

Modeling and Analysis of Camshaft

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ABSTRACT: Aim of the research is to modeling design and analysis of a camshaft. The model is created by the basic needs of an engine with the available background data such as power to be transmitted, forces acting over the camshaft by means of valve train while running at maximum speed. The cam shaft and its associated parts control the opening and closing of the valves. The associated parts are push rods, rocker arms, valve springs and tappets. In this work, a camshaft is designed for multi cylinder engine and 3D-model of the camshaft is created using modeling software Solidworks. The model created in Soliworks is imported in for FEA analysis than completed the element properties, chose the material for the camshaft, meshing and constraints the loads are applied on camshaft. The results have been taken has deformation, thermal stress and von misses stresses for the static state of the camshaft. The load is applied on different materials like carbon steel EN-8.

KEYWORDS: camshaft, CATIA, ANSYS

I. INTRODUCTION

The camshaft is a mechanical component of an internal combustion engine. It opens and closes the inlet and exhaust valves of the engine at the right time, with the exact stroke and in a precisely defined sequence. The camshaft is driven by the crankshaft by way of gearwheels, a toothed belt or a timing chain. With a transmission ratio of 2:1, the rate of rotation of the camshaft is half that of the crankshaft.

Cam is a mechanical member for transmitting a desired motion to a follower by direct contact. The driver is called cam and driven is called follower. Cam mechanism is a case of a higher pair with line contact. Camshaft is the Brain of the engine must include cam lobes, bearing journals, and a thrust face to prevent fore and after motion of the camshaft. Valve train system for an engine is vital importance in terms of performance, fuel consumption, vibration and noise etc. Due to the fact that valve train system is main control mechanism and predetermined specified motion actor for engines, all effects on parts of systems should be considered during design process.

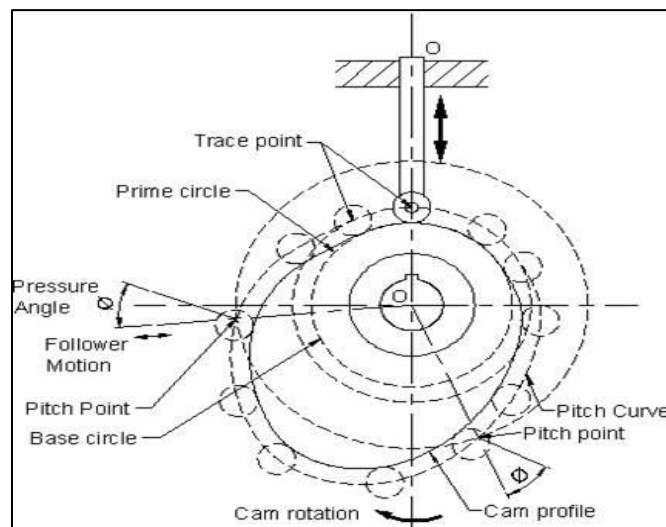


Fig.1 Cam profile nomenclature

II. LITERATURE REVIEW

Modeling, Design and Finite Element Analysis of Cam Shaft: The goal of the Research is to modeling design and analysis of a camshaft. The determination of exact load values becomes the challenging one compared with other rotating members. This Research provides the guidelines to solve such situation. The objective is to determine the stress distribution on the cam shaft for both static and dynamic case and finding out the factor of safety here the approach becomes fully CAE based. CAE based approach enriches the Research and limits the time duration. We found that the factor of safety is the ratio of yield tensile strength to the design strength for ductile materials and ultimate tensile strength to the design strength. From the FEA output the maximum design strength is 240.6 N/mm² from the material property the ultimate tensile strength of the material is 720 N/mm², then the factor of safety becomes within that safety limit [1].

Experimental and Theoretical Research of Cams Wearing of Cams Mechanism: Experimental method of cam mechanisms with roller follower sizes measuring with digital photograph treatment results interpretation is studied. These results define displacement of cam mechanisms of bending automatic press. We have defined transfer functions of velocity and acceleration, which indicate the wear of cams. Recommendations have been given on choosing the law of motion of follower framed by given cyclogram at cam recover. Sizes measurement of cam mechanism was done according to results of digital photograph results treatment [2].

Camshaft Design for an Inlet-Restricted FSAE Engine : Restricting the flow rate of air to the intake manifold is a convenient and popular method used by several motor sport disciplines to regulate engine performance. This principle is applied in the Formula SAE and Formula Student competitions, the rules of which stipulate that all the air entering the engine must pass through a 20mm diameter orifice. This, in turn, reduces the amount of fresh air entering the cylinder during the subsequent intake stroke and therefore reduces the torque produced. The objective of the study described in this paper was to mitigate the reverse flow effect by reducing the duration of the valve overlap period. A thermodynamic model of the Yamaha YZF R6 engine was developed for this purpose and validated using cycle-averaged and crank angle-resolved test data. The resulting model was then used to find the optimum values of lift, duration and timing for both the intake and exhaust valves [3].

Design and analysis of cam shaft for multi cylinder engine: The cam shaft and its associated parts control the opening and closing of the two valves. The cam lobes force the valves open by pressing on the valve, or on some intermediate mechanism as they rotate. A common example is the camshaft of an automobile, which takes the rotary motion of the engine and translates it in to the reciprocating motion necessary to operate the intake and exhaust valves of the cylinders. In this work, a camshaft is designed for multi cylinder engine and 3D-model of the camshaft is created using modeling software pro/Engineer. The model created in pro/E is imported in to ANSYS. After completing the element properties, meshing and constraints the loads are applied on camshaft for three different materials namely aluminium alloy 360, forged steel and cast iron. Material optimization was carry out to replace the traditional material with new composite alloys. Static analysis is carried out to find the displacement and stress due to loads and then modal analysis is carried out to determine the frequency values due to its geometric shape and material property [4].

An experimental study of diesel engine cam and follower wear with particular reference to the properties of the materials: The main objective of this paper is to study and experimentally quantify the cam and follower wear mechanisms of a diesel direct valve-gear. The investigation was carried out on a laboratory bench equipped with an engine head with a camshaft, followers and systems creating the conditions necessary for a routine run of the valve gear The rotational speed, valve displacement and the torque required by the valve gear were measured. Camshaft C9 and the thimble shaped followers with regulating plates F6 were also examined in a diesel engine. The effects of the materials the kinematic pair was made of, heat treatment and thermo chemical treatment, the cams' own stresses at the moment-of-friction value, as well as the extent and nature of element wear, were analyzed. Q 2000 Elsevier Science S.A. All rights reserved. Typical cam shapes after wear demonstrate that the attack side wears out more than the taper side. Cam overheating during induction hardening increases the thickness and hardness of the hardened layer, the amount of retained austenite They run more or less perpendicularly to the direction of the sliding on the follower surface. The faces of the mating followers show a number of tear-outs and some delimitation wear on the surface and the cementite plates are broken. The formation of a nitrided layer on the hard and thick martensitobainitic matrix of cams C5 ensures its small radial wear. The cams undergo smooth abrasive wear. The followers also undergo smooth abrasive wear of a small value. Nitridingpearlitoferrit cast iron results in considerable wear of the C3 cams. Mating with a follower made of toughened, surface hardened and ionitrided steel ensures

small frictional resistance and less abrasive wear with regard to tribologic wear. This material pair of the friction kinematic pair is recommended [5].

III. METHODOLOGY

- First we chose the design of the camshaft of Honda Civic.
- Than create the part on CATIA (Computer aided three dimensional interactive application) so that we see the isometric view of the part.
- Than the FEM Analysis will do.
- Than FEA analysis on ansys.
- Preprocessor of the part will done.
- Solution will obtain from the ansys software.

Designating CAD DATA

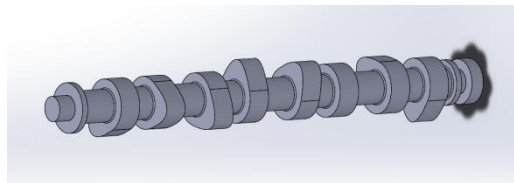


Fig No. 2: CAD Model of camshaft

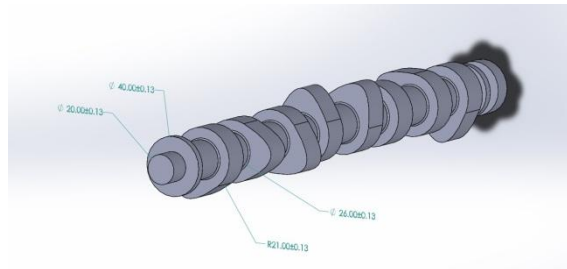


Fig No. 3: Dimensions of the camshaft

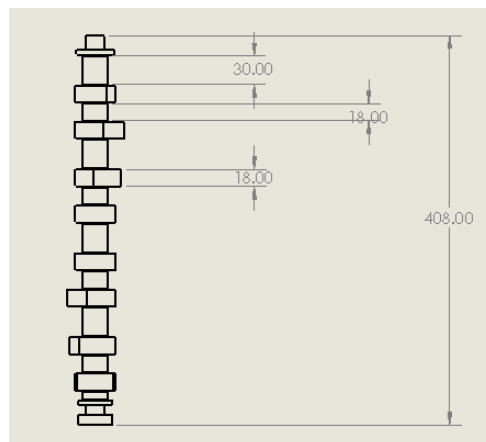


Fig No. 4: Distance between two cam and separation between two conjugative cylinders



IV. CALCULATIONS

Diameter of bore (D-bore) = 75mm = 0.075 m.

Length of stroke (L) = 94.4mm = 0.0944m

For continuity equation,

$$A \times V = C$$

$$A_c = \pi/4(D_b)^2,$$

where A_c = Area of cylinder

$$= \pi/4 (0.075)^2$$

$$= 4.417 \times 10^{-3} \text{ m}^2$$

$$V = 2LN/60$$

N = Speed of piston

$$= 2 \times 0.052 \times 8000/60 = 20 \text{ m/s}$$

$$Q = A_c \times V = C$$

$$Q = 4.417 \times 10^{-3} \times 20$$

$$= 0.08834 \text{ m}^3/\text{sec}$$

Inlet valve:

Velocity = 145 m/s

$$\pi/4 \text{ dip}^2 \times V_{ip} = A_c \times V$$

V_{ip} = velocity of inlet port.

$$\pi/4 \text{ dip}^2 \times 145 = 0.08834$$

dip = diameter of inlet port.

$$\text{dip}^2 = 0.08834 \times 4/(\pi \times 145)$$

$$\text{dip}^2 = 0.000775 \text{ m}$$

$$\text{dip} = 2.785 \times 10^{-2} \text{ m.}$$

$$\text{dip} = 27.85 \text{ mm.}$$

Design Of Camshaft:

Diameter of CamShaft = 26 mm.

Base circle diameter:

$D_{\text{base circle}} = 42 \text{ mm.}$

Width of cam:

Width of Cam = 18 mm.

Forces:

Force (F) = $F_{\text{spring}} + F_{\text{inertial}} + F_{\text{frictional}}$ (ignored)

Forces on inlet cam:

$$F = F_s + F_i$$

F_s = spring force.

F_i = inertial force.

$$\text{div} = \text{dip} + 2(0.05 \text{ dip to } 0.07 \text{ dip})$$

$$= 0.02785 + 2(0.05 \times 0.02785)$$

$$= 0.03072 \text{ m.}$$

d_v = Valve diameter.

$$F_s = 703.33 \text{ N}$$

$$F_i = m v \times a v.$$

$$m v = 40 \text{ gms.}$$

Speed of camshaft (N) = 8000/2

$$= 4000 \text{ rpm.}$$

In degrees per sec = $4000/60 \times 360^\circ$
 = $2400^\circ/\text{sec}$.
 $t = 58^\circ / 24000^\circ$
 = 2.4166×10^{-3} sec.

Acceleration:

$h_v = ut + \frac{1}{2} a t^2$ [u=0]
 $10.5211 \times 10^{-3} = (0) (2.4166 \times 10^{-3}) + 0.5 \times a v \times (2.4166 \times 10^{-3})^2$
 $10.5211 \times 10^{-3} = 0 + 2.9210 \times 10^{-6} a v$
 $a v = (10.5211 \times 10^{-3}) / (2.9201 \times 10^{-6})$
 $a v = 3626.7149 \text{ m/s}^2$
 $F_i = 40 \times 3626.7149 \text{ N}$
 $F_i = 149 \text{ N}$
 $F_i = \text{inertial force.}$
 $F_t = F_s + F_i$
 $= 703.33 + 149$
 $= 852.33 \text{ N.}$

V. ANALYSIS

FEA Analysis

Mesh

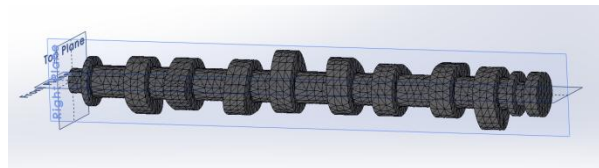


Fig.5 Loading and Constraints

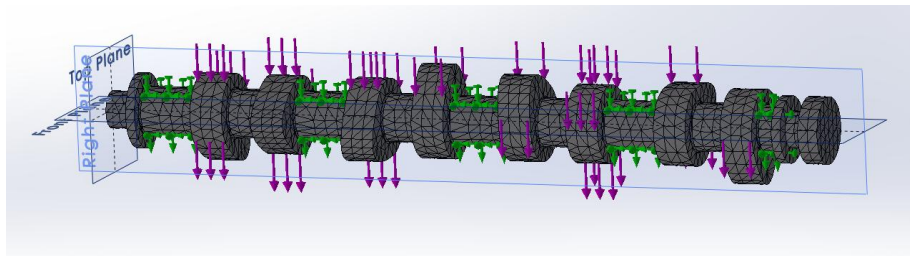


Fig.6 Loading and Fixing Geometry

Von-Mises Stress

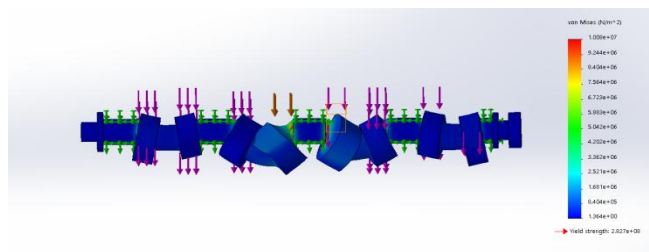


Fig. 7 Von-Mises Stress

Displacement

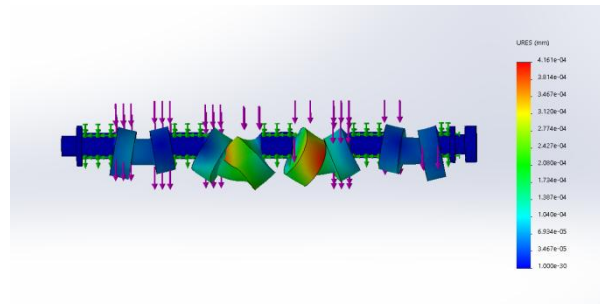


Fig.8 Displacement

Strain

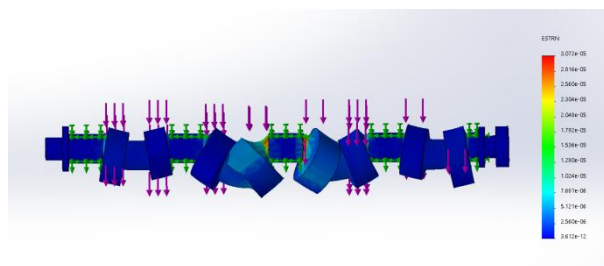


Fig.9 Strain

VI. CONCLUSION

The analysis which was done demonstrated that camshaft stress distribution can be predicted through Finite Element Analysis application tool. The structural static analysis and has been done. EN8 can bear more stresses compared to currently used materials that are gray cast iron and chilled cast steel.

Considerable drop in the maximum values of Von – Misses stresses, Displacement (deflection) and strain was observed. Hence accordingly the weight of the camshaft can also be significantly reduced by using carbon steel en8 materials. Hence respective dimensions can be altered according to the space requirements in the cam shaft cabinet which will help in reducing weight of the components and hence inertial forces which will again reduce the net force acting on the cam and cam-shaft assembly.

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