower and cam systems that one can choose from is quite broad which depends on the shape of contacting surface of the cam and the profile of the follower. The existing cams used in internal combustion engines are made in a variety of forms which have a line contact with follower. As line contact between current cam and follower mechanism results in high frictional losses which results in low mechanical efficiency. Hence in this work an attempt is made to change the flat face of cam to a curved face cam, so that the required point contact can be achieved to minimize frictional losses.

PROBLEM STATEMENT

Design optimization of cam & follower mechanism of an Internal Combustion engine for improving the engine efficiency. The current mechanism employs a flat cam. We have to change the flat face of follower to a curved face cam, thus achieving the required reduced line contact with same strength. We have to keep the stresses in the mechanism within limit after modification of cam.

OBJECTIVE

Conduct a static stress analysis using Finite Element Analysis software for modified curved cam & existing cam check the feasibility of its use.

METHODOLOGY

The objective in building a solid model is to mesh that model with nodes and elements. Once the creation of solid model is completed, set element attributes and establishing meshing controls, which turn the ANSYS program to generate the finite element mesh. For defining the elements attributes, the user has to select the correct element type. This is most important task in finite element analysis because it decides the accuracy and computational time of analysisConduct static stress analysis using FEA software for modified curved cam & existing cam to check the feasibility of its use**.** Conduct a static stress analysis of existing cam using FEA software then modefy the geometry to a curved cam & then check for developed stresses in FEA software. The material of cam we have to select here the existing cam material is 100Cr6 so that we have to select that material. 100Cr6 is the widely used material for camafter that we have choose the element type for meshing here I am preferring solid 90 which is a higher order version of the 3-D eight node thermal element (Solid 70). The element has 20 nodes with a single degree of freedom, temperature, at each node. The 20 node elements have compatible temperature shapes and are well suited to model curved boundaries.The type of meshing used for cam is FREE mesh. The meshed model looks like as shown in fig B. After cam meshing we have to give applied load and set boundary conditions.

A. Solid Modeling of Cam

To perform finite element analysis of cam, the solid model of the same is essential. Fig.1shows a solid model of cam.

ISSN: 2278 – 7798

B. MaterialProperties

Table-I: Material Properties

Material	100cr6
Young's modulus	2.1e5MPas
Poisson Ratio	0.3
Density	7.850×10^{-6} Kg/mm^3
Yield Strength	410MPa

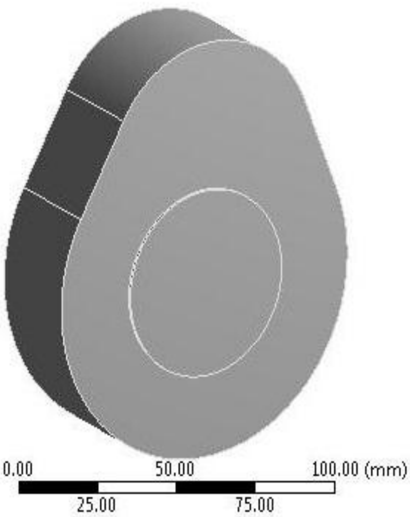

Figure 1: Solid Model Of Existing Cam

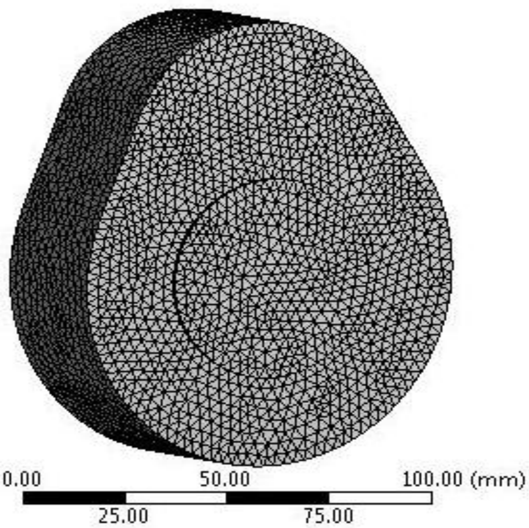

Figure 2: Meshed Model Of Existing Cam

C. Finite Element Analysis Procedure

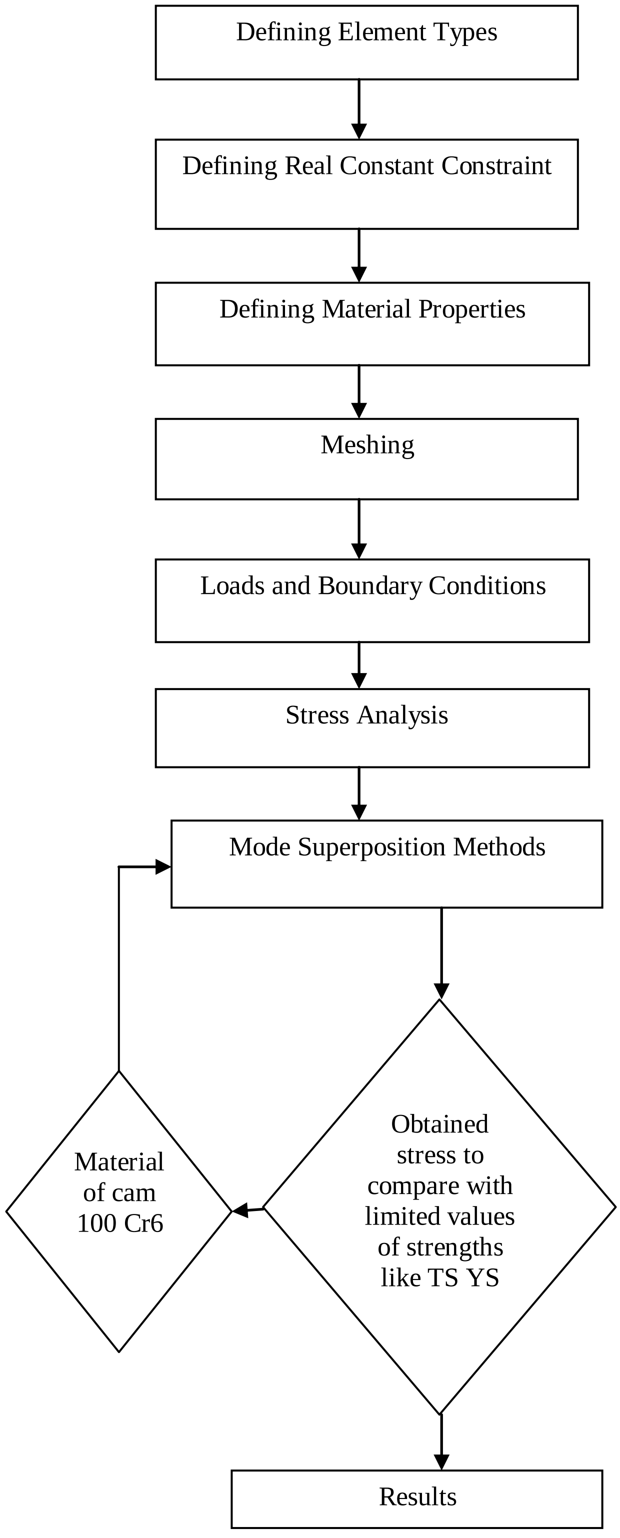

Figure 3: Flow Chart OfFinite Element Analysis Procedure

ISSN: 2278 – 7798

Stress Analysis

D. Original Existing Cam

By creating the geometry of existing cam as shown in fig.1 with flat face width of 35 mm& meshing it as shown in fig.2 for stress analysis. I have given the load of 1962N on existing cam & stresses developed are 42.308 MPa& deformation of 0.0015606 mm. as shown in following results (Fig. 4and Fig. 5). Here we can see the stresses developed and deformation of material formed which is quite less than the material ability but because of contact area of existing cam the frictional forces are somewhat large. So if we success to achieve the reduced contact between cam and follower then there will be less material contact and less frictional forces due to that engine efficiency must be increase.

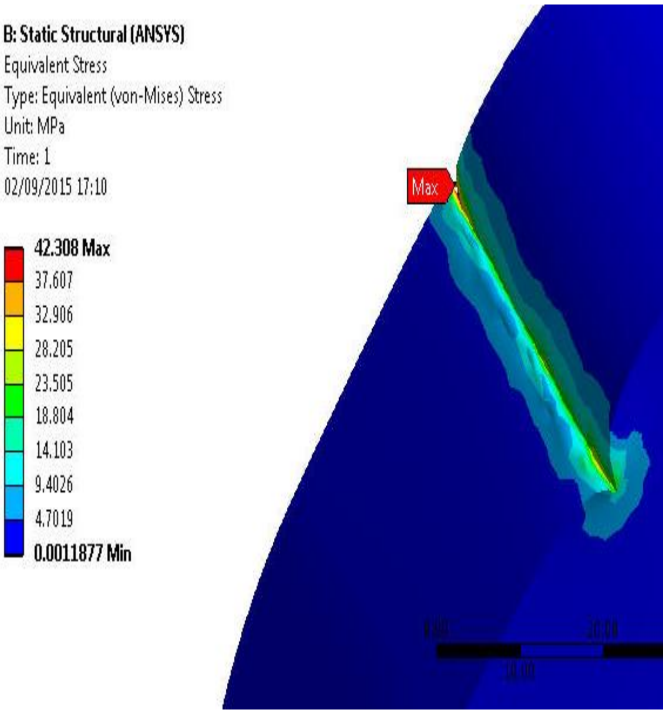

Figure 4: Magnified image of stress

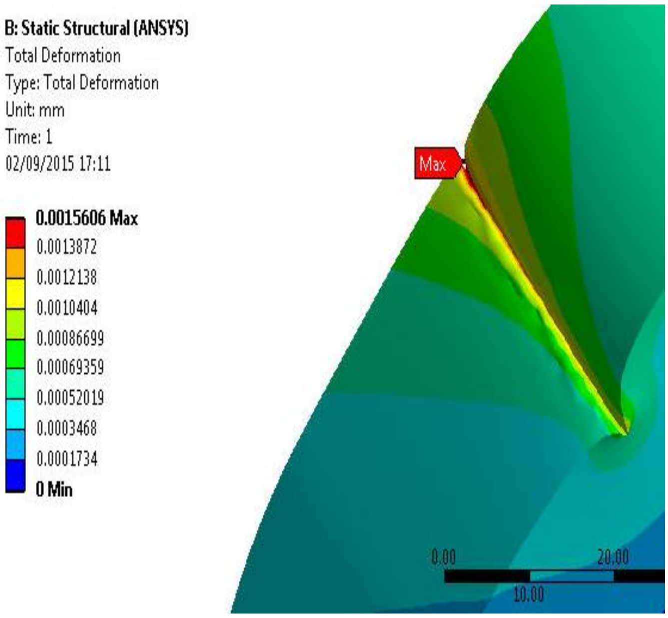

Figure 5: Magnified image of deformation

E. Modified Cam

To perform finite element analysis of modified cam, the solid model of the same is essential only the geometry of cam should be change as shown in Fig. 6 because of that the contact area will be decreased from 35 mm to 05 mm. after modifying geometry of cam meshing could be done. For this also we are preferring solid 90 element and same material 100Cr6. After meshing the cam will look like as shown in fig. 7now by giving the boundary conditions and applied load we can perform the stress analysis and can find out the developed stresses and deformation happened.Here for modified cam I have given the same load of 1962N on existing cam & stresses developed are 238.99 MPa& deformation of 0.0044703 mm. as shown in following results (Fig.8& Fig.9).

ISSN: 2278 – 7798

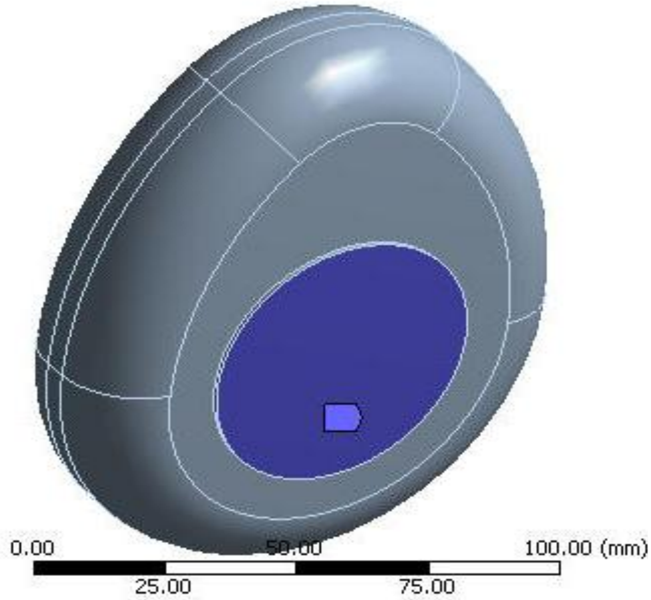

Figure6: Solid Model of Modified Cam

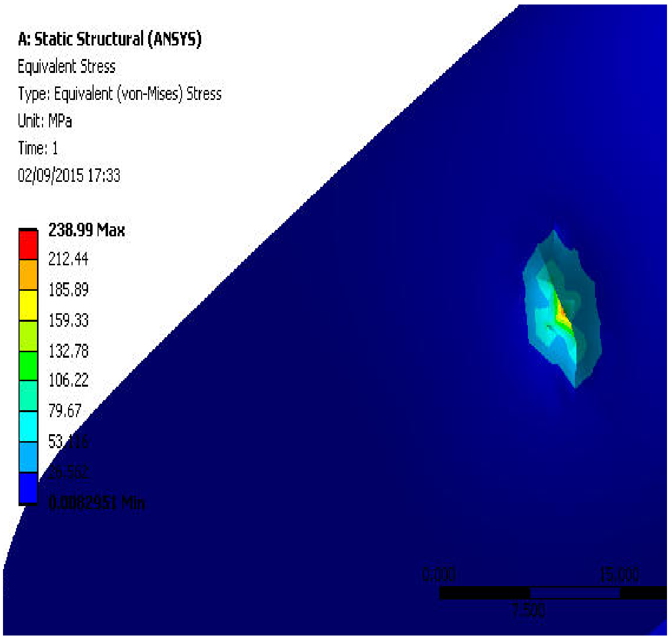

Figure8: Magnified Image of Deformation

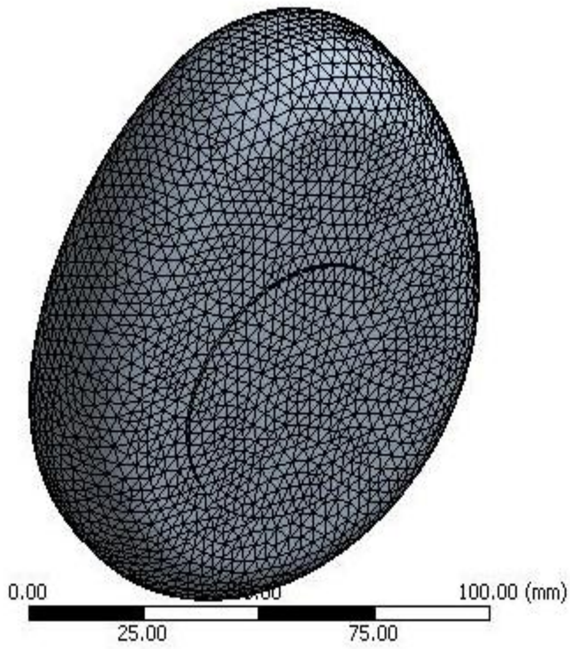

Figure7: Meshed Model of Modified Cam

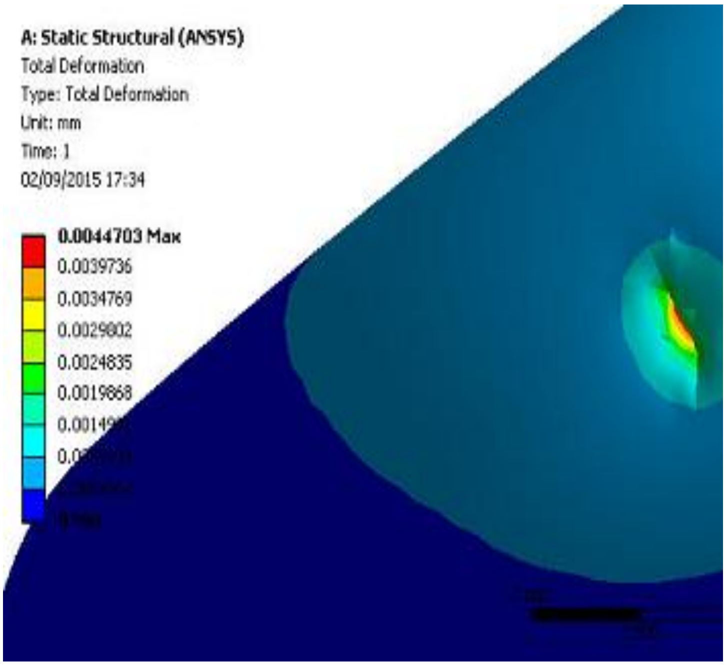

Figure 9: Magnified Image of Deformation

ISSN: 2278 – 7798

Conclusion

Load applied on existing and optimized cam is 1962N von-Mises stresses are 42 MPa max in existing cam. Where as it is 238MPa in optimized cam means five times more but still the results are acceptable because that are within safe limit.

Deformation on existing cam surface is 0.00156mm & 0.00447mm on optimized cam means four times more than existing but still is acceptable because it is within limit.

From above results it is clear that optimization is acceptable to get the benefit of low surface contact of cam and follower hence low friction so that low friction loss of energy and hence mechanical efficiency of engine must be increased by this concept of optimization.

Acknowledgment

A work of such a great significance is not possible without the help of my guide Prof. Surendra C. Patil and HOD for suggestions, co-operation & continuous guidance. It's my pleasure to thanks to my principalwho always a constant source of inspiration & always provided joyful atmosphere.

References

TusharKiran, S. K. Srivastava,"Analysis and Simulation of Cam Follower Mechanism Using Polynomial Cam Profile", *International Journal of Multidisciplinary and Current Research*, Research Article ISSN: 2321-3124, Int. Journal of Multidisciplinary and Current research, Nov/Dec 2013, pp211-220.

[1] KhinMaung Chin, "Design and Kinematics Analysis of Cam-Follower System", *GMSARN International Conference on Sustainable Development: Issues and Prospects for the GMS* 12-14 Nov. 2008.

Prof. H.D.Desai, Prof. V.K.Patel, "Computer Aided Kinematic and Dynamic Analysis of Cam and Follower",*Proceedings of the World Congress on Engineering* 2010 Vol II WCE 2010, June 30 July2, 2010, London, U.K.

Fathi Al-Shamma, Faiz F. Mustafa, Sahar M. Saliman, "An Optimum Design of Cam Mechanisms with Roller Follower for Combined Effect of Impact and High Contact Loads", *Al-Khwarizmi Engineering Journal*, Vol. 6, No. 4, PP 62 - 71 (2010).

E.E. Zayas, S. Cardona, L. Jordi, "Analysis and synthesis of the displacement function of the follower in constant-breadth cam mechanisms",*Mechanism and Machine Theory*, 44, (2009), 1938–1949.

[2] Yuan L. Lai, Jui P. Hung, and Jian H. Chen,"Roller Guide Design and Manufacturing for Spatial Cylindrical Cams", *World Academy of Science, Engineering and Technology*,Vol:2 2008-02-29.

[3] Per Lindholm, Stefan Björklund, Miguel Calvo Cortes, "Characterisation of wear on a cam follower systemin a diesel engine", *Wear*, 254 (2003), pp 1199–1207.

[4] O.E. Simolowo, M.Phil. and O.A. Bamiro, Ph.D. "Roller-Cam Systems Design: Development of Profile Analysis Software",*The Pacific Journal of Science and Technology*, Volume 10. Number 1. May 2009.

[5] J. Michalski, J. Marszalek, K. Kubiak, "An experimental study of diesel engine cam and follower wear with particular reference to the properties of the materials", 2000, *Elsevier Science*, *Wear*, 240, 2000, pp168–179.

ISSN: 2278 – 7798