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Failure Analysis of Camshaft - A Review

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Abstract:- Below stated paper presents a review of static, structural still as model analysis of engine camshaft. the Camshaft is nothing but a significant substance within the engines of automobile vehicles and other applications. Camshaft plays a significant role in or smooth and efficient working of engines. The goal of the project is to style camshaft with its modelling and analysis under FEM. Nowadays, the leading camshaft manufacturers have developed the varied schemes of cam profile for the goal of obtaining an optimistic & efficient engine performance. Since the engine operation deals with high load and high speed, it's mandatory to analyse the failure of engine components under this simultaneous loading. Till date, many analyses are distributed on the failure of the engine components. The analysis is completed by various software, Nowadays ANSYS could be a popular one within the industry.

As camshaft is a mechanism used to operate engine valves with proper opening/closing timings, it is continuously subjected to high speed rotational movement causing vibrations in the system. They are also subjected to varying contact fatigue loads because of contact between plunger and the cam. Due to these fluctuations in loads and speeds, it will result in vibration and fatigue failures of the shaft.

Hence, model, still as fatigue analysis have to be distributed on the camshafts for the enhancement of safety still because of the lifetime of the member. during this thesis, a numerical finite element technique was applied on an engine camshaft model to hold out the above- mentioned analysis of engine camshaft. Primarily, the camshaft was designed in CATIA software and so prepared during a STEP format for further analysis. Then this model is then spooled in ANSYS software, to get the natural frequency, mode shapes and also the fatigue alternative stresses of the camshaft member.

Keywords:- *Stress Analysis, Modal Analysis, Fatigue analysis, Finite Element Analysis, ANSYS, CATIA*

I. INTRODUCTION

Cam could be a nothing but a mechanical element utilized in engine valve mechanism for transmitting a particular motion to its follower utilizing direct contact. during this pair of a cam and follower, cam plays the role of driver, simultaneously follower plays the role of the driven element. Cam and follower mechanism is an example of a better pair with line contact.

The Camshaft is nothing bur chief constituent of engine valve mechanism which has cam lobes, bearing journals, and a thrust face to limit the undesirable motions of mechanism. the entire and sole application of camshaft within the engine is to work the inlet & valve as per the stroke timings using motion transfer through direct contact. If the transfer of motions has not occurred during a proper way, then it'll directly affect the valve timings leading to reduced efficiency of the engine strokes. For obtaining precise work of camshaft, all motions related to this mechanism are studied, analysed and designed optimally. instead of major elements camshafts also contains minor parts like push rods, rocker arms, valve springs still as tappet. In the working of this mechanism, the camshaft is operated with the help of crankshaft. Using some timing gears in keeping with the engine strokes. When camshaft gets the motion, it'll be transferred to many engine valves in keeping with suction exhaust cycles to see the order of firing of the engine.

Coming to the failure part, Fatigue failure of the associated components of the camshaft generally develops which tends to strain concentration within the geometric figures like cavities, cracks, cuts and edges. also the resilience along with high cycle fatigue behaviour. a number of the common incidents leading to camshaft failure are contact fatigue, inadequate greasing and cam wear. Thus it becomes important to analyse the fatigue phenomenon to see the conditions of failure thanks to fatigue. so it will be neutralised. A vital objective of the various experts working in the research and development team is to presume breakdowns and prolong the operating life of camshaft.

There are several specifications on which, the efficiency of the camshaft alters. some of them are cam specifications, lift contour, valve train composition and also the various manufacturing techniques. Several manufacturing industries are making worthy efforts to analyse and optimize the effect of grinding on the operating life of the camshaft. The lobes of the Camshaft are grinded accurately to get the desired surface finish and also the lift contour. Thus It is found that the service life of the camshaft, depends on the strategy of grinding implemented (Offensive, conservative or soft). There are several steps involved in the manufacturing as well as grinding of camshafts. During grinding of camshafts, thermal stresses will be generated which causes thermal damage to camshafts resulting in reduced output rates of the camshaft. Thus, it is important to obtain a smooth link between the grinding process and the engineering design of camshaft to obtain high rates of production with higher efficiency.

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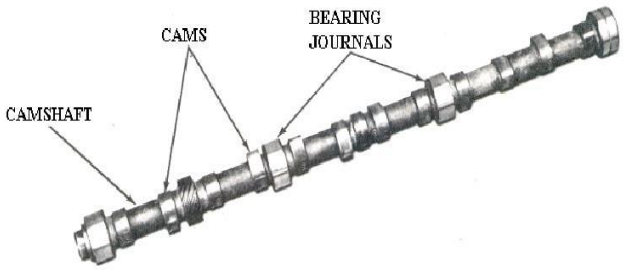

Fig 1:- Camshaft

II. LITERATURE SURVEY

The several works of literature are reviewed related to failure analysis of camshaft assembly.

A.S. Dhavale and et.al.[1] During this article studied Modelling and Fracture Analysis of the camshaft to style good mechanism linkages the dynamic behaviour of the components must be considered, this includes the mathematical behaviour of the physical model. For this instance, the presentation of two mass, single level of opportunity and different level of flexibility dynamic models of cam supporter frameworks are examined.

Bayrakceken and et.al.[2] During this paper they explained the fracture analysis of camshaft assembly of an automobile fabricated from nodular cast-iron. The analysed camshaft is fractured after an awfully short period of usage of the car. For the determination of the failure reason, the microstructure and chemical compositions of the camshaft material are determined. Some fractographic studies are applied to assess the fracture conditions. Stress analysis is additionally applied by the finite element technique for the determination of highly stressed regions on the camshaft.

Dr P.s. Chauhan and et.al.[3] studied the finite element analysis of the camshafts assembly of assorted materials with Different meshing conditions has been conducted within this work. SolidWorks and ANSYS Software are used for drafting and FEA analysis of camshaft respectively.

G. Wanga, D. Taylor and et.al.[4] During this paper explained Camshafts fabricated from grey cast-iron and utilized in Rover vehicles were tested under cyclic bending and torsion and modelled using FE. a fresh technique brought up as crack modelling was accustomed to predict the fatigue limit. the tactic uses a linear elastic finite element analysis to derive constant stress intensity factor (K) for stress concentrations in components.

Levent Cenk Kumruog˘lu and et.al.[5] within the study, the mechanical and metallographic properties of camshafts produced from chilled cast-iron were examined experimentally and numerically relating with the solidification, cooling rate and metal flow. First of all, with the help of the 3-dimensional drawing and elegance programs, the total casting methodology was planned. This planning was analysed with casting simulation software After those camshafts were produced experimentally at the foundry.

Li Fengjun, Cai Anke and et.al.[6] During this paper conducted the of the fracture failure of the camshaft is that a too strong chilled trend existed within the transition region. Visual section characteristic shows nearly white, the microstructure of fracture zone is Ledeburite, and its hardness is additionally beyond the range of the standard.

Mutukula Pavan Kumar and et.al.[7] within the study Modelling and analysis of camshaft is completed. Modelling of a camshaft is completed in solid works 2016 design software. Static analysis is applied in Ansys workbench 16.0. a Load applied is 850N and materials applied are 42CrMo4 (special alloy steel), Aluminium Silicon Magnesium Alloy and Magnesium Alloy. Structural deformations like stress, deformation and strain are studied and tabulated.

Santosh Patil, S. F. Patil and et.al.[8] During this paper studied Camshafts rotate at high speeds causing vibrations within the system. Camshafts are subjected to varying contact fatigue loads due to the contact of the plunger on the cam. because of these fluctuations, vibration and fatigue failures occur on the shaft. Hence modal and fatigue analysis need to be applied on the camshafts to form sure safety and to work out the lifetime of the member. during this study, a numerical finite element technique was applied to on the camshaft model to carry out the above -mentioned analysis. The camshaft was modelled in CATIA software and exported in STEP format for further analysis. The ANSYS software was then employed, to induce the natural frequency, mode shapes and thus the fatigue alternative stresses of the camshaft member.

S.G.Thorat, Nitesh Dubey and et.al.[9] During this article they conducted the design and analysis of the camshaft utilizing finite element analysis. the target of the task is to plan camshaft diagnostically, it's displaying and examination under FEM. In FEM, the conduct of camshaft is acquired by conduct the mixture conduct of the components to influence the cam to shaft robust within the least conceivable load cases.

Samta Jain and et.al.[10] During this paper studied Static Structural and Modal Analysis of Engine Camshaft using ANSYS Software. This paper presents a review of modelling, static structural analysis and modal analysis of engine camshaft. the Camshaft is one among the important parts within the engines of an automobile and other vehicles. This camshaft rotates at high speeds causing stress and vibrations within the system. Camshafts are subjected to varying contact fatigue loads due to the contact of the plunger on the cam. Camshafts are rotating components with a critical load. These exact values are needed to be determined to avoid failure within the camshaft.

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Uma Mahesh and et.al.[11] During this paper studied the Computational geometric modelling and finite element structural analysis of automobile camshaft within this work we are designed Automobile camshaft by Numerical Calculations thereafter it's Designed by using Modelling software CATIA and CAE(Structural) Analysis is applied in ANSYS-WORKBENCH by varying three different materials Cast-iron, steel and ALMMC to analyze which material will give the best performance for camshaft.

Vivekanandan.Pa and et.al.[12] During this study they conducted Modelling, Design and Finite Element Analysis of Camshaft. The goal of the Research is to modelling design and analysis of a camshaft. In FEM, the behaviour of camshaft is obtained by analysing the collective behaviour of the weather to create the camshaft robust within the least possible load cases. This analysis could be a crucial step for fixing the optimum size of a camshaft and knowing the dynamic behaviours of the camshaft.

Wanjari and et.al.[13] During this paper studied the failure of the camshaft. They studied that there are two kinds of arrangements single overhead cams and double-overhead cams. They told that in double overhead arrangement one head has two cams and are usually utilized just in case of engines having four or more valves per cylinder.

III. FINDINGS ON LITERATURE SURVEY

- There are various elements which cause camshaft failures like material properties, engine speed, engine load, lubricant properties, etc.
- To avoid failure of camshafts, primarily conditions of failures are determined by analysis of respective failure parameters.
- Camshafts are subjected to high-speed rotational movement at fluctuating loads which causes vibrations within the system. As there's live contact between plunger and cam, camshafts also subjected to varying contact fatigue loads. As a result of these fluctuations, vibration and fatigue failures occur on the shaft.
- A numerical finite element technique was applied to an engine camshaft model to carry out the analysis. The ANSYS software is then utilised to define the natural frequency as well as various stress values which develops in camshafts while its operation.
- ANSYS can co-operate with plenty advanced engineering techniques virtually and promptly. advanced engineering techniques and CAD systems are unified within the ANSYS technology to obtain unique automation and performance.

IV. CONCLUSIONS

From this thesis, the following conclusions have been summarized below:

- Camshaft plays vital role in engine performance by improving the preciseness and efficiency of operation of valve timings & maintains optimistic firing order of engine.
- In this thesis, we studied & analysed failures in the camshafts as well as effect of those failures on the engine performance. Major reasons for camshafts are, Geometrical stress concentrations, Fluctuations in engine loads and speeds, Fatigue, Material damages or some weakness. We also aimed at upgrading the operating life of the camshaft by rectifying the failure probabilities.
- To predict and avoid the premature failure of the camshaft, we need to consider and analyse all the factors which results in failure of camshaft and then design it. Vibration can also be the reason for any failure. So for analysing and rectifying vibration and resonance phenomenon, have to determine the natural frequency to minimize vibration and resonance phenomenon.
- In this thesis, the modal analysis carried out using ANSYS software. The alternating stress calculated using the ANSYS module. The figures generated from software analysis are then conventionally compared to theoretical stress values.

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